University of Dhaka

NEUROIMAGING AS AN ASSESSMENT TOOL IN THE MANAGEMENT OF SPEECH AND LANGUAGE DISORDERS ASSOCIATED WITH CEREBROVASCULAR DISEASE

By

DR. SADIA SALAM

Registration Number: 137

Academic Year: 2016-2017

A Thesis submitted in Partial Fulfilment of the Requirements for the Degree of Doctor of Philosophy in Communication Disorders

Department of Communication Disorders

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Declaration

I hereby declare that the thesis is entirely my original work and has not been submitted for any other award. All the quotations, citations and summaries have been duly acknowledged.

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This Thesis is an attempt to consolidate and document all the research, related activities and analyses carried out under the supervision and guidance of the research supervisor during the research period from August 2017 to August 2021. All the background, communication, data collection, analyses, results, interpretation & discussion have been presented in this thesis for evaluation of the research effort & progress made since registration for future reference. Ethical approval was taken from the respective authorities and informed consent was obtained from patients.

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Abstract

Rationale: Post stroke aphasia is a common condition. About 60% stroke patient suffer from aphasia in varying degree of severity after an episode of stroke. Lack of a baseline assessment of aphasia, many patients deprived from appropriate long-term management of aphasia. No quick assessment tool in available in Bengali language yet. Again, application of a proper assessment tool in native language might be helpful to find out the demographic variation among Bengali population. Neuroimaging correlation with the clinical assessment can be useful for speech and language therapist in terms of prognosis.

objectives: The dilemma is still present about the neuroimaging findings and clinical correlation of speech disorders after cerebrovascular events. However, the aim of this study is to identify the brain areas applying the techniques of neuroimaging predominantly affected in different types of aphasia with the routine application of a novel aphasia assessment tool in native language. This might be helpful and guide the speech and language pathologist in course of long-term management of patients.

Methods: A retrospective study was conducted among 131 patients, 89 males and 42 females, with stroke within 14 days with speech impairment. The average age is 60.52 of whom 58.8 % were hypertensive and 42.7 % were diabetic and 98.5 % righthanded. Aphasia was assessed by "Hakim-Sadia's smart aphasia assessment tool" and categorized in Broca's, Wernicke's, and Global Aphasia. 106 patients had unenhanced CT scan and 25 patients underwent MRI.

Results: Among 131 patients, 80% had Broca's Aphasia, 18.3 % with Global aphasia and the rest 1.5% had Wernicke's aphasia. Total 23 areas with ischemic change were identified through neuroimaging. In case of Broca's Aphasia, 44.8% patients presented with generalized brain atrophy with peri ventricular ischemia (P= 0.094). On the other hand, Wernicke's Aphasia is associated with lesions in sylvian fissure (P= 0.000) and Global Aphasia was associated with lesion in the left middle cerebral artery territory (P= 0.000).

Conclusion: Neuroimaging, the most objective method for diagnosing brain pathology, can validate the clinical assessment of aphasia and the correlation of finding about the lesion site, side and size can be predictor for the prognosis of post ischemic aphasia. Wernicke's Aphasia and

Global Aphasia was associated with lesion sites, the sylvian fissure & right thalamus and the left MCA territory, respectively. In case of Broca's Aphasia, no association was found, rather the lesions were scattered throughout brain. However, Patients with generalized brain atrophy with peri ventricular ischemic change usually presented with Broca's Aphasia.

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Abbreviations and Acronyms

BDAE-Boston Diagnostic Aphasia Examination

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CT- Computed Tomography

CNS- Central Nervous System

DM- Diabètes Mellites

ESS- European Stroke Scale

GCS – Glasgow Coma Scale

H-SSAAT 19- Hakim- Sadia's Smart Aphasia Assessment Tool 2019

HTN- Hypertension

LSH- Left sided Hemiparesis

MRI- Magnetic Resonance Imaging

MCA- Middle Cerebral Artery

NIHSS- National Institutes of Health Stroke Scale

PET- Positron Emission Tomography

RSH- Right sided hemiparesis

SPECT- Single Photon Emission Computed Tomography

WAB- Western Aphasia Battery

Chapter One

Introduction

1.0 Background and Statement of the Problem

Different countries have different protocols, techniques, and expertise to manage a specific health problem. Stoke is leading health problem all around the world. Aphasia is one of the common morbidities resulting from stroke. Stoke can only be accurately diagnosed by a preliminary Neuroimaging technique. There are various Neuroimaging techniques available throughout the world. Availability and expense are the main factors to choose an imaging technique in a specific setup. As the stoke assessment is primarily depends on imaging, it can easily be assumed that aphasia is also somewhat dependent on imaging for primary assessment. Moreover, the treatment, management and prognosis of stroke are also depending on the imaging findings. Similarly, aphasia management and prognosis are also closely related to the imaging findings. To choose the right imaging technique is particularly important, the correct and proper interpretation of imaging is equally important. More important is to understand the language of imaging interpretation for the personal of different specialties both the clinician of stroke department and for the personals or health professional related to aphasia management, the speech and language pathologist. A bridging or collaboration is required with these three departments with different tools applying in one patient. Everyone is doing his specific job form different department with specific protocol, but the goal is same for all health personals. The better management of the patients, proper diagnosis, appropriate treatment, early recovery, less hospital stays, prevent disease as to prevent readmission, ensure good quality of life are the main factors that the health care professional keep in their mind while dealing with a patient.

Not all the sectors of health care have been developed equally at the same time. Few developed early whereas others are developing now. Neurology and Imaging has an exceptionally long story of development. Whereas aphasiology is comparatively less developed in terms of both clinical application and research. Research has been done on stroke and MRI imaging is incredible. Again, aphasiology is a very new entity for Bangladesh as the Department of Communication Disorders only established in University of Dhaka, the largest and oldest University in Bangladesh, four years back in 2015. However, the imaging interpretation might be same of similar for all countries also the stroke management might be same in same group of countries, like developed or developing countries but aphasia assessment cannot be similar for most of the countries. As the language is not same for every country. The assessment tool that has been invented for an English-speaking people might not be at all helpful for an Arabic speaking people or even for a Bengali speaking people. This variation of languages makes a necessity to do further research of every language separately to understand the nature of the problem of a specific language and the best therapy for those specific people. Like the management protocol or the imaging interpretation of developed country might be helpful and can be applied for treating stroke patients. Nevertheless, the assessment tool of aphasia for English language might not be readily applicable for Bengali language. Massive research is required to develop our own language tool that has not been done seriously in the past. For applying the better therapy of a post stroke aphasic patient, it is particularly important to perform the preliminary assessment of the patient. So, there is a basic need of developing a Bangla assessment Tool for the post stroke patient first.

In our country, patients with stroke and aphasia directly go for stoke management only. No initial aphasia assessment is done. There are several reasons of not doing it. Lack of facility, lack of manpower and expertise, limited time and so on. However, for patient parties and sometimes even to the health personal, the physical disabilities like hemiparesis or hemiplegia are more concerning than the intellectual and cognitive disabilities. They are not very convinced to do the initial aphasia assessment for the patients or they are not trained or advice to do so. The clinician took it as the matter that will deal later by the speech and language therapist. Unfortunately, the referral for the speech therapy is given after 2-8 weeks later according to the need-based symptom relieve and after finishing the initial stroke treatment. Moreover, not all the patients are overly concern about their physical and cognitive problems. The literacy rate is not remarkably high in this country. Now, it is going higher as the government took various steps for the education of the children. But the older group between 50-60 years, those experiences stroke mostly are maximum illiterate villagers. It is also said that hypertension and diabetes are particularly important modifiable risk factors for stroke though no evidence is found on the favor of diabetes or controversy is still there, but hypertension is regarded as one important known factor for cerebrovascular accident. In villages, who are more involve with the framing and manual labor, are very less concern about these risk factors by routine checkup. For them, the physical weakness is really concerning than the cognitive problems. So as soon as they are treated and feel better for the hemiparesis, they demand for hospital discharge and does not bother to meet the speech therapist after getting a referral from the clinician for speech therapy after 8 weeks later. Again, the socio-economic condition of almost 70% population does not allow them to go to the therapist after the expensive investigation and lifesaving treatment after the stroke episode. Only the solvent and educated group of patients might go for the therapy. For this reason, most of the patients with post stroke therapy are lost before reaching to the therapist. This scenario can only be changed with the active participation of the clinician for involving themselves in every step for treatment. This condition can only be changed if the emergency doctors to the neurologist take active part and some responsibilities for the initial assessment and counselling the patient to understand the necessity of aphasia therapy for the better quality of life of a patient.

On the part of the therapist, when he gets a post stroke aphasiac patient after 2 months of the episode roughly, he does not have any idea about the initial assessment state. This is because the doctors only documented it as “stroke with speech difficulties. As we know, classic aphasia and post stroke aphasia is slightly different from each other. Post stroke aphasia changes its nature and type quite interestingly with the progression of time. They also change from one type of aphasia to another type also. This means the value of initial state is extremely high. That can help therapist to understand the nature of the problem, prognosis, and the appropriate therapy for the specific patients. However, most of the developed countries have hospital database, where all the health record is available for one patient. Health professionals have access on it and can have any information that is required for treatment and therapy. Unfortunately, most of the hospital in Bangladesh, except some corporate private hospitals do not have the facility of the data base system. As a result, the hard copies of all medical documents, history papers to discharge letter from the hospital, even the referral letter are particularly important. The referral letter gives all the information to the speech therapist about his baseline condition. So ‘speech difficulty’ might be enough for the clinician for referral but really consists of a very less value in research purpose or if we want to develop anything for the post stroke aphasic patient. One example can be given for instance: GCS score. It has been used to describe the consciousness of a patients with the acute brain injury. It is particularly useful in determining the not only the baseline status of that patient but also it helps in taking crucial decision of further management of the patient, like surgical and medical management. Moreover, it gives the idea of prognosis as well. (Servadei et al., 1998)

There are few more problem on the part of therapist too. They need the complete information from the beginning, and they need to understand the imaging assessment too. As post stroke aphasia is the result of brain injury, the recovery from that aphasia is also due to some brain recovery, or lateralization. It will be extremely helpful for the patient if the therapist has a clear understanding of the area of brain damage of neuroimaging and the interpretation and correlation of the report interpreted by an expert neuro radiologist would be greatly beneficial. However, the clinical presentation is not always as similar as the corresponding brain damages. It is only possible to identify these exceptional clinical presentations when one will understand a regular finding very well. In the summary, there is no doubt to make a correlation among the emergency department, neurology, neuroradiology and speech and therapy department to understand the post stroke aphasia in Bengali population.

1.1 Rationale

After an episode of acute ischemic stroke one of the common and important presenting complain is slurring or difficulty of speech. Many patients develop aphasia of different types, with different level of disease extension and severity. Aphasia can be divided usually in seven categories. However, Broca's, Werneck's and Global are the three principal types and more commonly seen in patients. The location of these areas is anatomically closely defined and established in the literature. For example, Broca's area corresponds to opercular, and triangular parts of the inferior frontal gyrus (BA 44 and 45) and Wernicke's area corresponds to the left posterior superior temporal gyrus (BA 22). It is expected that a when a patient is suffering from a specific type of aphasia, the lesion should be found in that area. It can only be established by neuroimaging e.g., CT, MRI, fMRI, SPECT, and PET.

CT and MRI are anatomical imaging and are extremely specific to detect locations of lesion with size. In the context of Bangladesh most of the tertiary hospitals both in the government and private sectors have the facilities of performing CT or MRI in an emergency setup for stroke patients.

On the other hand, functional imaging SPECT and PET are more related with functional status e.g., blood flow & metabolism and very less specific for appropriate localization. PET scan is extremely expensive and very less available. SPECT imaging is done with radioactive substance called Tc-99m ECD. Tc-99 is imported from South Africa. The production of Tc-99 is limited nowadays which makes it difficult to import the isotope in required amount. ECD is awfully expensive brain specific medicine which is truly not feasible for our country to buy for regular services to the patients or even for research.

In the context of Bangladesh, the possible way is to establish the clinical diagnosis of aphasia through CT or MRI correlation. In case of writing a report of CT and MRI the format is quite different for the bookish anatomical location of the speech and language centres in brain. From that perspective in this study, it has been attempted to make a bridge or connection between the type of aphasia with the true anatomical site explained, identified, and interpreted by the current reporting formats of Neuroimaging in our country.

Stroke is an acute emergency condition. In an emergency setup all the assessment must be done with optimum time. For example, GCS score can be done in 1 or 2 minutes. However, it has a broad impact in the further management of a neurologic patient. Assessments of Language Processing (PALPA) (63.8%). the Western Aphasia Battery (63.2%), The Boston Naming Test (63.2%) and Boston Diagnostic Aphasia examination (50.6%) are commonly used aphasia assessment Tool (Vogel, Maruff, & Morgan, 2010). However, these are very elaborate tool that are not at all suitable to apply in the emergency setup. A new noble aphasia assessment tool will be launched for the assessment of aphasia in the emergency setup with stroke patient with aphasia. The type of aphasia with severity will be assessed initially when a patient arrives with acute stoke. Another objective of this study is to check the validation of this assessment tool correlating with the neuroimaging.

Aphasia is the commonest, recognizable morbidity after stroke (60.3%). Though it may cause serious psychological effect, but still haven't got enough attention comparing with the physical morbidity, hemiparesis (53.4%), second commonest clinical presentation (Fekadu, Chelkeba, & Kebede, 2019). Unenhanced CT and MRI, the only available imaging tool in context of Bangladesh and only 3 basic types of Aphasia Broca's, Wernicke's and Global aphasia can be identified (Heiss, Kessler, Thiel, Ghaemi, & Karbe, 1999). The anatomical location of 'concept area' is still unclear. Responsible area for conductive aphasia is arcuate fasciculus of white matter but more lesion found in supramarginal gyrus or temporo- parietal area of grey matter (Buchsbaum et al., 2011). Lesions in the brain areas causing trans-cortical motor and transcortical sensory aphasia lies within Broca's and Wernicke's areas which cannot be identified separately by an unenhanced CT scan or MRI. However, to evaluate the lesions patten in detail for each aphasia might be helpful for the speech and language pathologist who get the chance to assess the patient at least 2 months of the onset of disease after finishing treatment for all physical symptoms.

In the context of Bangladesh, no initial assessment of aphasia is made for stroke patients and the speech and language pathologist gets the referral usually for about 2 weeks to 2 months later depending on patients' medical condition. As a result, no diagnosis is made for the initial aphasia state. However, early detection is necessary, otherwise significant psychological and physical disability develop which directed to poor quality of life. Moreover, due to lack of a convenient assessment tool patients remain undiagnosed.

However, an early and quick assessment and steady and well-planned management might only result a better prognosis. Moreover, no research has reported yet regarding the epidemiology of post stroke aphasia for Bangladeshi population.

Relations between aphasia type, aphasia severity, lesion side and size need to be evaluated first by history taking, clinical examination, aphasia assessment by appropriate tool and neuroimaging. Therefore, this study is conducted to determine the current status post stroke aphasic patients by evaluating the frequency rate of aphasia type, severity and risk factors and the relations between clinical presentation and neuroimaging findings and to compare the findings with existing literatures. This relative frequency rate can be used as the preliminary reference for the further studies in post stroke aphasiology in Bengali population.

1.2 Aims & Objectives

The aim of this study is to determine accurately the type of aphasia by neuroimaging CT scan and MRI following acute ischaemic stroke and thereby using a new noble aphasia assessment tool to determine the benefit and accurate diagnosis of aphasia and predict future disease burden.

In order to do this, the specific objectives are as follows. We shall obtain CT and MRI neuro-imaging in patients with speech and language disorders following ischaemic strokes to:

a. Determine perfusion defects or cerebral lesion size and sites by CT and MRI,
b. Evaluate Aphasia type with a newly developed concise aphasia assessment tool,
c. Predict and correlate the utility of that assessment tool depending on the size, site and extent of cerebral lesions as determined by these imaging modalities.

1.3 Research Questions

1. Can neuroimaging be used to determine perfusion defect or cerebral lesion size, side, and locations effectively as an assessment tool following the development of speech and language disorders in patients with ischaemic strokes?
2. Can a new noble aphasia assessment tool validated by cerebral lesion as determi ned by CT & MRI neuroimaging predict the disease burden and rehabilitation potential in patients with speech disorders following ischaemic strokes?

Null hypothesis: Neuroimaging is not an effective assessment tool in the determination of Cerebral lesion sites, size and rehabilitation potential in speech and language disorders following Ischaemic stroke.

Alternative hypothesis: Neuroimaging is an effective assessment tool in the determination of Cerebral lesion sites, size and rehabilitation potential in speech and language disorders following Ischaemic stroke.

Chapter TWO

LITERATURE REVIEW

Neuroimaging is the most objective tool for the confirmatory diagnosis of any brain lesion. All the patient does not show the typical features or symptoms of a particular disease. Clinical examination always helpful for the provisional diagnosis. However, the confirmatory diagnosis can only be established after imaging in brain injury or lesion. Post stroke aphasia occur only after brain injury. After clinical examination, neuro-imaging assessment and correlation can only offer proper management and better prognosis.

El-Tallawy, Gad, Ali, and Abd-El-Hakim (2019) in Egypt conduct a study among all 1508 aphasic patient admitted to the neurology department and revealed that the frequency of aphasia due to stroke was 7.1%. He also stated that male was predominantly affected consisted about 57.9%. Among the types of aphasia global aphasia found to be the most common type of aphasia which was about 66.4%. Young patient, small sized lesion, and subcortical lesions were showed good prognosis. Patients with hemorrhagic stroke also showed better prognosis. However, they used an Arabic language assessment test named Kasr El-Eini Arabic Aphasia test (KAAT). For neuroimaging, Computerized tomography (CT) was mainly used, and/or MRI of the brain. Follow-up study of aphasic patients was done after 1 and 3 months and the prognostic factors that might be able to determine the aphasia recovery was age of the patient, aphasia type, size, site, and pathology of the lesion (El-Tallawy et al., 2019).

Bohra et al. (2015) conducted another study in India where he tried to find the relation between clinical presentation and anatomical location of the lesion site in the brain. He used the Hindi version of the Western Aphasia Battery (WAB) for speech assessment and all the neuroimaging of patients who experienced first time stroke and the age is over 18 years to identify type of aphasia and lesion site in brain. He concluded that among 260 of total stroke patients 27.9% was found to be aphasic which is quite similar to the previous study that discussed above. The notable the aphasia type was according to the maximum percentage, Global (33.33%), Broca's (28.3%), transcortical motor (13.33%), transcortical sensory (10%), Wernicke's (8.33%), anomic (5%), and conduction (1.67%) aphasia. He found no absolute correlation between the lesion site and the type of clinical aphasia in most of the patients with first episode of stroke. Though, he found that about 35% cases showed the typical correlation between the lesion site and the type of aphasia as per the traditional classification. According to this study about one third of the patients might be found the lesion at the right site of the brain as we expected. There are few other studies that have supported these finding. However, another study by Yourganov, Smith, Fridriksson, and Rorden (2015) also support there is no relation of lesion site and aphasia presentation. Even he identified all those areas that might probably causing the specific type of Aphasia. However, the site identified by them is hugely different from the areas that usually described in the CT and MRI report of our country. There is always a need of establish a clear and standard document for Bengali population. A correlation needs to be made with the Aphasia type and the CT and MRI interpretation, that is the current practice and what might be done to improve this trend for the benefit of patients.

According to Yourganov et al. (2015), currently most the countries are flowing the classical aphasia classification mainly given by the Wernicke- Lectium Model. They are named Broca's, Wernicke's, conduction, transcortical motor, and sensory, anomic, and global aphasia. He described another insight about of the of classification or more appropriately clinical presentation of symptoms, which is based on the arterial supply of that area. Broca's Aphasia mainly clinically present with non-fluent speech production, relatively spared auditory comprehension, and, less commonly, agrammatic sentence processing. On the other hand, Werneck's aphasia mainly presents with fluent jargon and poor auditory comprehension. In case of Global Aphasia patient is mute. It has been observed the any damage of the area supplied by the superior division of Middle cerebral artery might clinically presents the features of Broca's Aphasia. Similarly, the damages in the area supplied by the inferior division of Middle cerebral artery may represents all the symptoms of Wernicke's Aphasia. In case of global Aphasia extensive area of damage is usually visible in the brain area supplied by the Middle cerebral artery. It can easily understand that the brain area that is defined as the Broca's and Wernicke center is not as extensive as the tern defined by the total area supplied by an arterial system. This might be one of the reasons that brain lesion is not in the exact brain center as the clinical aphasia presents. The area is broader than we calculate it. From that point of view, it will be always helpful for the clinician and the speech and language pathologist to understand the nature and also for the future research if the probable areas are formulated that are more prone to show the similar type of clinical presentations. The less frequent type of Aphasia is transcortical motor which is thought to be presents by the damage of the brain area supplied by anterior cerebral artery and area between anterior cerebral and middle cerebral artery (Hillis, 2007). Anatomically this area is situated just anterior and superior to Broca's area (Freedman, Alexander, & Naeser, 1984). Another similar type of Aphasia, that is transcortical sensory is assumed to be found if any damage occurs in the area supplied by the posterior cerebral artery and area between posterior and middle cerebral artery. Anatomically the lesion is found around the Wernicke area (Alexander, Hiltbrunner, & Fischer, 1989). In case of Global Aphasia usually both the centers are found to be damaged as large lesion is found in the area that is supplied by the middle cerebral artery (Mazzocchi & Vignolo, 1979).

On the contrary, just the opposite result was also found in many studies that is on the favor of having strong relation with aphasia type and lesion site according to the classical classification. One of these studies was conducted by Yang, Zhao, Wang, Chen, and Zhang (2008) in China in conducted another study to find out the correlation of various type and characteristics of post stroke aphasia with the brain lesion by MRI in the acute stage of aphasia. About 325 patients lesion sites were identified through MRI imaging. The MRI was done within 1 week of the onset of stroke. Speech and language or the post stroke aphasia was evaluated by the Western battery aphasia (WAB) test and the Boston diagnostic aphasia examination (BDAE) respectively for standard severity grading. Within the 325 patients who demonstrated clinical signs of aphasia, two hundred and eighty-eight cases were located within classical language centers while 37 cases were located at other sites. The study concluded that 95% post aphasic patients lesion correlated with the classical lesion sites. However, though the percentage is extremely low, but a very few cases had lesion in the Broca’s, and Wernicke’s area did not have any language difficulty. The study also revealed that 25% patients had Broca’s Aphasia, Global 16% and 14% had Wernicke’s Aphasia. This paper is a strong evidence of lesion site correlates with specific aphasic disorders fit classical data associated with previous aphasia research and if so, prognosis is poor for those patients. Consequently, this paper demonstrates the power of MRI in prognosticating the potential for a patient to recover from aphasia due to stroke.

In this context, another review was done by Musa-Mamman and Salisu-Abdullahi (2015) that revealed that about 20-40% patients with stroke develop aphasia. It is an acquired language disability and the probable important factors to determine prognosis were not only lesion size, site, aphasia type, severity but only the hemodynamic factors or responses as a result of the treatment. However, he gave emphasis on neuroplasticity and the treatment the patient is getting. A time bound early treatment might be particularly good for reestablishing the damaged circulation as well as less brain damage occur. He added, there was completely no role of the demographic factors like age, gender, education, or family history.

The first Brazilian cohort study regarding post stroke aphasia was conducted in 2019 only tried to find out the prevalence rate of aphasia after first time ever stroke. The National Institute of Health Stroke Scale (NIHSS) had been used by the neurologist to diagnose aphasia. They revealed that 22.6% patients only affected with aphasia after stroke. They also found that the age was more, and chances of severity was higher in post stroke aphasic patients They also reported that among the stoke patient's mortality is higher in the patients who had existing aphasia and the mortality rate was more. It was double in post stroke aphasic patient than in the post stroke non aphasic patients which was respectively 24.1% and 10.7%. Also, the application of thrombolytic therapy and hospital stay was higher in patients with post stoke aphasia than post stroke non aphasia, 21.32 days and 17.46 days respectively (Lima et al., 2020).

Regarding the severity assessment, an interesting study was conducted by Korean researchers among 97 post-stoke aphasic patient to explore the relations between post-stroke aphasia severity and aphasia type and the lesion location. All the patients had the onset of disease within 90 days of onset and diagnosis confirmed with MRI imaging of unilateral left hemispheric stroke and had treatment accordingly. The speech and language were assessed by the Korean version of the Western Aphasia Battery (K-WAB) and severities of aphasia were quantified using WAB Aphasia

Quotients (AQ). By the Magnetic resonance imaging (MRI) the lesions were divided in only two groups, cortical and subcortical lesions, respectively. Lesion's locations were classified as cortical or subcortical and were determined by MRI. They concluded that Global Aphasia is the most severe form of all aphasia. The proposed severity classification was, 1) mild; anomic type, 2) moderate; Wernicke's, transcortical motor, transcortical sensory, conduction 3) moderately severe; Broca's aphasia, and 4) severe; global aphasia. On the basis of location there were three severity group.1) mild; subcortical 2) moderate; cortical lesions involving Broca's and/or Wernicke's areas, and 3) severe; insular and cortical lesions not in Broca's or Wernicke's areas (Kang et al., 2010).

A research has been done by Shuster (2018)on the utility and appropriate use of the neuroimaging technique. Neuroimaging can be used as a predicting factor. After stroke at least one third patients suffer from the aphasia. Families are worried and eagerly asked about the prognosis of a post stroke aphasic patient. Neuroimaging has an important role in aphasia assessment. So, they reviewed existing all publication and adapted a model that might be useful step toward initiating a discussion of how neuroimaging biomarkers of recovery could be employed clinically to provide improved quality of care for individuals with aphasia (Shuster, 2018).

Modern views on the architecture and function of the brain are quite different from the old classical theory. The specific subtypes of aphasia are associated with specific centers within the language area. A study was conducted which included 221 post stroke aphasic patients who particularly had lesion on the territory of the middle cerebral artery (MCA) and were evaluated with CT scan with a standardized grid model. They found absolutely no association between type of aphasia and lesion site (Willmes & Poeck, 1993).

Many researchers have proven that there is no relation between the location of lesion and the aphasia presentation. Some patients had lesions in the basal ganglia and of the head of the caudate nucleus but producing aphasia (Willmes & Poeck, 1993). It should be kept in the mind that aphasia changes its pattern, as well as the localization become difficult to match with clinical presentation due to the plasticity in the presence of a stable lesion and for the impact of the neurological condition that has produced the lesion.

Another study was directed by Blunk, De Bleser, Willmes, and Zeumer (1981) to see the lesion site and correlate with aphasia types. They used a grid model of the brain, sliced in five portion and qualitative and quantitively analysis were performed. Data were analyzed for 70 patients having Broca's, Wernicke, and global aphasics. The result was found positive for the Wernicke's Aphasia. The lesion of Wernicke's aphasia was in the Wernicke's area. On the other hand, the lesion for Broca's aphasia was found to be in the insular cortex of the frontal white matter. This study was designed about 40 years back. However, we are planning to see the correlation today. One should keep in their mind that they have those facilities in 80's whereas in our country we don't have them properly even today. However, the journey of this endeavor of clinical aphasiology needs to be started at some point. Mapping software is available in our country but still not routinely. A correlation should be made on the real scenario so that a systemic need-based protocol can be established for the management of post stroke aphasia.

Cerebral lateralization, plasticity, crossed aphasia are the few important factors that might be counted during making the relationship with different type of aphasia and the lesion site. In general, it is expected that the righthanded person has a dominant left hemisphere and lesion should be on the left side for having any presentation of aphasia. This is also not always true. In 1989, it was reported that two female patients had stroke in the left side and were presented with global aphasia. With time gradually they recovered. However, few years later they had stroke on the right side and the aphasic condition worsen (A. Basso, Gardelli, Grassi, & Mariotti, 1989).

Bakar, Kirshner, and Wertz (1996) formulated another report with three aphasic patients, two with Global aphasia and one with Broca's aphasia underwent both anatomical imaging, CT scan and the functional imaging, Single Photon Emission Computed Tomography (SPECT) and Positron Emission Tomography (PET) and analyzed. They were all righthanded with the lesion detected on the right hemisphere. Aphasia secondary to lesions in the right hemisphere with right-handed patients is due to cross aphasia. Functional imaging like Positron Emission Tomography (PET) or Single Photon Emission Computed Tomography (SPECT) was performed to see whether left hemisphere structures were metabolically depressed during the acute phase and, in 1 patient, during recovery; and to review the modern literature on crossed aphasia, with special reference to left hemisphere involvement.

Another report was done for three right-handed patients with crossed aphasia secondary to acute infarctions in the right hemisphere and left hemiparesis. They underwent serial testing with the Boston Diagnostic Aphasia Examination. Two patients had severe Global aphasia and one had Broca's aphasia. In all cases, Computed Tomographic scans failed to reveal any left hemispheric lesions. Functional imaging with PET or SPECT showed extensive hypometabolism or hypoperfusion in the right hemisphere, with initial reductions in the left hemisphere as well. Functional imaging with PET or SPECT presented extensive hypometabolism or hypoperfusion in the right hemisphere, with initial reductions also in the left hemisphere of the brain. It was because of crossed Aphasia or Diaschisis, the left hemisphere showed depression in the acute phase of disease. One patient with Broca's aphasia started recovering and did not show any hypoperfusion or hypometabolism in left hemisphere in the acute phase. However, abnormal dominance for example right dominance has some language function due to crossed aphasia (Bakar et al., 1996).

The neural mechanism is under evaluation of aphasia recovery after left hemispheric stroke. According to the old theories, right hemispheric activation is helpful in case of left hemispheric chronic stroke. Whereas recent studies are suggesting right hemispheric involvement is not helpful rather disadvantageous as described above. Study was conducted among 32 left hemisphere stroke survivors with aphasia underwent language assessment with the Western Aphasia Battery-Revised (WAB-R) and regression-based lesion-symptom mapping and voxel-based morphometry a novel combination of support vector regression-based lesion-symptom mapping and voxel-based morphometry to determine whether local grey matter volume in the right hemisphere independently contributes to aphasia outcomes after chronic left hemisphere stroke. Finally, they stated that gray matter of right hemisphere is involved in speech and language production when the left brain is suffering from chronic stroke. For evidence, they found that the grey matter structure of right hemisphere posterior dorsal stream has showed hypertrophy after a stroke in left hemisphere causing aphasia (Xing et al., 2016).

From the above discussion, we found that the lesion site might or might not correlate with the clinical presentation of aphasia. Again, patients might be left or right-handed and the lesion should not be always on the dominant side due to brain lateralization, plasticity, crossed aphasia and so on. Prevalence of type of aphasia might vary in chorology in different country in different races might not be similar throughout the world. Scientists has an urge for an aphasia assessment tool in their native language despite having internationally accepted aphasia tool, for example, Western Aphasia Battery (WAB) and Boston Diagnostic Aphasia Examination (BDAE) etc. These tools are very elaborative and time consuming as the result many countries already develop need based quick assessment tool keeping an eye on their own language. Similarly, Imaging tool selection varies with different countries in different decade according to their availability, feasibility, expense, and development.

Chapter Three

THEORETICAL ASPECTS

Stroke is one of the leading causes of mortality and morbidity throughout the world. People of Bangladeshi and South Asian heritage are at a high risk of cardiovascular events (Lopez, Mathers, Ezzati, Jamison, & Murray, 2006). Strokes may be ischaemic (85%) or haemorrhagic (15%) in nature. Aphasia is the most frequent, commonest, and easily recognisable morbidity. In addition to the physical effects, aphasia has significant psychosocial impact on patients' quality of life. The second most clinical presentation or morbidity is hemiparesis where the physical disability is very prominent and often draws more attention than speech problems. However, the incidence and prevalence rate of different type of post stroke aphasia is different from the aphasias caused by reasons other than vascular events. The nature and type of post stroke aphasia may evolve over time. The complex recovery system of the central nervous system, brain plasticity and lateralization along with environmental support such as speech and language therapy can regulate, often unpredictably the course of the recovery. Research in developed countries have focused towards developing a superior understanding of this process usually using their local languages.

Neuroimaging is the most objective method to explore central nervous system (CNS) injury after an episode of stroke. Aphasia is the result of any cell injury to the speech and language centres or pathways of the brain. In general, damage to specific centres causes specific type of aphasia which can only be evident through imaging. It is particularly important to know the initial type of aphasia at the onset of disease for the purpose of treatment and to determine the prognosis.

In developed country such as the United Kingdom centralized stroke services provided to the people with stroke on designated stroke wards. This enables an early multidisciplinary assessment of speech impairment by teams which include stroke consultant/ physician, stroke specialist nurses and speech and language therapist. Early treatment on specialized stroke unit has been associated with superior prognosis. Speech assessment is an important part of initial assessment and is used in all standardized stroke assessment tool e.g., FAST, ABCD2 and ROSIER Scale. In developed countries they have the opportunity to perform an initial assessment of the speech impairment at the initial stage of acute stroke by a speech and language pathologist. Various counties have developed some concise assessment tools to document the initial state of impairment before doing the worldwide recognised elaborate assessments like Western Aphasia Battery (WAB). Usually, WAB is performed when the patient is stable after initial management.

However, in a developing country like Bangladesh standardized assessment is not possible, which has just been upgraded from least developed country, because it does not have the luxury to do all the assessment for all patients with post stroke Aphasia. In the emergency set up or in the stroke clinic there is no provision of the speech and language assessment of stroke patient. All the patients are treated for stroke only, despite of having speech impairment, they are treated for the stoke only and after finishing all the management for stroke they are referred to the speech and language clinic which usually takes about 2- 8 weeks. Unfortunately, among them only a few percentages of patients attend speech and language therapy centres. However, those patients might have changed their aphasia pattern and difficult to get that information to understand the natural process of the disability. However, there is lack of post aphasia epidemiology in Bangladesh. No research has still reported regarding this. Again, it is difficult to conduct such research due to the lack of coordination between the departments that stroke patients attend. Similarly, no initial aphasia assessment is routinely practiced or recorded, which is another drawback for us to collect sufficient data for Bangladeshi population as done in other developing countries. However, there is immense need of developing an assessment tool for our population to evaluate our language problem pattern and gradually develop epidemiology for Bengali people.

A densely populated country like Bangladesh, where health facilities and the resource personals are limited, needs a quick but simple tool to assess the initial speech problem by the junior's clinician without spending no extra time or questions for it apart from the routine questionnaires. The initial diagnosis can easily be verified by the neuroimaging technique by corelating the lesion site in brain. A correlation needs to be made among these post stroke aphasia, aphasia assessment and neuroimaging for the proper assessment, treatment, and further long term management and to predict the prognosis of aphasia.

Strokes are mainly of two types. They are haemorrhagic and ischemic. Usually, surgical management is required for the haemorrhagic stroke management. Even if the patient has aphasia, might completely resolved as soon as the pressure effect is resolved by removing the blood collection from the brain. The brain parenchyma is not damaged in those situations but only disturbed by the pressure effect of the blood that are collected due to the cerebrovascular accident form ruptured blood vessels. However, eventually there might develop some ischemia as the vessel is ruptured, though there is a lot of collateral blood supply in the brain. On the other hand, in ischemic stroke brain tissue is damaged due to lack of blood supply. Usually, thrombus in the cerebral vessels cause irreversible damage to the neuron. Neuron has no capacity to regenerate like other tissues of the body. Reduced blood supply in a certain limit cause irreversible death to the brain tissue.

Speech and language centres are in the brain parenchyma. For example, Broca's and Wernicke's area are anatomically situated in frontal and temporal region. Any damage to these areas might cause Broca's and Wernicke's Aphasia. Broca's area is responsible for speech production and Wernicke's area for speech comprehension. Another brain area named 'concept area' is also located in the brain (Hux, 2011). However, no anatomical location is still specified for concept area. It is expected that the damage of this area might cause anomic aphasia where patients have naming problem. Nowadays most accepted aphasia classification is followed by Wernicke-Lecthium model. According to this model there are 7 types of Aphasia. They are Broca's, Wernicke's, Global, Conductive, Anomic, Transcortical motor and transcortical sensory. In Broca's Aphasia patients lose the ability of properly production of speech. On the other hand, patients lose the comprehensive ability, though the speak fluently and irrelevantly, in Wernicke's Aphasia. From the above discussion, Broca's Aphasia and Wernicke's Aphasia is caused by damage to the respective centers in the brain that can only be evident by a Neuroimaging technique. Existing research shows that the Global Aphasia is caused by the larger lesions in the brain area supplied by middle cerebral artery. Sometimes the lesion in case of Global Aphasia is so large that it involves both of the Broca's and Wernicke's areas. Arcuate fasciculus is the bundle of axons situated in the inferior parietal lobe that extends into the subcortical white matter that bridges between the Broca's and Wernicke's centre. Arcuate fasciculus is the reason for conductive aphasia where the patients lose the ability of repetition only, though their production and comprehension ability are intact. Though fMRI can detect all the location accurately, plain CT scan and MRI which are the most common available facility in our country, usually unable to detect all the lesions. There is controversy regarding the location of lesion in conductive aphasia that more lesion is detected in the grey matter than in white matter. In Anomic aphasia, naming problem, patient is unable to recall and utter the name of a specific thing when it is required. Any lesion in the concept area aggravates this aphasia. Unfortunately, no specific anatomic al location is detected for the concept area yet in the brain rather than it is said that the lesion can be located anywhere in the parietal lobe. However, transcortical motor and sensory aphasia is remarkably similar to Broca's and Wernicke's aphasia, respectively. Similarly, When the connections between these two centers and the concept center are damaged, that result in these two forms of transcortical aphasias. It is also evident that lesion might be overlapping in any areas either the centers or the connecting areas which might not be possible to locate very specifically through unenhanced CT or MRI.

Protocol review for CT reporting is authorized by the American College of Radiology and the Joint Commission on the Accreditation of Hospitals (Sachs, Hunt, Mansoubi, & Borgstede, 2017). Additional steps are underway for further standardize output and reporting of imaging interpretation. However, CT & MRI report interpretation is not as straight as anatomical locations. Not necessarily, the CT reports always explains lesions in the speech and language centers directly. On the other hand, clinical presentation of an aphasic patient is not always correlated with the lesion site. However, if the site can be determined that are randomly affected and how they are named, might be helpful for the clinician and speech and language pathologist in the long-term management and therapy of the aphasic patients.

In the summary, there is a need of initial proper assessment of the type of post stroke Aphasia in the emergency stroke care system for both assessment and future research for development of Bengali Population. A short, simple, bedside tool needs to be developed for initial diagnosis of aphasia type and severity which might also give the incidence and prevalence rate of different type of post stoke aphasia in our country. The essential validation of the diagnosis of aphasia can be done by neuroimaging, namely unenhanced CT and MRI, the only available imaging tool in context of Bangladesh. Only three basic types of Aphasia like Broca's, Wernicke's and Global should be assessed as unenhanced CT or MRI can only detect the lesion site for these aphasias. A correlation needs to be made about those multiple areas that are predominantly affected as the clinical presentation and site of the lesion is not always the same. Overall, a correlation needs to be made on post stroke aphasia assessment, brain lesion, neuroimaging interpretation and the management of aphasia for Bangladeshi population.

3.1 Stroke

Globally stroke is the second leading cause of death (Donkor, 2018). Every year almost 62000 strokes occur in Canada irrespective of age group, from neonates to elderly people. However, occurrence rates are high usually by rising age. The lifetime risk of overt stroke is estimated at one in four by age 80 years, and the lifetime risk of silent or covert stroke is likely closer to 100% (Musuka, Wilton, Traboulsi, & Hill, 2015). Stroke affects men and women equally and the consequences causes a major social and economic burdens to society. It costs approximately more than $3 billion annually in Canada (Musuka et al., 2015).

In the USA, the fifth leading cause of death but first leading cause of long-term adult disability. Every year approximately 795,000 stroke occurs in the US population (Roger et al., 2011). It is expected that the prevalence of stroke will increase by 3.4 million people between 2012 and 2030 due to the aging of the population, coupled with the reduction in case fatality after stroke (Ovbiagele et al., 2013; Pearson et al., 2013). Though stroke mortality had decreased in the US over the past two decades, its recent trends in mortality indicate that these decreases may have levelled off, and that stroke mortality is going to be rising again. Reasons is not clear and uncertain, but it might be the reflection of the consequences of the obesity epidemic, and associated diabetes. The morbidity associated with stroke is quiet high and it costs about approximately $34 billion per year for healthcare services, medications and missed days of work (Mozaffarian et al., 2015; Ovbiagele et al., 2013). Nowadays the financial burden of morbidity and cost burden, moreover, based on studies of clinical stroke and using traditional measures such as physical disability and healthcare costs have become so important that even the burden of cerebrovascular disease itself underestimated. However, with the development of medical sciences the early diagnosis subclinical cerebrovascular disease including so-called “silent infarction” identified on brain imaging is up to 28% of the population over age 65 (Vermeer, Longstreth, & Koudstaal, 2007), and ischemic white matter disease is associated with memory loss, dementia, gait impairment, and other functional disability which is really appreciated. Furthermore, the global burden of stroke is high. It is the second leading cause of death worldwide, with a particularly large impact in developing nations (Donkor, 2018; Feigin, Lawes, Bennett, Barker-Collo, & Parag, 2009; Johnston, Mendis, & Mathers, 2009).

Unlike US and Canada, stroke is one leading cause of death as well as morbidity and disability burden for Bangladesh as well. No specific statistical data is found on post ischemic aphasia's favour though.

3.1.1 Types and Risk Factors

Stroke is a syndrome. There are two main types of stroke, one is ischemic stroke about 80-85% of cases and the other type is haemorrhagic that consists 15-20% of total cases (Musuka et al., 2015). Haemorrhagic strokes are again divided equally into two types. They are intracerebral haemorrhage and atraumatic subarachnoid haemorrhage. However, in the past, haemorrhagic stroke was called "cerebrovascular accident" and "reversible ischemic neurologic deficit". Nowadays these terms are not meaningful and should no longer be used. The severity of ischemic stroke ranges from mild to very severe. They are termed clinically as mild or transient (termed a minor stroke or transient ischemic attack) to very severe (termed major ischemic stroke). In all cases the underlying causes are identical. The distinction between transient ischemic attack and ischemic stroke is no more than one of severity; therefore, it is not useful to think of these two entities in separate categories (Musuka et al., 2015).

Ischemic stroke can be further divided into etiologic subtypes, or categories that might represent the causes of the stroke. The causes are usually cardioembolic, atherosclerotic, lacunar, other specific causes (dissections, vasculitis, specific genetic disorders, others), and strokes of unknown cause(Adams et al., 1993). It is interesting that the risk factors for hemorrhagic and ischemic stroke are similar, but there are some distinguished differences. However, there are also differences in risk factors among the etiologic categories of ischemic stroke. Hypertension is a predominantly important risk factor for hemorrhagic stroke. Hypertension contributes to atherosclerotic disease, and it might cause to ischemic stroke as well. Hyperlipidemia, on the other hand, is a particularly important risk factor for strokes. Atherosclerosis in extracranial and intracranial blood vessels might cause stroke just as it is a risk factor for coronary atherosclerosis (Tirschwell et al., 2004). Atrial fibrillation is a risk factor for cardioembolic stroke.

Risk factors for stroke can be classified as modifiable and non-modifiable (See Table 1). Age, sex, family history and race/ethnicity are non-modifiable risk factors; while hypertension, smoking, diet, and physical inactivity are among some of identified modifiable risk factors (Boehme, Esenwa, & Elkind, 2017).

Table 1 Major modifiable and non-modifiable risk factors for stroke

	Non-Modifiable Risk Factors	**Modifiable Risk Factors**
Ischemic stroke	Age	Hypertension
	Sex	Current Smoking
	Race/ Ethnicity	Waist to hip ratio
		Diet
		Physical inactivity
		Diabetes
		Alcohol consumption
		Cardiac cause
		Apolipoprotein B to A1
	Genetics	
Hemorrhagic Stroke	Age	Hypertension

	Non-Modifiable Risk Factors	Modifiable Risk Factors
	Sex	Current smoking
	Race/ Ethnicity	Waist to hip ratio
		Alcohol Consumption
		Diet
	Genetics	

(Source: Colledge, N. R., Walker, B. R., Ralston, S., & Davidson, S. (2010). *Davidson's principles and practice of medicine*. Edinburgh: Churchill Livingstone/Elsevier.)

Zhao et al. (2008) stated that the developing countries suffer from a high proportion of hemorrhagic stroke, relative to ischemic stroke, because of the over burden of uncontrolled hypertensive disorders. On the other hand, appropriate treatment, and management of hypertension in developed countries hemorrhagic stroke is reduced. Again, with Western style and diet, the proportion of hemorrhagic strokes declines. On the other hand, the proportion of ischemic strokes, as well as cardiovascular disease in general have increased due to western lifestyle. This pattern of the epidemiologic transition has been clearly visualized over a relative short period of time in the studies of stroke patients in Beijing, China, during that country's rapid economic development over recent decades, from hypertensive hemorrhagic stroke to ischemic strokes, and their associated risk factors. From 1984 through 2004, for example, the incidence of hemorrhagic stroke declined by 1.7% annually, while the incidence of ischemic stroke increased by 8.7%. The proportion of deaths due to cerebrovascular disease declined, moreover, and the proportion of ischemic heart disease increased.

Diabetes is one of the most important and independent risk factors for stroke. It increases almost twice risk of getting stroke for diabetic patients. 20% diabetic patients die from stroke. Even the pre-diabetics are also at increased risk of stroke (Banerjee et al., 2012; Sui et al., 2011). Approximately 8% of Americans have diabetes, with nearly half of Americans over 65 pre-diabetic (Utsumi & Elkind, 1986). The duration of diabetes is also significantly corelated with increased stroke risk. The Northern Manhattan Study stated that duration of diabetes was associated with ischemic stroke. Compared to non-diabetic participants, those with diabetes for 0-5 years have more risk of stroke and 5-10 years were at increased risk, and the risk for those with diabetes for ≥10 years increased markedly (Banerjee et al., 2012). It has been observed that usually the younger diabetic patients are more prone to have an episode of stroke, also more common in African American, and have a higher prevalence of other stroke risk factors. Nowadays the younger people are having more increased risk of stroke due diabetes (Kissela et al., 2005). However, diabetes can easily be controlled by using the combined behavioral modification and medical therapy which might be helpful in reducing the risk of stroke. (Anselmino, Malmberg, Ohrvik, & Ryden, 2008; Gaede, Lund-Andersen, Parving, & Pedersen, 2008) Interestingly, glycemic control alone in diabetics does not confer the reduced risk that intensive interventions with behavior modification plus medical intervention all together is highly effective. (Gray et al., 2007; Holman, Paul, Bethel, Matthews, & Neil, 2008).Genetics is placed an overlapping location between modifiable and non-modifiable to represent the fact that genetic risk factors are increasing recognized as potentially modifiable, either directly or through modification of gene-environment interactions (O'Donnell et al., 2010).

3.1.2 Pathophysiology of Stroke

It has been stated earlier that Hemorrhagic stroke or intracerebral hemorrhage, represents 10–15 % of stroke cases. Hemorrhagic stroke is more dangerous in terms of morbidity and mortality, although the incidence of this type of stroke is low statistically. Unfortunately, the death rate of patients with hemorrhagic stroke within 30 days is about 38% (Rosamond et al., 1999), and the rest of the survivor or at least more than a half of it needs assistance to some extent for the daily living (Rost et al., 2008) . Ischemic stroke, however, quite common comparing to hemorrhagic stroke, consisting about 85% of all stroke cases. Moreover, luckily ischemic stroke has a much lower 30-day mortality, which is only 12 % (Lloyd-Jones et al., 2009). Morbidity in ischemic stroke may also be severe but it can be reduced if proper diagnosis can be made without any delay and appropriate management provided immediately (See Figure 1).

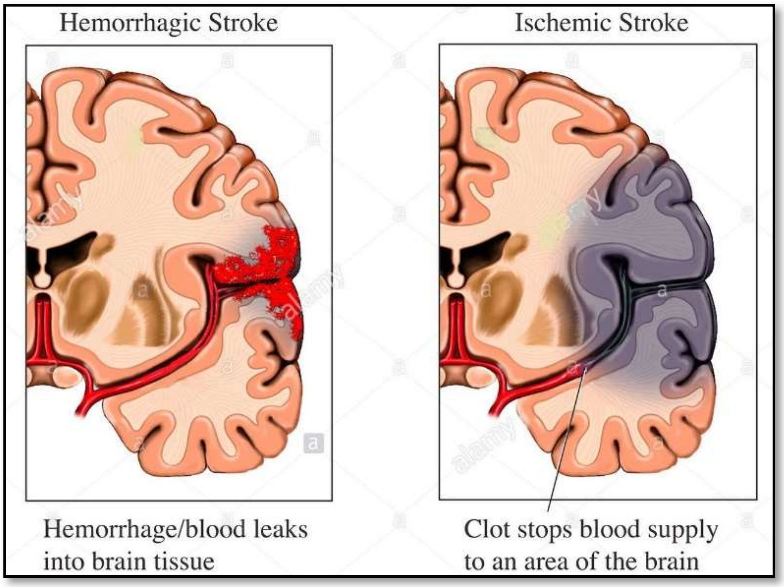

Figure 1 Pathophysiology of Haemorrhagic and Ischemic stroke (Source: WWW.brainsgate .com)

When the infraction is due to the occlusion of the veins, sometimes it may turn into a hemorrhagic lesion and vice versa. So, whenever a hemorrhagic infarction is found, clinician must search for a venous occlusion without a delay (Vymazal, Rulseh, Keller, & Janouskova, 2012)

Additionally, transient ischemic attack (TIA) may observe commonly in the neurology ward which involves focal neurological deficit that resolves within 24 h. TIA thought to be self-limited but creates confusion while diagnosing of ischemic stroke. A TIA is also a strong short-term risk factor for stroke, as up to 20 % of patients that have a TIA will suffer from a stroke within 90 days (Lloyd-Jones et al., 2009).

It is evident that the brain is metabolically active and needs about 50ml/100g/min blood flow with an oxygen metabolic rate of 3.5cc/100g/min (Doyle, Simon, & Stenzel-Poore, 2008). When the blood flow drops below 10ml/100g/min, brain cell functions are severely affected and it is impossible for neurons to survive long at levels below 5ml/100g/min (Doyle et al., 2008). Generally, only a 30 seconds interruption of blood flow in the brain may cause metabolic alteration of the brain. In ischemic stroke, disruption of blood flows to the brain for a few minutes' causes hypoxia and hypoglycemia, which leads to infarction of brain tissues (Dirnagl, Iadecola, & Moskowitz, 1999). A vicious cycle called ischemic cascade follows due to accumulation of sodium, calcium, and water in the injured brain cells, which lead to release of excitatory neurotransmitters causing further cell injury (Dirnagl et al., 1999). However, in hemorrhagic stroke, the hematoma causes compression that is pressure effect to the surrounding tissue resulting in tissue injury (Hademenos & Massoud, 1997; Lyden & Zivin, 1993) .

The brain's regulatory mechanism attempts to maintain equilibrium by increasing blood pressure but the increased intracranial pressure forces out cerebrospinal fluid causing damage to circulation (Hademenos & Massoud, 1997; Lyden & Zivin, 1993). It is a double-edged sword. The blood from brain hemorrhage exerts some direct toxic effects on brain tissue and vasculature (Lyden & Zivin, 1993). Mass effect develops with neuronal damage resulting from excitotoxicity, free radicals, apoptosis, ischemia, diaschisis, neuropathic products, and pressure necrosis (Hademenos & Massoud, 1997).

3.1.3 Clinical Presentations of Stroke

Stroke is classified as the second leading cause of death worldwide with an annual mortality rate of about 5.5 million (Lopez et al., 2006). Stroke not only has the burden of high mortality but the high morbidity that might result the huge burden of the 50% of survivors (Lopez et al., 2006; Nilsen, 2010; Warlow, 1998). Thus, stroke is a disease of immense public health importance with serious economic and social consequences. The public health burden of stroke is set to rise over future decades because of demographic transitions of populations, particularly in developing countries (Donkor, 2018).

Etiology of stroke is thought to be not effective on the patient's clinical and functional status (Memetoglu, Taraktas, Badur, & Ozkan, 2014). However, the most common presentations stated by Fekadu et al. (2019) was headache complained by 75.0% of the patients followed by aphasia 60.3% and hemiparesis 53.4% (Fekadu et al., 2019).

In some literatures, strokes are divided in three types e.g. Ischemic, intracerebral hemorrhage and subarachnoid hemorrhage (Price et al., 2018). The main symptom or the hallmark of the diagnosis of ischemic stroke is the onset of focal neurological impairment. Speech difficulties or impairment is the most frequent presenting symptoms of ischemic stroke. Hemiparesis or weakness on one-half of the body is the second most common complain. Few other complaints that is quite common might mimic a stroke, for example, seizure, conversion disorder, migraine headache, and hypoglycemia etc. Transient ischemic attack (TIA) is the most common complain that needs to be exclude while diagnosing a stroke. Careful and complete clinical history taking is the most important in diagnosing a stroke patient. Then the diagnostic imaging is the most reliable tool to conclude the confirm diagnosis. Neuroimaging can differentiate among the different categories of stroke, for example, ischemic stroke from intracerebral hemorrhage, as well as to diagnose entities other than stroke. However, the advice of investigation depends on availability of the technique, the patient's eligibility for thrombolysis, and presence of contraindications. Sudden onset of a severe headache is the hallmark of the diagnosis of subarachnoid hemorrhage and a simple computed tomography (CT) without contrast is the imaging technique of choice. Additional biochemical test can also be helpful. Cerebrospinal fluid inspection for bilirubin is recommended if subarachnoid hemorrhage is suspected in a patient with a normal computed tomography result. Finally, the awareness of the patients regarding the early symptoms identification public education about common presenting stroke symptoms (See Table 2) may improve patient knowledge and clinical outcomes (Yew & Cheng, 2015).

Table 2 Most common symptoms and signs of ischemic stroke

Serial	Symptoms	Prevalence rate %
1	Acute onset	96
2	Subjective Arm weakness	63
3	Subjective leg weakness	54
4	Self-reported speech problem	53
5	Subjective fascial weakness	23
6	Arm paraesthesia	20
7	Leg paraesthesia	17
8	Headache	14
9	Non-orthostatic dizziness	13
	Signs	
10	Arm paresis	69
11	Leg paresis	61
12	Dysphasia or dysarthria	57
13	Hemiparetic or ataxic gait	53
14	Fascial paresis	45
15	Eye movement abnormality	27
16	Visual field defect	24

(Source: Yew & Cheng, 2015)

Among choosing the imaging modalities which is particularly case sensitive, each and every patient with stroke symptoms should undergo urgent neuroimaging with non-contrast Computed Tomography (CT) or Magnetic Imaging Resonance (MRI) (Wintermark et al., 2013). The primary purpose of neuroimaging in a patient with suspected ischemic stroke is to rule out the presence of non-ischemic central nervous system lesions and to distinguish between ischemic and haemorrhagic stroke (Yew & Cheng, 2015).

The initial and the most important first step is the evaluation of patients with symptoms of acute stroke having whether hemorrhagic and ischemic stroke. However, the eligibility for treating patients intravenous (IV) tissue plasminogen activator (tPA), non-contrast CT (NCCT) need assessments among all patients with acute ischemic stroke. Though the IV tPA can then be initiated without waiting for further imaging. The patients who might need endovascular therapy require further imaging assessment. In the western world they use three imaging options: (1) NCCT followed immediately by digital subtraction angiography for vascular assessment, (2) NCCT plus CT angiography (CTA) with or without perfusion CT or (3) MRI plus MR angiography (MRA) with or without perfusion MR at institutions that can offer MRI 24/7 without delaying treatment. To prevent next episode of recurrent stroke vascular imaging is recommended in patients who are not candidates for IV or endovascular therapy, and in patients with TIAs (Wintermark et al., 2013).

Patients presenting with disabilities acute ischemic stroke can be given treatment within 3 hours and they might be treated with intravenous tissue plasminogen activator (alteplase) if eligible. 150 mg of aspirin should be given immediately to all acute stroke patients after conforming the infraction by excluded intracranial hemorrhage by imaging. In patients with large hemispheric infarct (malignant MCA territory infarct), aspirin may be delayed until surgery or decision is made not to operate. Oral medication like Aspirin (at least 150 mg) should be continued until 2 weeks after the onset of stroke. A proton pump inhibitor in addition to aspirin should be added is dyspepsia present.

Surgery for ischemic stroke: Decompressive hemicraniectomy surgery is indicated within a maximum of 48 hours in patients with middle cerebral artery (MCA) infarction if the patients age is 60 years or below and CT scan showing signs of an infarct of at least 50% of the MCA territory. Patients with large cerebellar infarct causing compression of brainstem and altered consciousness should be surgically managed with suboccipital craniectomy. Symptomatic hydrocephalus should be treated surgically with ventriculostomy. Patients with cerebellar haemorrhage (>3 cm in diameter) who are deteriorating neurologically or who have signs of brain stem dysfunction should have suboccipital craniectomy and surgical evacuation of hematoma (Prasad et al., 2011).

3.2 Aphasia

Aphasia is most common speech & language disorders and every year approximately 100,000 stroke survivors are diagnosed with aphasia. Ellis and Urban (2016) conducted a review study were conducted among 1617 articles to examine the relationship between age and: (a) presence or likelihood of aphasia after stroke, (b) aphasia type, (c) aphasia recovery patterns, and (d) aphasia clinical outcomes. Forty studies including 14,795 study participants were included in the review. They found that: (a) stroke patients with aphasia are typically older than stroke patients without aphasia and (b) aphasia type and age are associated, for example, younger patients with aphasia are more likely to have non-fluent or Broca's type of aphasia. In contrast, studies examining aphasia recovery and aphasia clinical outcomes did not demonstrate a positive relationship between age and recovery or clinical outcomes. This study concluded that stroke is a condition of the elderly. However, age appears to be only influenced likelihood of aphasia and aphasia type.

Another systematic review was conducted by Flowers et al. (2016) to explain the frequency, recovery, and associated outcomes for poststroke aphasia over the long-term effect. They have reviewed total 248 articles and concluded with the result. They also stated that the ischemic stroke is very predominant among all. It is also unfortunate that patient with aphasia suffer approximately about 2 years. Flowers et al. (2016, p. 2188) concluded -

> The median frequencies for mixed stroke (ischemic and haemorrhagic) were 30% and 34% for acute and rehabilitation, respectively. Frequencies by stroke type were lowest for acute subarachnoid haemorrhage (9%) and highest for acute ischemic stroke (62%) when arrival to the hospital was ≤3 hours from stroke onset. After monitoring aphasia for 1 year, it has been demonstrated that aphasia frequencies became 2% to 12% lower than baseline. Negative outcomes associated with aphasia included greater odds of in-hospital death and longer mean length of stay in days in acute settings. Patients with aphasia had greater disability from 28 days to 2 years than those without aphasia. By 2 years, they used more rehabilitation services and returned home less frequently.

3.2.1 Types

It has been found among studying 14,795 post stroke patient with aphasia that Motor or Broca's Aphasia is most common type among all other (Ellis & Urban, 2016). Yourganov et al. (2015) has conducted a study predicting aphasia type from any brain damage by MRI scans of 98 patients where he has classified aphasia mainly five types. They are Broca's, Wernicke's, Global, Conductive, and Anomic based on scores on the Western Aphasia Battery (WAB). However, any damage on the parietal lobe or temporal lobe of brain by any injury or cerebrovascular accident might cause anomic aphasia. Even genetic cause might be a reason for anomic aphasia. Anomic aphasia mainly caused by some structural disease. However, it may also originate in Alzheimer's disease or other neurodegenerative diseases.

Modern aphasia classification largely based on a model of language localization typically referred to as the Wernicke-Lichtheim model. This model was largely developed by Wernicke and Lichtheim between 1874 and 1886. The Wernicke–Lichtheim model finally classified aphasia into seven types (See Fig 2). The model suggests an clarification of the commonly observed language impairments both in the production and comprehension of people with aphasia (Hux, 2011).

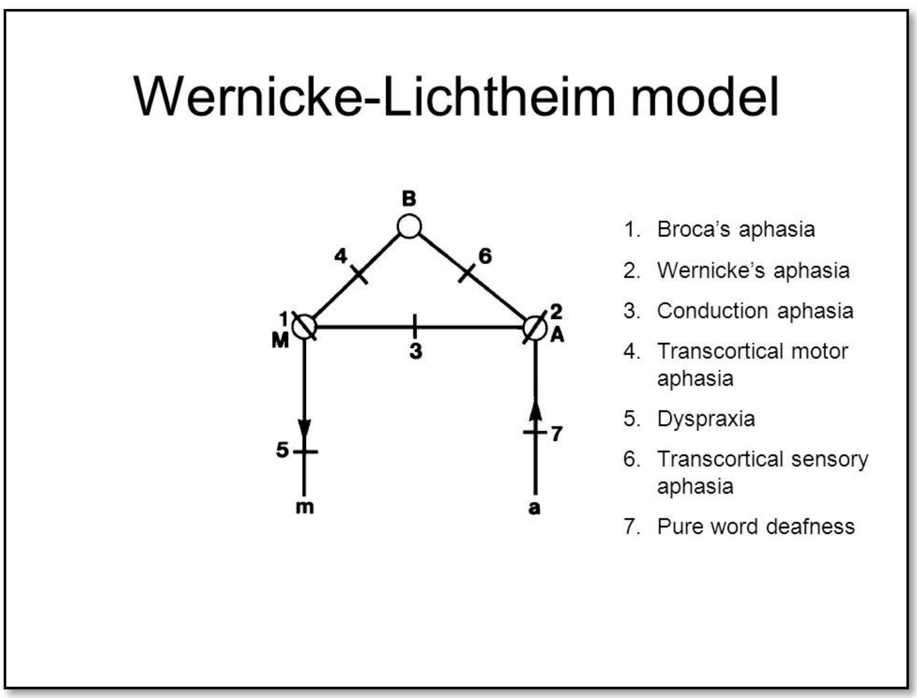

Figure 2 Types of Aphasia by Wernicke -Lichtheim model (Source: Hux,2011)

Hux (2011) documented that Ludwig Lichtheim in 1885 revealed the new concept that coincide with the work of Pierre Paul Broca and Karl Wernicke, describing a connectionist model of language processing. He named it as either the Wernicke–Lichtheim or classical model of aphasia. The model covers both neuroanatomical and functional basis and predicted the communicative consequences of damage to various brain regions. It served as the foundation for classifying the types of aphasia already observed as well as providing a means for predicting aphasia types not yet observed but assumed logically.

The Wernicke-Lichtheim model assumes the existence of three interconnected "language centers": sensory, motor, and concept. The original Wernicke's model consisted of only the sensory and motor centers whereas Lichtheim discovered a new brain area related to speech and language and termed the area as the concept center (See Figure 3).

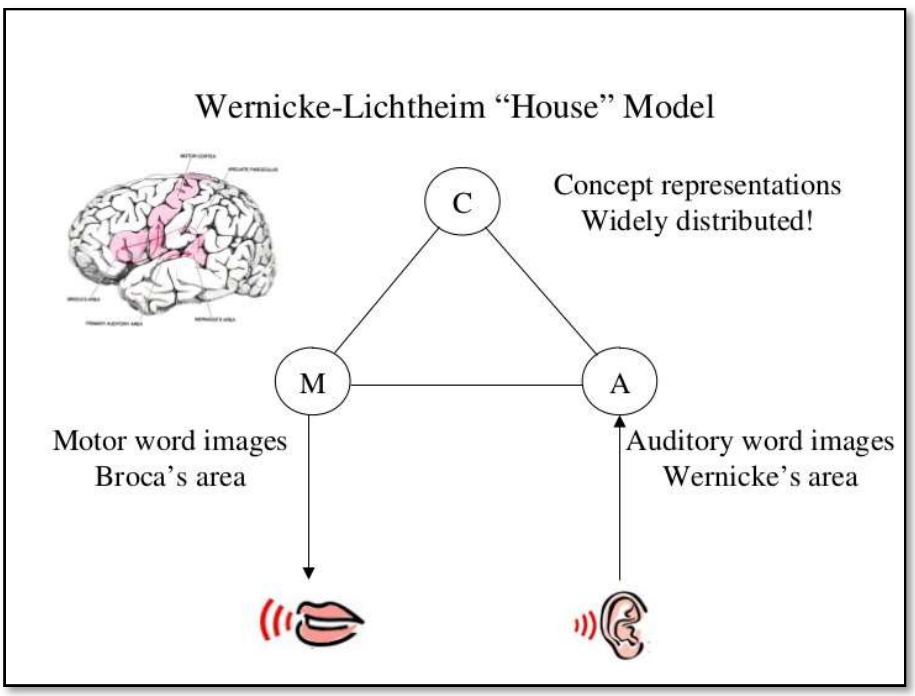

Figure 3Wernicke-Lichtheim Model (Source: Hux, 2011)

However, he was not able to specify its anatomical location. Later on, Wernicke revised his model accordingly. According to the model any insult or damage, only to the centers but also their connective tract would result in a specific aphasia type.

However, he descried an exception in his model. According to him any injury or ischemia to this center would cause memory deficits rather than aphasia. According to this model, damage to the motor and sensory centers produces impairment in expression and comprehension respectively called motor and sensory aphasia. Damage to the tract that connects these two centers, the arcuate fasciculus, results in conduction aphasia, which manifests in difficulties repeating other's speech. When the connections between these two centers and the concept center are damaged, it results in two forms of transcortical aphasia (Tesak & Code, 2008).

In transcortical motor aphasia, in which a patient has difficulty with expression, similar as Broca's aphasia but repetition is relatively preserved. On the other hand, transcortical sensory aphasia, in which comprehension is impaired, but repetition is preserved. The main pathology is in the location of damage. It is assumed that these two types of aphasia thought to be due to the injuries in the connecting tract areas of those centres rather than injury in the centre itself. When the damage is extensive and covers several loci, it results in what Lichtheim called total aphasia (Lichtheim, 1885). Nowadays this condition is typically referred to as global aphasia. Finally, amnestic aphasia, in current world more commonly mentioned to as 'anomic aphasia', is a comparatively mild language impairment. The only problem is to face difficulties in finding appropriate word in appropriate time. It is clearly stated that it is not linked to damage to a specific area of the brain neither in the speech centre nor in the connecting tracts areas. This model of language localization revolutionized the concept of aphasia typology despite resistance from others in the field.

Geschwind (1965) also classified aphasia based on location of the injured area in the brain on the basis of previous evidence. He anticipated that there might be solitary lesion in the specific speech and language center of brain or in the connecting fiber tract. Similarly, the lesion exhibited in both areas might resultant the same. According to his research, the clinical presentation might be according to the site of the lesion. This theory is completely accepted and proved right by the recent advanced research with improved technologies, especially with drastically improved imaging techniques (Benson, Benson, & Ardila, 1996). However, it is also evident that no two individuals with aphasia present with the same clinical symptoms, as a result the aphasia classification based on clinical symptom was not very well accepted (Caplan, 1987).

There are few other classifications of aphasia as well. One of the important, notable, and different classification is given by Luria. However, it was not performed with the patients of post stoke aphasia but with the patients suffering from bullet wounds. Nowadays the most popular and widely used aphasia classification is the one that was in the western Aphasia battery. Western Aphasia Battery is regarded as one of the most standard aphasia assessment tools, but it only describes the classical aphasia types in any patient with language impairment. It is not specific for post stoke patients (Clark et al., 2019).

There is a relation between the vascular supply and the clinical symptoms. Hillis has revealed the relation of aphasia blood supply. However, it can easily describe the relation between these two. Speech and language centers are located in specific areas of brain. The location of Broca's area is a region in the lower frontal lobe of the dominant hemisphere, usually the left side of the brain. It consists of Brodmann area 44 (pars opercularis) and 45 (pars triangularis). Speech problem only be evident when there is any vascular insult or mechanical problem in the respected cerebral cortex where the brain center lies. Hillis proved this idea retrospectively (Hillis, 2007).

Ischemia is the posterior frontal gyrus and insular cortex produce the symptoms of Broca's aphasia. The symptoms of Broca's aphasia or non-fluent aphasia is mainly in speech production. Agrammatic sentence production is also noted in Broca's aphasia. However, ischemia occurs in this region mainly due to the interruption of the blood flow in the superior division of the MCA.

On the other hand, inferior division of the left MCA supplies the neural regions of brain. Any infraction to this area due to the disruption of blood flow in the inferior division of left MCA may cause Wernicke's aphasia. The main complaint of Wernicke's aphasia is jargon or irrational fluent taking. Disruption of the blood flow to the anterior cerebral artery (ACA) most likely produces transcortical motor aphasia (Hillis, 2007) ACA mainly supplies anterior and superior to Broca's area (Freedman et al., 1984). Posterior cerebral artery (PCA) supplies Wernicke's area. Any disruption in the area which is supplied by the MCA and PCA produces the symptoms very close to the transcortical sensory aphasia (Alexander et al., 1989). A big clot that blocks the main steam of the MCA might produce Global aphasia. It is observed that the MCA territory covered both Broca's area and Wernicke's area. The patient is usually unresponsive (Mazzocchi & Vignolo, 1979). Conduction aphasia predominantly shows repetitive problem, good comprehension though. The lesion is localized the junction of the Broca's and Wernicke's areas. This is a neuronal tract in the white matter connecting both centers. This junction is called arcuate fasciculus. (Geschwind, 1965). More recent studies found that lesions are more present in the supramarginal gyrus, left dorsal superior temporal gyrus, or the temporo-parietal of grey matter than in the arcuate fasciculus in white matter (Buchsbaum et al., 2011; Hickok et al., 2000).

It is really difficult and yet not very clear to determine the type of aphasia from brain damage and the neurological findings, then the classical Wernicke-Lichtheim model had suggested (Yourganov et al., 2015). As mentioned above, previously it was regarded that conduction aphasia due to the white-matter damage, especially arcuate fasciculus, proposed by the classical Wernicke-Lichtheim model. Nowadays, it is regarded as the result of damage to grey matter around the temporo-parietal junction (Damasio, 1992; Hickok et al., 2000). It has been observed that , not on the damage in to Broca's area causes Broca's aphasia. Also, the damage to the other areas of brain can produce Broca's Aphasia. Similarly, lesion in Wernicke's area and other area's may cause Wernicke's aphasia (Damasio, 1992; Fridriksson, Fillmore, Guo, & Rorden, 2015). Prediction from the lesion site in the brain by the neuroimaging showed poor accuracy rate (Anna Basso, Lecours, Moraschini, & Vanier, 1985; Willmes & Poeck, 1993) . The reason behind it might be the heterogeneity of brain. The brain damage is not same for all the patients having same type of aphasia. The brain heterogeneity causes this variation. Gradually over time, advance research among bigger sample group and latest imaging tool overcome this shortcoming. With developed technique the brain lesion sites can be identified more accurately (Henseler, Regenbrecht, & Obrig, 2014; Kreisler et al., 2000). Nowadays, voxel-based mapping system is identified as the most reliable approach for the identification of the lesion site on the brain parenchyma and correlate with the symptoms (Bates et al., 2003). In this technique univariate method where the impact of each cortical location is evaluated independent of the other locations. However , this might introduce a spatial bias (Mah, Husain, Rees, & Nachev, 2014).

3.2.2 Speech and language Centers

Aphasia is a language disorder resultant from the damage commonly to the left hemisphere of the brain. Aphasic patients can reveal various patterns of language problem according to the location of damage of the cortical language areas or brain centres. In general, patients with similar lesion location and size show somewhat similar aphasic symptoms. However, patients with similar language impairment allow reasonable number of heterogeneity in patterns of cortical damage in the neuroimaging (Willmes & Poeck, 1993). In a retrospective study on 221 aphasic patients with one vascular lesion in the territory of the middle cerebral artery, with localization of lesions by CT scan standardized grid model, aphasia assessed by the Aachen Aphasia Test. Willmes and Poeck (1993) concluded that there were no unequivocal association between type of aphasia and localization of lesions (Willmes & Poeck, 1993).

3.2.3 Pathophysiology of post stroke Aphasia

For appropriate Aphasia treatment it is especially important to understand the pathophysiological mechanism of post-stroke aphasia on a neurophysiological systems level, also to know the changes in the molecular level. The treatment region is moving from standardized therapies towards more targeted individualized treatment strategies comprising behavioural therapies. Nowadays, non-invasive brain stimulation (NIBS) is the newer and effective way of management (Thiel & Zumbansen, 2016).

Post-stroke aphasia syndromes occur due to the interruption of brain networks that are responsible for the in-language production and comprehension, might have disturbed due to permanent focal ischemia. The main two main pathophysiological theories of this post-stroke aphasia can be explained by: 1) understanding language processing in terms of distributed networks rather than language centres, and 2) understanding the molecular pathophysiology of ischemic brain injury as a dynamic process beyond the direct destruction of network centres and their connections (Thiel & Zumbansen, 2016).

3.2.4 Speech and language Assessment

Nowadays a wide range of language tests are available for the post-stroke care (Vogel et al., 2010). Stroke scales such as the European Stroke Scale (ESS)(Table : 4) (Hantson et al., 1994), Canadian Neurological Scale (CNS) (Côté, Hachinski, Shurvell, Norris, & Wolfson, 1986) and National Institutes of Health Stroke Scale (NIHSS) can grade acute stroke severity and include subtest items which evaluate acute language functioning (Goldstein, Bertels, & Davis, 1989). The structure and the purpose of these scale is to inform hyperacute stroke treatment decision making (See Table-3). However, they are used to measure and identify stroke patients with aphasia, though they have not been specifically validated for identify or severity assessment of aphasia (El Hachioui et al., 2017). Moreover, they do not assist with diagnostically differentiating between aphasic and non-aphasic stroke populations.

Table 3NIHSS scale for assessing Aphasia in stroke patients (Source: Goldstein et al., 1989)

Providence | Health System

2706

NIH STROKE SCALE

PSVMC - Providence St. Vincent Medical Center
PMH - Providence Milwaukie Hospital
PPMC - Providence Portland Medical Center

PATIENT IMPRINT

Category	Score/Description		Date/Time Initials	Date/Time Initials	Date/Time Initials	Date/Time Initials	Date/Time Initials
1a. Level of Consciousness (Alert, drowsy, etc.)	0 = Alert 1 = Drowsy 2 = Stuporous 3 = Coma						
1b. LOC Questions (Month, age)	0 = Answers both correctly 1 = Answers one correctly 2 = Incorrect						
1c. LOC Commands (Open/close eyes, make fist/let go)	0 = Obeys both correctly 1 = Obeys one correctly 2 = Incorrect						
2. Best Gaze (Eyes open - patient follows examiner's finger or face)	0 = Normal 1 = Partial gaze palsy 2 = Forced deviation						
3. Visual Fields (Introduce visual stimulus/threat to pt's visual field quadrants)	0 = No visual loss 1 = Partial Hemianopia 2 = Complete Hemianopia 3 = Bilateral Hemianopia (Blind)						
4. Facial Paresis (Show teeth, raise eyebrows and squeeze eyes shut)	0 = Normal 1 = Minor 2 = Partial 3 = Complete						
5a. Motor Arm - Left **5b. Motor Arm - Right** (Elevate arm to 90º if patient is sitting, 45º if supine)	0 = No drift 1 = Drift 2 = Can't resist gravity 3 = No effort against gravity 4 = No movement X = Untestable (Joint fusion or limb amp)	Left					
		Right					
6a. Motor Leg - Left **6b. Motor Leg - Right** (Elevate leg 30º with patient supine)	0 = No drift 1 = Drift 2 = Can't resist gravity 3 = No effort against gravity 4 = No movement X = Untestable (Joint fusion or limb amp)	Left					
		Right					
7. Limb Ataxia (Finger-nose, heel down shin)	0 = No ataxia 1 = Present in one limb 2 = Present in two limbs						
8. Sensory (Pin prick to face, arm, trunk, and leg - compare side to side)	0 = Normal 1 = Partial loss 2 = Severe loss						
9. Best Language (Name item, describe a picture and read sentences)	0 = No aphasia 1 = Mild to moderate aphasia 2 = Severe aphasia 3 = Mute						
10. Dysarthria (Evaluate speech clarity by patient repeating listed words)	0 = Normal articulation 1 = Mild to moderate slurring of words 2 = Near to unintelligable or worse X = Intubated or other physical barrier						
11. Extinction and Inattention (Use information from prior testing to identify neglect or double simultaneous stimuli testing)	0 = No neglect 1 = Partial neglect 2 = Complete neglect						
	TOTAL SCORE						

INITIAL	SIGNATURE	INITIAL	SIGNATURE	INITIAL	SIGNATURE

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Table 4 European stoke scale (ESS) (Source: Hantson et al., 1994)

comprehension	patient performs 3 commands	8
	patient performs 1 or 2 commands	4
	patient does not perform any command	0
speech	normal speech	8
	slight word-finding difficulty, conversation is possible	6
	severe word-finding difficulties, conversation is difficult	4
	only yes or no	2
	mute	0
visual field	normal	8
	deficit	0
gaze	normal	8
	median eye position, deviation to one side impossible	4
	lateral eye position, return to midline possible	2
	lateral eye position, return to midline impossible	0
facial movement	normal	8
	paresis	4
	paralysis	0
arm (ability to maintain outstretched position)	arm maintains position for 5 seconds	4
	arm maintains position for 5 seconds but affected hand pronates	3
	arm drifts before 5 seconds pass and maintains lower position	2
	arm can't maintain position but attempts to oppose gravity	1
	arm falls	0
arm (raising)	normal	4
	straight arm, movement not full	3
	flexed arm	2
	trace movements	1
	no movement	0

Table 5 RACE scale that corresponds to NIHSS scale for post stroke aphasia patients (Source: Goldstein et al., 1989)

Item	Instruction		RACE score	NIHSS score equivalence
Facial palsy	Ask the patient to show teeth	Absent (symmetrical movement)	0	0
		Mild (slightly asymmetrical)	1	1
		Moderate to severe (completely asymmetrical)	2	2-3
Arm motor function	Extending the arm of the patient 90 degrees (if sitting) or 45 degrees (if supine)	Normal to mild (limb upheld more than 10 seconds)	0	0-1
		Moderate (limb upheld less than 10 seconds)	1	2
		Severe (patient do not rise the arm against gravity)	2	3-4
Leg motor function	Extending the leg of the patient 30 degrees (in supine)	Normal to mild (limb upheld more than 5 seconds)	0	0-1
		Moderate (limb upheld less than 5 seconds)	1	2
		Severe (patient do not rise the leg against gravity)	2	3-4
Head and gaze deviation	Observe eyes and cephalic deviation to one side	Absent (eye movements to both sides were possible and no cephalic deviation was observed)	0	0
		Present (eyes and cephalic deviation to one side was observed)	1	1-2
Aphasia (if right hemiparesis)	Ask the patient two verbal orders - "close your eyes" - "make a fist"	Normal (performs both tasks correctly)	0	0
		Moderate (performs one task correctly)	1	1
		Severe (performs neither tasks)	2	2
Agnosia (if left hemiparesis)	Asking: - "Who is this arm" while showing him/her the paretic arm (asomatognosia) - "Can you move well this arm?" (anosognosia)	Normal (no asomatognosia nor anosognosia)	0	0
		Moderate (asomatognosia or anosognosia)	1	1
		Severe (both of them)	2	2
RACE Score total			0-9	

Few other brief screening tests are also available, specifically designed to assess post-stroke language performance, such as the Frenchay Aphasia Screening Test (Enderby, Wood, Wade, & Hewer, 1986) and Language Screening Test (Flamand-Roze et al., 2011). Unfortunately , all these aphasia tests are nor designed by specialist health professional with an aim of using by the multiple 'non-specialist' health professionals (Al-Khawaja, Wade, & Collin, 1996; El Hachioui et al., 2017; Thommessen, Thoresen, Bautz-Holter, & Laake, 1999) just to identify at-risk patients and for quick referral (Al-Khawaja et al., 1996; El Hachioui et al., 2017; Enderby et al., 1986; Flamand-Roze et al., 2011; Thommessen et al., 1999; Yew & Cheng, 2015). These language tests are not able to assess the language status broadly. Typically it can only assess a narrow range of language abilities (Kim, Kim, Kim, & Heo, 2011). It is observed that most of these quick assessment tests do not, check reading/writing status (Flamand-Roze et al., 2011; Kim et al., 2011). In the conclusion, they are not considered suitable for use in isolation for diagnostic purposes (Flowers et al., 2016).

To diagnosis the aphasia resulting from stroke are typically performed by Speech pathologists (Brady, Kelly, Godwin, Enderby, & Campbell, 2016). Language assessment is performed to evaluate a range of language skills, identify the strength and weakness of patient's communicative skills. Moreover, it is mostly important for definitive diagnosis and planning treatment of language impairment (Johnson & Jacobson, 2007). Speech pathologists often have only a brief window, frequently around 30 minutes, in which to conduct a thorough clinical assessment of acute language impairment (Rohde et al., 2018). However, this is a scenario in case of western world. It is quite different in Bangladesh. Vogel et al. (2010) described that within acute hospital settings, stroke patients usually have their initial language assessment within 2 days of admission by speech language pathologist. On the other hand, the patients from the emergency room went to imaging room and on the basis on imaging finding patients were shorted out for admission, specific therapy or for surgical procedures. After finishing all these steps then they get a referral for the speech and language therapist. For some patients it takes about 2 weeks and for other it is about 2 months. By the time it is too late to know the preliminary condition. For this, there might be some short, quick assessment tool that should not be complicated, can easily be used by the junior clinicians at bedside just to categorize the speech problem at the beginning, which might be helpful in context to this country. Despite the often highly variable patient performances during this acute recovery phase, logistical demands dictate that clinicians need to make swift diagnostic decisions or run the risk of patients being missed and lost post discharge (Johnson & Jacobson, 2007) and despite the likelihood that some patients' difficulties may resolve, accurate aphasia diagnosis ensures that appropriate follow-up procedures are implemented.

3.2.4.1 Western Aphasia Battery

Western Aphasia Battery (WAB) is an effective language assessment tool for patients suffering from speech and language difficulties due to any neurological deficit after having an episode of stroke or injury. It is based on assessing English language. This tool is applicable only for adult patients age range from 18-89 years. It determines the presence, degree, and type of Aphasia. With this instrument both linguistics and non-linguistic skills are assessed. The linguistic skills are speech, fluency, comprehension, reading and writing. On the other hand, the non-linguistics skills that are assessed are drawing, calculation, block design and apraxia.

The diagnostic goal of The Western Aphasia Battery (WAB) is to classifying aphasia subtypes and rating the severity of the impairment or difficulties in speech and language (Caramazza & Badecker, 1989). Practically the examination is performed by four language test and 3 performance domains. Spontaneous speech, comprehension, repetition, and naming are the four language subtests. Weighted performance on these language subtests. The Aphasia Quotient (AQ) measures the severity of Aphasia.

In 2006, Pearson Assessments published a revised version (WAB-R) was published by. WAB-R is almost similar as the original WAB. It helps to identify the presence, degree, and type of aphasia (See figure 4).

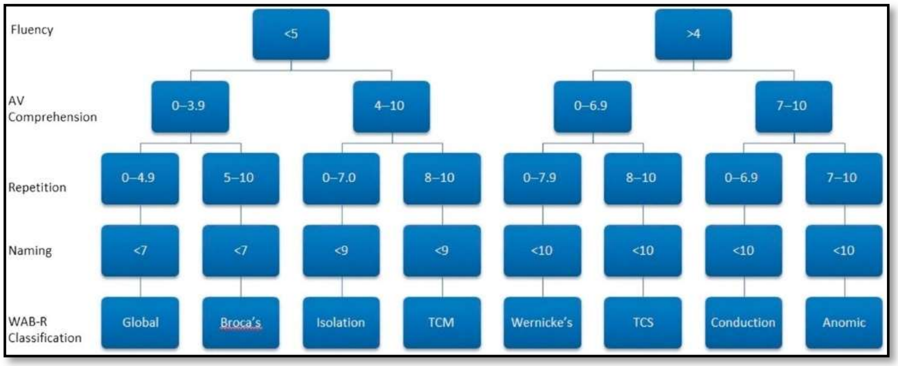

Figure 4 Western Aphasia Battery–Revised (WAB-R) classification criteria.

AV = auditory verbal; TCM = transcortical motor; TCS = transcortical sensory (Clark et al., 2019).

Table 6 Western Aphasia Battery–Revised (WAB-R) (Clark et al., 2019)

WAB-R subtest	Task description	Scoring
Information Content	Conversational questions Picture description	Accuracy of responses to six questions Completeness of picture description
Fluency	Conversational questions Picture description	0, 1 = Stereotypes or lack of verbal response 2, 4, 5 = Varied severity of telegraphic speech 3, 7, 8 = Varied severity of jargon speech 6, 9 = Varied severity of anomia 10 = Normal
AV Comprehension	Yes/no questions Word recognition Sequential commands	Accuracy
Repetition	Word, phrase, and sentence repetition	Accuracy
Naming	Object naming Word fluency Sentence completion Responsive speech	Accuracy (cued or uncured) Presence of paraphasias

3.3 Neuroimaging

The prediction of recovery and outcome after stroke can be assessed with the accurate and appropriate clinical data. This prediction can be more useful when imaging modalities are used and the appropriate size, site, location, and the pathophysiology are revealed. In other word diagnosis of stoke is not established without the imaging evidence. Not only that having the baseline imaging always helps for the future prediction of the recovery, management and even the therapeutic effects. Stroke management is completely impossible without neuroimaging. The recovery of ischemic tissue and the progression of damage are dependent on the quality of blood supply. Therefore, condition of the supplying vessels and development of the collateral vessels are important to watch out though the management process for the requirement of intervention or not. Also, it has an impact on the potential to integrate areas surrounding the lesions that are not typically part of a functional network into the recovery process.

Nowadays, stroke is a major global health problem. Worldwide stroke is one of the most important causes of long-term adult disability worldwide. Though one study revealed that from 1990 to 2013 the mortality and morbidity for long term affected chronic disease is significantly reduced but on the contrary the number of people suffering from stroke is significantly increased (Feigin et al., 2015). It is also evident that approximately 14% which is exceedingly small in respect of total population affected by stoke, recovered completely. Again more than 25% of the total number survived with assistance and the rest of the patients which consists almost half of the total were partially recovered with the chronic disabilities of stroke (Miller et al., 2010). This 50% stroke affected people with chronic disabilities represent about more than 47 million. People with all age group are affected by stoke. Previously stroke was only regarded as a disease of old people.

Nowadays, the concept is changed. About two-third of all stroke occur among persons of age below 70 years (Miller et al., 2010).

So, it can be stated that stroke completely changes a man's life. The decisions that were taken for the initial management of a patient has the long-term effect on the prognosis of his future quality of life. The duration of less time in ischemia provides the most benefited outcomes in terms of disability (Heiss & Rosner, 1983).

A lot of evidences are available to establish that neuroimaging data may be helpful for the recovery and prognosis of stroke patients. It is highly recommended to perform an initial imaging in the subacute stage within 1-3 weeks after the stroke episode. It is also equally important to counsel the patient and relatives properly on realistic basis. They should be informed about the attainable goals for treatment and rehabilitation, planning of discharge. It might help them for anticipating possible consequences for home adjustments and for the community support (Kwakkel, Veerbeek, Harmeling-van der Wel, van Wegen, & Kollen, 2011).

One study revealed that word repetition from a language screening task supporting the importance of perception and motor production are the predictor factors for the prognosis of post aphasic state (Glize et al., 2017). On the other hand, advantages of targeted rehabilitative procedures can be determined from studies of evoked potentials (Lee et al., 2010). Recently another study showed that the causative classification of stroke is valid for the prediction of recovery (Arsava et al., 2017).

The THRACE trial (Thrombectomie des Artères Cérébrales), was conducted among four hundred one patients that included (25 centers), comprising 299 MRI-selected and 102 CT-selected patients, a randomized trial from June 2010 to February 2015 with an aim to evaluate the efficacy of Magnetic Resonance Imaging (MRI) or computed tomography (CT) in terms of comparing the outcome of workflow and functional consequence in acute ischemic stroke patients. The result showed that the duration of MRI scan is longer for about 7 minutes comparing with CT scan, MRI-based selection for acute ischemic stroke patients is accomplished within a timeframe similar to CT-based selection, without delaying treatment or impacting functional outcome. However, this THRACE trail encouraged using MRI which has inherent imaging advantages over CT (Provost et al., 2019).

Neuroimaging is now available, feasible, cost-effective as a routine investigation for the clinical work-up of stroke patients. Imaging studies not only give the confirmatory diagnosis but also provide valuable insights into the pathophysiology of stroke and the extent of injury, and good prognostic factor for prediction of stroke and stroke outcome. Again, sufficient literatures are not available for the biomarker as the prognostic factor of functional recovery after stroke (B. Kim & Winstein, 2017). Most recent evidence in favour of combination of neuroimaging and clinical assessment is the best way to predict the long term outcome of the stroke patients (Kwah & Herbert, 2016). The role and contributions of various neuroimaging modalities for the stroke patients after ischemic stroke are discussed below.

3.3.1 Computed Tomography (CT)

The routinely used, most available, cheap, less time consuming, comparatively cheaper imaging procedure in acute stroke is CT. A CT scan can provide all the necessary information after an episode of stroke such as it allows differentiation between haemorrhagic and ischemic stroke, localization, and extent of the lesion, and assists in decision-making regarding the administration of potentially risky stroke therapies including thrombolysis and endovascular thrombectomy. Unenhanced CT is about 52% sensitive in assessment of abnormal parenchymal changes indicative of ischaemia (Von Kummer et al., 1997). Unenhanced CT is best viewed as series comprising thick and thin slices, typically 5 and 0.5 mm. If sub-millimetre slices are considered too noisy, an intermediate thickness such as 2.5 mm may be preferred. The thicker slices provide good appreciation of the brain parenchyma, detection of haemorrhage and assessment of grey, white matter differentiation. Thin slice imaging offers increased spatial resolution for resolving partial volume averaging and detecting ridiculously small infarcts (See Figure: 7). It is particularly useful in identifying small thrombi, increasing sensitivity from 67 to 97% (Riedel, Zoubie, Ulmer, Gierthmuehlen, & Jansen, 2012) (See Figure 5).

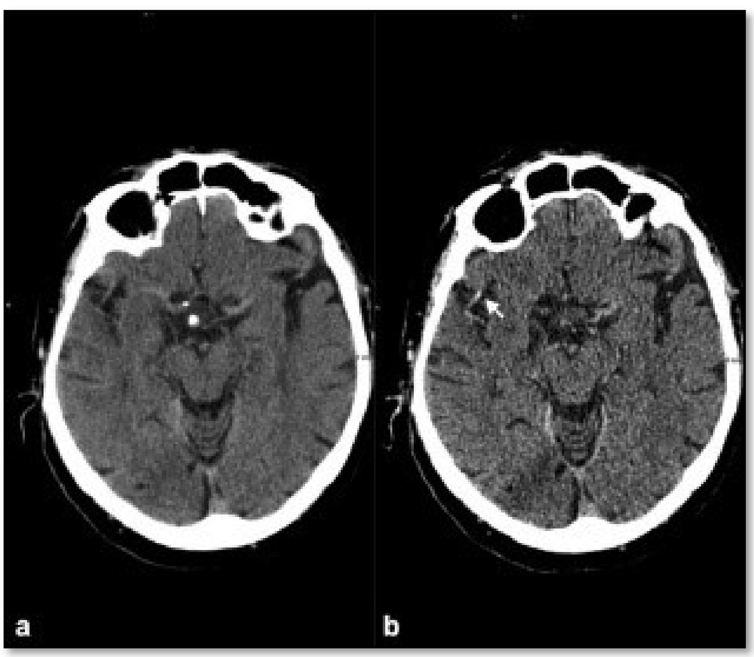

Figure 5 Thrombus in the right sylvian fissure 5-mm (a) and 0.5-mm slice (b) (Source: Riedel et al., 2021)

In the figure 5, (a) (5-mm slices) Fails to demonstrate the proximal right sylvian fissure thrombus observed on (b) (Arrow) (0.5-mm slices) showing the importance of thin slice review (Riedel et al., 2012; Smith & Rowland-Hill, 2018).

Few other technical aspects like the standard axial plane, reviewing images in reformatted coronal and sagittal planes also found extremely useful in accurate localization of infarction and confirming suspicion of abnormality in the axial plane. In assessing beam hardening artefact at the skull base and localizing small peripheral cortical infarcts the above mentioned technique is particularly useful (Smith & Rowland-Hill, 2018). The extent of early ischaemic changes on CT is clinically helpful to predict the clinical outcome of post stroke. Stroke severity scores such as the National Institute of Health Stroke Score (NIHSS) might be one of the predictors of clinical outcome (Barber, Demchuk, Zhang, & Buchan, 2000; Patel et al., 2001; Srinivasan, Goyal, Azri, & Lum, 2006).

Initial infarct volume determined within 72 hours of ischemic stroke onset was an independent predictor of outcome at 90 days (Vogt, Laage, Shuaib, & Schneider, 2012). Site of the lesion is an important factor for the mortality after stroke. It has been shown that most of the stroke patients with the injury in the insular cortex has not been able to survive (Borsody, Warner Gargano, Reeves, & Jacobs, 2009). In a prospective study of patients with acute ischemic stroke, anterior choroidal infarcts were found to have an intermediate long-term prognosis between lacunar infarcts and large artery territory hemispheric infarcts (Ois, Cuadrado-Godia, Solano, Perich-Alsina, & Roquer, 2009). Patients with upper limb paresis showed poor prognosis when the lesion was in the internal capsule. On the other hand, lesion in corona radiata or motor cortex showed comparatively better prognosis (Schiemanck, Kwakkel, Post, Kappelle, & Prevo, 2008). Ischemic stroke having non lacunar infract with brain oedema revealed poorer outcome (Battey et al., 2014).

The Alberta Stroke Program identified 10 regions in the territory of middle cerebral artery to determine the extent and location of the commonly affected ischemic changes. They called it Early Computed Tomography Score (ASPECTS) (Barber et al., 2000). Also, the initial lesion volume was a strong and independent predictor of stroke outcome (Vogt et al., 2012).

Plain CT does not accurately indicate the infarct core or provide information about the ischaemic penumbra. However, in Bangladesh, there is no sufficient opportunity to perform enhanced CT to everyone. According to The European Cooperative Acute Stroke Study acute ischaemic involvement of more than one-third of the MCA territory is a contraindication to IV thrombolysis due to the risk of haemorrhagic transformation (Hacke et al., 1995). ASPECTS provide a template to estimate the size of baseline infarct. This assessment is not very reliable in case of early change within 90 min of stroke onset, and even proved less reliable in detecting small core infarction sometimes unable to pick (Bal et al., 2015). Patient factors are also affected and reduce the sensitivity of detecting ischemia by CT scan. Cerebral atrophy and leukoariosis might be the best example of it. CT has poor sensitivity for detection of posterior fossa infarcts. Other pitfalls when assessing acute thrombus include variability in slice thickness, vessel wall calcification and increased haematocrit (Menon & Goyal, 2015).

On the other hand, unenhanced CT have an incredibly positive and useful role in selecting the patients for IVT according to current guidelines. Again, it highly shows sensitivity for acute haemorrhage. Detectable changes of early infarction correlate with outcome and the risk of treatment related haemorrhage. However, intraluminal thrombus can be detected with reasonable sensitivity (Smith & Rowland-Hill, 2018).

3.3.2 Magnetic Resonance Imaging (MRI)

Computed tomography (CT) is the most commonly used diagnostic imaging tool because of its accessibility and rapid acquisition time and also less expensive comparing other imaging modalities (Provost et al., 2019). However, magnetic resonance imaging (MRI) has advantages over CT. Diffusion-weighted imaging (DWI) best detects acute ischemia. In a study conducted by Chalela et al. (2007) stated that in the emergency setting MRI is better than CT for detection of acute ischaemia. It can easily detect acute and chronic haemorrhage as well. Therefore, MRI is the preferred test for accurate diagnosis of patients with suspected acute stroke. The study also said that it has been performed in emergency cases of suspected stroke, the results are directly applicable to clinical practice.

In case of accurate diagnosis of stroke and stroke-like events MRI is helpful (Chernyshev et al., 2010; Fernandes, Whiteley, Hart, & Salman, 2013; Liu, Almast, & Ekholm, 2013). Stroke followed by endovascular treatment or thrombolysis the detection and lesion core measurement can be done by MRI (Leslie-Mazwi et al., 2016; Nogueira et al., 2018). When the time of occurrence of stroke is unknown, MRI is useful in such situation as it can identifies strokes occurred approximately within the previous 4.5 hours. However, it is useful for thrombolysis (Thomalla et al., 2018). The drawbacks of MRI theoretically include screening time for contraindications, limited access, additional time needed to clear the MRI scan and place the patient on the table, and longer scan duration (Provost et al., 2019).

Although MRI has always been regarded as one of the best techniques in the acute workup of stroke, it is still used more on academic purpose or for complicated with other problems in brain along with stroke. MRI is known to generally be more sensitive than CT in the detection of ischemia, and show even better sensitivity for acute stroke imaging (Vymazal et al., 2012) . However, studies showed, it is not always easy to detect a small haemorrhagic lesion through MRI. However, in case of ischemia there is no such restrictions.

MRI is comparatively high-resolution imaging technique and able to detect small stroke lesions. However, the size is not always reflecting the clinical presentation whereas the location is also related with it, especially since small lesions of the subcortical white. Finally, Schiemanck et al. (2008) concluded that matter or the brainstem can produce disproportionate clinical disturbances. Methodological shortcomings of most studies confound the prognostic value of MRI in predicting stroke outcome, and few studies have focused on functional outcome. Therefore, the location of the lesion needs to be considered when the outcome of the disability should be measured.

Non-motor pathways can also be studied by relating their damage to higher brain function, for example, language performance. Injuries in the superior longitudinal and arcuate fasciculi of the left hemisphere showed correlation with decreased ability to repeat spoken language, additionally were correlated with comprehension deficits. Again, this problem was not at all correlated with the size of the lesion and were independent of the degree of damage to cortical areas (Breier, Hasan, Zhang, Men, & Papanicolaou, 2008). The outcome of aphasia was improved in patients whose left arcuate fasciculus could be reconstructed (Kim & Jang, 2013).

MRI has good resolution and provides comprehensive multiparametric assessment of the brain parenchyma and circulation in acute stroke. It is, no doubt, superior to CT in many respects. Most importantly MRI has the provision of DWI which can describe the infarct core. DWI can be directly compared with PWI, other sequences and clinical status to assess tissue salvageability. SWI is extremely sensitive to microhaemorrhage, which may have proved to be significant in determining treatment.

Another advantage is for detection of posterior circulation strokes where CT fails to work accurately. It is likely to have a role in patients who present late or at an unknown interval of time after symptom onset to select who may benefit from reperfusion therapy. These benefits are at least in part counterbalance by limits in availability and safety and the potential for a clinically significant delay in instituting treatment (Smith & Rowland-Hill, 2018).

3.3.3 Functional Imaging

After stroke functional deficit depends on various factors. However, it can be determined by the location and the extent of tissue damage. On the other hand, functional recovery completely depends on the adaptive plasticity of the rest of the healthy tissues. These healthy tissues include the cerebral cortex of brain and the unaffected elements of the functional tracts. Once the brain tissue is damaged in the adult brain it cannot be replaced or regenerate. As a result, any improvement, or recovery of the neurological problems can only be attained if there is re-activation of functionally disturbed or the brain plasticity occurs among the healthy brain tissue around in the morphologically preserved areas or by enlistment of alternative pathways within the functional network. Affected people might show a completely new functional and anatomical situation or this activation of alternative pathways may be accompanied by the development of different strategies to deal with the new functional-anatomical situation at the behavioural level. To some extent the sprouting of fibres from surviving neurons can make new synapses that might play a role in the long-term recovery. However, for the formation of these new connections there must be some changes in the blood flow pattern and in the metabolism. Therefore, functional imaging technique may have important role after post stroke patients to observe those changes in blood flow and in the metabolism that is not possible to determine through anatomical imaging. It is obvious that the site, size, and extent of lesion can accurately diagnose through the CT and MRI scans. For this information functional imaging is not at all required and not routinely practised. However, beyond that information the role of functional cannot be denied. Functional imaging can be applied effectively for reviewing physiological correlates of plasticity and regaining noninvasively after localized brain damage. The detected patterns depend on the site, extent, and on the type and dynamics of the development of the lesion. The changes of the functional pattern in the brain proportional to the recovery process of the existing neurological symptoms. However, to observe these functional changes the best imaging techniques are Positron Emission Tomography (PET) and functional MRI (fMRI).

Several functional changes take places during the brain injury and recovery process. Theses functional changes may include the activity changes at the time of the brain injury, the altered brain activity after the injury and the changes while plasticity development. Sequential periodic images by the fMRI is particularly useful in detecting these changes accurately (Herholz & Heiss, 2000; Rijntjes & Weiller, 2002; Rossini, Calautti, Pauri, & Baron, 2003). These periodic image analyses can be done by performing multiple fMRI at different stages of disease. For example, the images can be acquired at the onset of disease at rest and then in the follow up hospital visits. These two images might help in comparing location and extent to deficit and outcome. Also, the images can be taken at rest and during activation tasks. These images might be helpful in comparing the changes in activation patterns to functional performance. It can also demonstrate the recruiting and compensatory mechanisms in the functional network responsible for complete or partial recovery of disturbed functions (Eliassen et al., 2008; Thirumala, Hier, & Patel, 2002; Ward, 2007). Not many studies have been performed by applying this last and most complete design together with extensive testing for the evaluation of the quality of performance finally achieved (Cramer, 2008; Eliassen et al., 2008).

3.3.4 Nuclear Medicine (SPECT & PET)

Nuclear Medicine, primarily via tomographic methods, like SPECT & PET has made important role to find out the hemodynamic and metabolic significances after post ischemia. Many of the pathophysiologic processes and consequences that follow stroke, acute, subacute, and chronic state, including completed infarct core, adjacent penumbra, and diaschisis, have been investigated in Nuclear Medicine. These results are helpful for the long-term outcome of the disease not for acute diagnosis (Lewis, Toney, & Baron, 2012).

Single Photon Emission Computed Tomography (SPECT) is used to help detect the type, location, and cause of stroke. In addition to detecting acute stroke, SPECT is also used in the evaluation of TIA patients to determine which parts of the brain may be at risk. Neuroimaging in ischemic stroke continues to be one of the most developing fields in nuclear medicine (Oku, Kashiwagi, & Hatazawa, 2010).

Nuclear medicine imaging is first presented as a diagnostic method to assess the stroke process. The initial brain damage and resulting neurological disability can be primarily assessed in terms of changes in the vascular and hemodynamic status of the cerebral circulation in addition to alterations in the metabolic status around the infarction region (Mountz, 2007).

3.3.5 Post-Stroke Aphasia and imaging

In case of post stroke Aphasia , impaired glucose metabolism is noted in the ipsilateral hemisphere, which is due to the lesion itself and in the contralateral hemisphere due to functional deactivation, has been explained by the glucose metabolism imaging technique (Heiss, Emunds, & Herholz, 1993). Some studies also explained that in right-handed individuals with language dominance in the left hemisphere, the more specific area, left temporo-parietal region, in particular the angular gyrus, supramarginal gyrus, and lateral and transverse superior temporal gyrus (STG) are mostly and constantly disturbed but the extent of impairment is related to the severity of aphasia. The functional disturbance by regional Cerebral Blood Flow (rCBF) in speech-relevant brain regions early after stroke, is predictive of the eventual outcome of aphasia. Several researches are going on this in the western world. Also, the metabolism in the hemisphere, just abound the healthy tissue of the infract can also be an indicator of the outcome of post-stroke aphasia, functional recovery (Heiss, Thiel, Kessler, & Herholz, 2003).

Additionally, Heiss et al stated that functionality of the bi-hemispheric network has a significant impact on the outcome; although the brain recruits right-hemispheric regions for speech-processing when the left-hemispheric centers are impaired, outcome studies reveal that this strategy is significantly less effective than repair of the speech-relevant network in adults (Heiss et al., 1999) . The study explains the importance of left hemispheric undamaged portion whereas the homologous right hemisphere areas can be deduced from activation studies in the course after post-stroke aphasia in the perspective of recovery (Heiss et al., 1999). Different parts of the brain are not activated at the same time (Y. Cao, Vikingstad, George, Johnson, & Welch, 1999; Saur, Buchert, Knab, Weiller, & Rother, 2006; Warburton, Price, Swinburn, & Wise, 1999). Parallel studies on this revel some interesting results. Heiss et al. (1993, p. 430) stated -

> The subcortical and frontal groups improved substantially; they activated the right inferior frontal gyrus and the right superior temporal gyrus (STG) at baseline and regained left STG activation at follow-up. The temporal group improved only in word comprehension; it activated the left Broca area and supplementary motor areas at baseline and the precentral gyrus bilaterally as well as the right STG at follow-up, but could not reactivate the left STG. These differential activation patterns suggest a hierarchy within the language-related network regarding effectiveness for improvement of aphasia, ie, right hemispheric areas contribute, if left hemispheric regions are destroyed. Efficient restoration of language is usually only achieved if left temporal areas are preserved and can be reintegrated into the functional network.

These functional studies showed more relationship or usefulness with the process of recovery of post stroke in various ways rather than initial diagnosis. Firstly, the optimal recovery can only be achieved by restoration of the original activation pattern after small brain lesions outside primary centers. Secondly, when the primary functional centers are damaged, reduction of collateral inhibition leads to the activation of areas around the lesion (intra-hemispheric compensation). Finally, If the ipsilateral network is severely damaged, reduction of transcallosal inhibition causes the activation of contralateral homotopic areas, which is usually not as efficient as intra-hemispheric compensation. In most instances, the disinhibition of homotopic areas contralateral to the lesion impairs the capacity for recovery (Umarova et al., 2016).

After ischemic stroke it is difficult to assume or predict recovery process and the long-term functional outcomes. Moreover, it is an extraordinarily complex thought imaging modalities to determine or understand the concomitant recovery process and to determine the future. However, there is no alternate modality except imaging to explore theses data or to provide added value over clinical prediction variables. In the future, this information, combined with clinical data may be used to guide both acute and rehabilitative therapies, and provide valuable prognostic information. Large databases including both clinical and imaging data may be developed to allow prognostic and therapeutic decision-making to be individualized based on specific clinical factors and individual pathophysiology (Heiss, 2017).

However, it is somewhat established that functional imaging has limited role as used for the baseline study or for initial diagnosis or assessment procedure. These are expensive and overly complex both technically and comprehendingly. The analysis and interpretation also need super expertise. Of course, this type of highly sophisticated studies can be used for research purpose. However, these are most inappropriate test for the purpose of routine use in the emergency setup in an underdeveloped country. On top of that, Bangladesh is densely populated country. Available health care facilities are honestly not enough to cover up this huge population. It is important to prove appropriate care and management to the patients keeping an eye with time constrains, as we must serve huge patients in limited time. Again, cost effectiveness is also an important factor. Not like few other counties, health service is not free for the patients in our country. As it is not provided by the government mostly, not many people can afford all these expensive investigations.

From the above discussion, the use activation of studies during recovery of post-stroke aphasia suggests a hierarchy of various mechanisms for the compensation of the lesion within the functional network.

3.3.6 Newer modalities

CT angiography (CTA)

CTA can provide a lot of information. First, it can generate the presence, location, and size of occlusive thrombus. CTA can even provide the information on collateral supply to the ischaemic territory. The advantages of CTA are widely available, rapid and provides excellent spatial resolution in assessment of the intra and extracranial vasculature. The sensitivity of CTA in the detection of significant stenosis or thrombotic occlusion of large intracranial and extracranial vessels is 95 to 99% (Wintermark, Rowley, & Lev, 2009). Patients have better chances of early improvement and early independence with lower haemorrhagic complications when treated with IVT those who have low National Institute of Health Stroke Score (NISHH) with distal occlusion on CTA patent vasculature (Sims et al., 2005; Wintermark et al., 2009). Some studies have also reveal sensitivity is higher in CTA in detecting early irreversible ischaemia than unenhanced CT alone (Camargo et al., 2007). However, one of the disadvantages is to speed up imaging and optimize arterial opacification, it has been shown that sometime the infract size is overestimated, which may inadvertently exclude patients from treatment (Pulli et al., 2012). CTA is superior for vessel luminal assessment, but there are limitations due to artefact. CTA assessment is relatively contraindicated with patients suffering from renal disease having high creatinine.

Few other disadvantages of CTP are increases imaging acquisition time, radiation dose and contrast dose. The maximum radiation exposure can be up to 9 and 10 mSv, which is high, when CTP used along with unenhanced CT and CTA can the increase dose of examinations to between. A non-contrast CT typically measures 4 mSv with multiphase CTA introducing a 1 mSv increment of exposure in comparison (Sims et al., 2005).

Nevertheless, CTA is an effective method for rapid assessment of the extra- and intracranial arterial vasculature providing a target for MT, thereby assisting with preprocedural planning. Assessment of collateral circulation by applying CTA can be used as a positive predictor of patient outcome (Smith & Rowland-Hill, 2018).

CT perfusion (CTP)

CT perfusion (CTP) produces a high spatial resolution quantitative measure of perfusion–blood volume mapping. When administering contrast, there is a linear relation of attenuation changes with contrast concentration that has been shown to produce comparable results with MR perfusion(Campbell et al., 2012; Konstas, Goldmakher, Lee, & Lev, 2009). Cerebral blood volume (CBV), cerebral blood flow (CBF) and mean transit time (MTT), i.e., the time difference between arterial inflow and venous outflow, and time-to-peak enhancement (TTP) can be derived by using automated or semi-automated software. Both qualitative and quantitative data can be acquired. Normal required cerebral blood flow is defined as 45–110 ml100 g–1 min–1 to main normal function of brain. This data can be applied to the three-compartment model of acute infarction and provide an estimate of the infarct core. When the blood flow is <10 ml100 g–1 min–1, there is irreversible infarction due to lack of enough cerebral blood flow. However, blood flow

>25 ml100 g–1 min–1can potentially salvageable brain tissue. However, the arterial supply must restore sufficiently quickly otherwise the tissue likely to survive (CBF). As CTP increases imaging acquisition time, radiation dose and contrast dose, it is an unsuitable test to perform in the emergency. CTP when used in combination with unenhanced CT and CTA can the increase dose of examinations to between 9 and 10 mSv. A non-contrast CT typically measures 4 mSv with multiphase CTA introducing a 1 mSv increment of exposure in comparison (Vo et al., 2015). However, lower dose protocols for CTP have been useful (Konstas et al., 2009).

Interpretation of CTP is complex and thus requires specialist training, experience and is time-consuming. CTP has some limitations and contraindications as well. Maps may be inaccurate in those patients having co-existing cardiovascular diseases, such as extracranial carotid occlusion/stenosis, atrial fibrillation, or poor cardiac output if inadequate image acquisition time is given. Reduced perfusion may also be seen in those patients who have seizures that mimic strokes and vasospasm (Allmendinger, Tang, Lui, & Spektor, 2012) .

Chapter Four

Methods & Materials

4.1 Study population

A retrospective quantitative study was conducted among 131 patients attended emergency hospital from March – October 2019 in the three leading tertiary hospitals in Bangladesh. All 131 people had ischemic strokes within last 14 days which was confirmed by neuroimaging with speech difficulties. All the patients with haemorrhagic stroke and previous history of speech and language disorders had been excluded. Usually, haemorrhagic patients require surgery for the management of stroke. Usually once the pressure effect is reduced after surgery, they recover completely. Haemorrhagic stroke patients usually suffer from less ischemia in brain. Neuroimaging was performed by multi-slice 16 CT scan in 106 patients (80.9%) and 25 patients (19.1%) had MRI by 1.5 tesla MRI machine. All the data were analysed by IBM SPSS statistics (Statistical Package for Social Science, version 22, 2013; IBM Corp., Armonk, NY, USA). Ethical Approvals was taken from the respective authorities and informed consents from patients.

Sample size calculation

- $n = \frac{z^2 P(1-P)}{d^2}$
- $= \frac{(1.645)^2 0.5(1-0.5)}{(0.075)^2}$ (90% confidence)
- $= 120$
- Here,
- n= Sample size
- d= Margin of error

- z = Standard normal for 90% confidence interval
- P = Prevalence of a characteristics e.g. lesion side

Inclusion Criteria

Ischemic Stroke within 14 days with speech impairment

Exclusion Criteria

Hemorrhagic Stroke

Recurrent stroke

Any other congenital or associated neurologic disorder

4.2 Protocols- CT & MRI

4.2.1 CT protocol for stroke

After an episode of stroke, initially no ischemia can be visualized in the in CT scan. Gradually the CT scan shows hypodense are due to formation of parenchymal oedema. Again, if there is any clot in the blood vessel, it will appear as an hyperdense area. Usually, two technique is available for performing a Ct scan of brain. One is 'Step and shoot' and another is 'Volumetric acquisition'. Volumetric acquisition is the most commonly used technique.

A standard CT scan report usually contain 4 parts. They are clinical note, technique, description, and comment.

4.2.2 MRI protocol for stroke

To image an infraction in the brain usually a few MRI sequences are done together. The sequences are T1 weighted, T2 weighted, FLAIR, Diffusion weighted imaging (DWI), Susceptibility weighted imaging (SWI). Images are taken in the sagittal plane only T1 weighted sequences. All other sequences images are taken in axial plane. T1 weighted can produce a better image of stroke after 2 weeks. On the other hand, rest of the four sequences are useful for acute stage. Only SWI is sensitive for hemorrhage. Rest of the sequences are sensitive to detect infraction.

4.3 Speech and Language Assessment

4.3.1 Hakim & Sadia's Smart Aphasia Assessment Tool-2019(H-SSAAT 19)

A new smart tool has been invented and used to assess type and severity of Aphasia which is named 'Hakim- Sadia's Smart Aphasia Assessment tool - 2019' (H-SSAAT 19).

Aphasia was assessed initially by a novel tool "Hakim-Sadia's smart aphasia assessment tool - 2019" (H-SSAAT 19) in Bengali language. It is a simple, quick, standard, bedside tool consists of 6 questionnaires that assess production and comprehension of speech and suitable for Bengali patients. All the patients who had no history of previous speech disorders were categorized in three types of aphasia e.g. Broca's, Wernicke's and Global. However, H-SSAAT 19 consists of 12 components comprehension, proficiency, recall of verbal material, word selection and semantics, fluency, concern about impairment, use of functional word, grammaticality, repetition, segmental phonology, comprehension of written material and production of writing only for literate patients. Patients were categorized in Broca's Wernicke's and Global Aphasia. A severity grading was done for Broca's aphasia depending on their clinical linguistic presentations and classified as a) resolving, b) mild, c) moderate and d) severe.

Table 7 Hakim & Sadia's Smart Aphasia Assessment Tool-2019(H-SSAAT 19)

Hakim & Sadia's Smart Aphasia Assessment Tool-2019 (H-SSAAT 19)
Broca's Aphasia
1.What is your name?
2.Tell me your address.
3.Why you have admitted to the hospital?
Check list

No	Component	Comment	Grading
i.	Comprehension of Spoken material	Normal	Mild
ii.	Conversational proficiency	Normal	
iii.	Short term retention and recall of verbal material	Normal	
iv.	Word selection	Normal	
v.	Word semantics	Normal	
vi.	Fluency	Impaired	
vii.	Concern about impairment /Error	Yes	
viii.	Use functional word	Impaired	Moderate
ix.	Grammaticality	Impaired	
x.	Repetition of what other say	Impaired	
xi.	Segmental phonology	Impaired	Severe
xii.	Comprehension of written material	Normal	Only for literate patients
xiii.	Production of writing	Impaired	

No	Component	Mild (Syntactical)	Moderate (Syntactical+ Morphological)	Severe (Syntactical+ Morphological+ Phonological)
i.	Fluency	√		
ii.	1.Functional word absent (Pronoun, adverb, Axillary verb) 2.Bound morpheme absent		√	
iii.	Segmental/ phonological problem			√

Wernicke's Aphasia Assessment:
4.What is the day/ date today?
5. Tell me the name of this abject? (Pen/ Spectacle)
6.What is the colour? (White paper)

Global Aphasia		
7. Patient is-		
i.	Mute	
ii.	Nonverbal response	

Worldwide the 'Western Aphasia Battery' is mostly accepted and widely used aphasia assessment tool. It is an overly complex, lengthy and time consuming but accurate method of assessing type of Aphasia. Instead of using the WBA, the new tool has been used for the following reasons,

- In the emergency setting no Aphasia assessment is done as a lack of a quick assessment tool.
- As the result no aphasia type can be documented initially in the emergency setup.
- It takes at least 2-4 weeks for a referral to speech and language pathologist for first assessment and by that time the diagnosis might have changed.
- Even the diagnosis might have changed the initial diagnosis will always be a good predictor for management and assume the prognosis.
- One of the examples is Glasgow Comma Scale (GCS)- A detail nervous system examination is accurate, most useful and less time consuming. Glasgow comma scale is essential and readily usable in emergency.
- A similar thought encouraged to use this smart tool for aphasia assessment only in the emergency setup. There is no quick aphasia assessment tool develop in native language yet.
- The base line diagnosis of aphasia can be done with it.

- Apart from Bengali language, most of the languages have already using a short assessment tool in their native langue for the evaluation of aphasia.

Table 8 Aphasia screening test for various languages

Screening test	Language	Subtests	Score range	Administration time	Designed for	Bedside
FAST	English	Full form: comprehension; expression; reading; writing	0–30 (full)	10 min	Stroke	Yes
		Short form: comprehension; expression	0–20 (short)	3 min		
LAST	French	Naming; repetition; automatic speech; picture recognition; executing verbal orders	0–15	2 min	Stroke	Yes
MAST*	Korean	Expression; comprehension	0–20	3 min	Stroke	n.r.
MAST	Czech and Spanish	Naming; automatic speech; repetition; following instructions; yes/no responses;	0–100	5–10 min	Severely impaired language/communication	Yes

Screening test	Language	Subtests	Score range	Administration time	Designed for	Bedside
		writing/spelling; object recognition; reading and executing instructions; verbal fluency				
ScreeLing	Dutch	Semantics; phonology; syntax	0–72	15 min	Stroke	Yes
SST	English	Receptive skills; expressive skills	0–20	3–5 min	Suspected language disorders	Yes

(Source: El Hachioui, 2017)

4.3.2 The need of a baseline diagnosis of Aphasia

Baseline diagnosis of aphasia is as important as the diagnosis of stroke. One study was performed 270 acute stroke patients with aphasia (203 with first-ever strokes) were included consecutively and prospectively from three hospitals in Copenhagen, Denmark, and assessed with the Western Aphasia Battery. The assessment was repeated 1 year after stroke. The result was found interesting. Diverse change of aphasia type with time was noticed (Pedersen, Vinter, & Olsen, 2004). For future appropriate management or to understand the natural history of every patient the baseline diagnosis would be a great help (See figure 6).

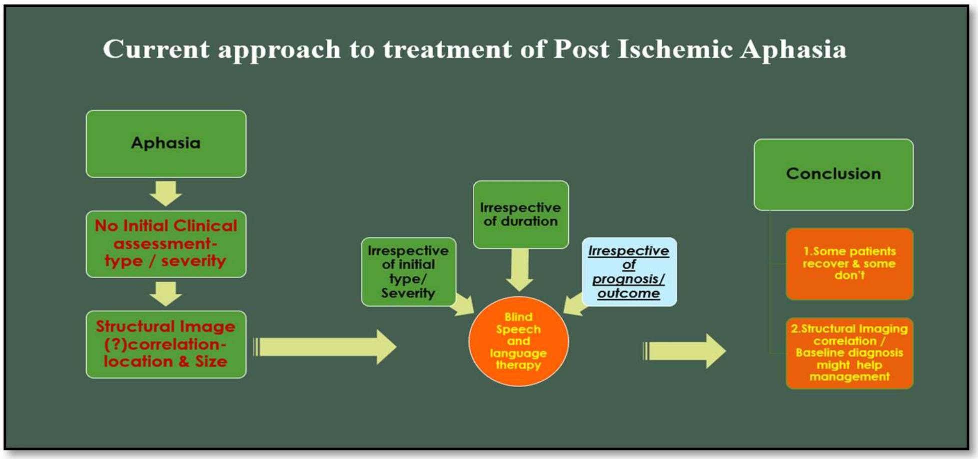

Figure 6 Current approach of treatment of post ischemic aphasia

Several type of language impairments are observed after an episode of stroke. Post-stroke language disorders are frequent and include aphasia, alexia, agraphia and acalculia. There are different definitions of aphasias, but the most widely accepted neurological and/or neuropsychological definition is loss or impairment of verbal communication, which occurs as a consequence of brain dysfunction (Sinanovic, Mrkonjic, Zukic, Vidovic, & Imamovic, 2011). Recovery from aphasia is mainly related and highly influenced by lesion location and type of aphasia. It has been described in the literature that ischemic stroke affect large area in the left hemisphere are more prone to have global aphasia. On the other hand, bad prognosis is found with the patients having subcortical lesions with anomia (Berthier, 2005; Hersh, Wood, & Armstrong, 2018).

The prognosis of aphasia recovery mainly depends upon the underlying aetiology. In cerebrovascular disease, aphasia recovery depends mainly upon the pathology and usually improve to some extent with time (Ashtary, Janghorbani, Chitsaz, Reisi, & Bahrami, 2006; Laska, Hellblom, Murray, Kahan, & Von Arbin, 2001; Pedersen, Jorgensen, Nakayama, Raaschou, & Olsen, 1995; Wade, Hewer, David, & Enderby, 1986). First few months usually shows significant improvement and plateaus after one year. The severity of the initial aphasia strongly associated with long term prognosis which suggests those with mild aphasia at the onset are the most likely to recover completely (Bakheit, Shaw, Carrington, & Griffiths, 2007; Pedersen et al., 2004). It is also concluded by Laska et al. (2001)that even patients with severe speech impairment have a considerable potential for recovery, particularly in the first 3 months after stroke.

In one study of poststroke aphasia assessments were made at baseline and 4, 8, 12 and 24 weeks later. The Western Aphasia Battery aphasia quotient was used to measure the initial severity and the rate and extent of improvement later from aphasia. The result was documented by Bakheit et al. (2007, p. 941) -

> Patients with Broca's aphasia appear to have the best prognosis for improvement of language function in the first year of stroke. The extent of improvement in patients with global aphasia is better than that of patients with Wernicke's aphasia.

Another study conducted by Wade et al. (1986, p. 11) revelled -

> Data relating to 976 patients registered as suffering an acute stroke has been analysed to determine the natural history of speech disturbance: these patients came from a community survey of 215,000 people over a 28-month period. Of the 545 patients assessed within 7 days of stroke, 24% were aphasic and 28% assessable. At 3 weeks, when over 90% of survivors were tested, 20% of those tested had aphasia. At 6 months only 12% of survivors had significant aphasia, but 44% of patients and 57% of carers thought speech was abnormal. Of those aphasics within 7 days, 40% remained so at 6 months; 60% of those aphasics at 3 weeks remained so. There was a high correlation between early and late

aphasia scores. Aphasia was associated with more severe disability (degree of limb weakness, loss of function, loss of IQ), and with a less good recovery of social activities, but did not cause any measurable increase in stress upon carers. In a Health District of 250,000 people, about 60 patients each year may be referred for speech therapy after an acute stroke.

From above literatures it is evident the importance of a baseline study. It is difficult to conduct research and appropriate management of the aphasic patients without a baseline diagnosis. Unfortunately, the scenario is vastly different in Bangladesh. No Aphasia assessment is done even in the tertiary hospitals at initial stage. In the stroke clinic or in the emergency department they only write "difficulties in speech' which is not at all useful. The elaborative Western Aphasia Battery (WAB) and Boston Diagnostic Aphasia Examination (BDAE) are not appropriate tool for baseline assessment. Hakim-Sadia's Smart Assessment Tool-19 (H-SAAT 19) is just an initiative to change the ancient views and to adopt new scientific approach for the benefit of vascular aphasic patients. For that reason, the tool has been made as easiest as possible so that the health professional can use it quickly.

One of the drawbacks of this smart tool is that it can only determine Global, Werneck's and Broca's Aphasia. One of the reasons was to keep it easy and simple for initial introduction with the health professionals. However, it can enrich and revised in the future. Again, it is a very less time-consuming tool. Transcortical motor and transcortical sensory might create confusion on that emergency setup.

After arrival patients with stroke in the accident and emergency department, the conscious patients are usually asked 5-6 questions for neurological assessments. This assessment tool is called

Glasgow Comma Scale. This new smart aphasia assessment tool is made with the same questionnaires. So that not a single moment will be lost for the quick management of the patient simultaneously an initial or baseline aphasia will be assessed without any extra disturbance of patients or clinicians.

There are two well-known Aphasia Assessment tool available. The first one is Western Aphasia Battery and other one is Boston Diagnostic Aphasia Examination.

4.4 Data analysis and assessment

Data entry was done using MS Words, MS Excel. Data analysis were done using IBM SPSS statistics (Statistical Package for Social Science, version 22, 2013; IBM Corp., Armonk, NY, USA). Quantitative data were presented as numbers and percentages. Chi-square pearsons tests were used to compare and to find the association among the quantitative variables. Tables and graphs are presented with MS Excel and Pivot Table. *P* value was considered statistically significant when $P < 0.05$. Regarding statistical analysis for rate of involvement of different areas of the brain areas Pivot table is used. H-SSAAT 19 is the qualitative analysis by answering a questionnaire. Imaging interpretation was done by specialist neuroradiologist following the standard institutional protocol.

Chapter Five

RESULT

5.1 Frequency rates

The study was conducted on 131 people among them 89 males (67.9 %) and 42 females (32.1%) of whom 77 (58.8 %) were hypertensive and 56 (42.7 %) were diabetic. 98. 5 % people claimed to be righthanded. All 131 people had ischemic strokes with aphasia/dysphasia as a presenting complaint. Patients with hemorrhagic strokes and other diagnosis such as space occupying lesions were excluded from the study. 105 patients had Broca's aphasia; 24 had Global aphasia and 2 had Wernicke's aphasia. Of these patients, 69 had speech problems only while 40 had right sided hemiparesis and 22 had left sided hemiparesis. Of the 105 patients with Broca's Aphasia severity was mild in 59 (56.19%), moderate in 9 (8.57%), and severe in 7 (6.67%). The rest of the patient had resolving symptoms. 106 patients had CT scan which is 80.9% of total patients. Rest of the patients 19.1% had MRI. Among all the patients 131 patients, 21 patients (16%) showed lacunar infract. The lesion size was larger than 15mm in rest 110 (84%) patients. 24 patients showed right sided lesion and 50 patients exhibited left sided lesions. Rest of the 57 patients had lesion in both right and left side which consist about 57% of total cases. They are elaborately described below.

1. **Male and female frequency rate**

The study was conducted on 131 patients of whom 89 (67.9 %) male and 42 (32.1%) female.

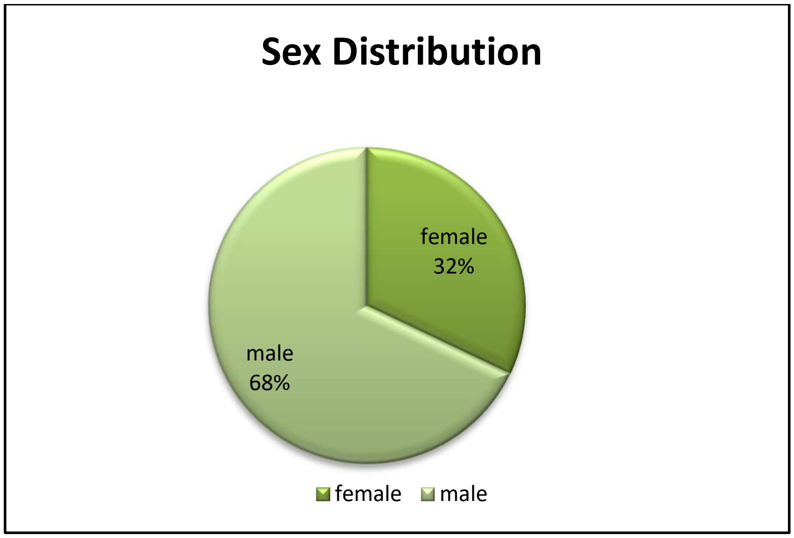

Figure 7 Sex distribution of study Population

2. Sex and age ratio

Among 89 male and less than a half female, it has been observed that the mean age for male was 60.35 and mean age for the female is 60.88. In summary, the mean age for all patients is 60.52.

Table 9 Average age of stroke patients

Age					
Sex	**Mean**	**N**	**Std. Deviation**	**Minimum**	**Maximum**
Male	60.35	89	16.186	19	95
Female	60.88	42	15.733	20	95
Total	60.52	131	15.984	19	95

Most of the patient are within 50 to 80 years. Maximum number of patients are found in between 51 to 60 years old.

In this study, 35 patients are belonging to in 51-60 years age group. The second highest group is 31 patients, and they belong to 61- 70 years and 23 patients are from 71-80 years. However, Majority patients suffer from stroke are from 50-80 years.

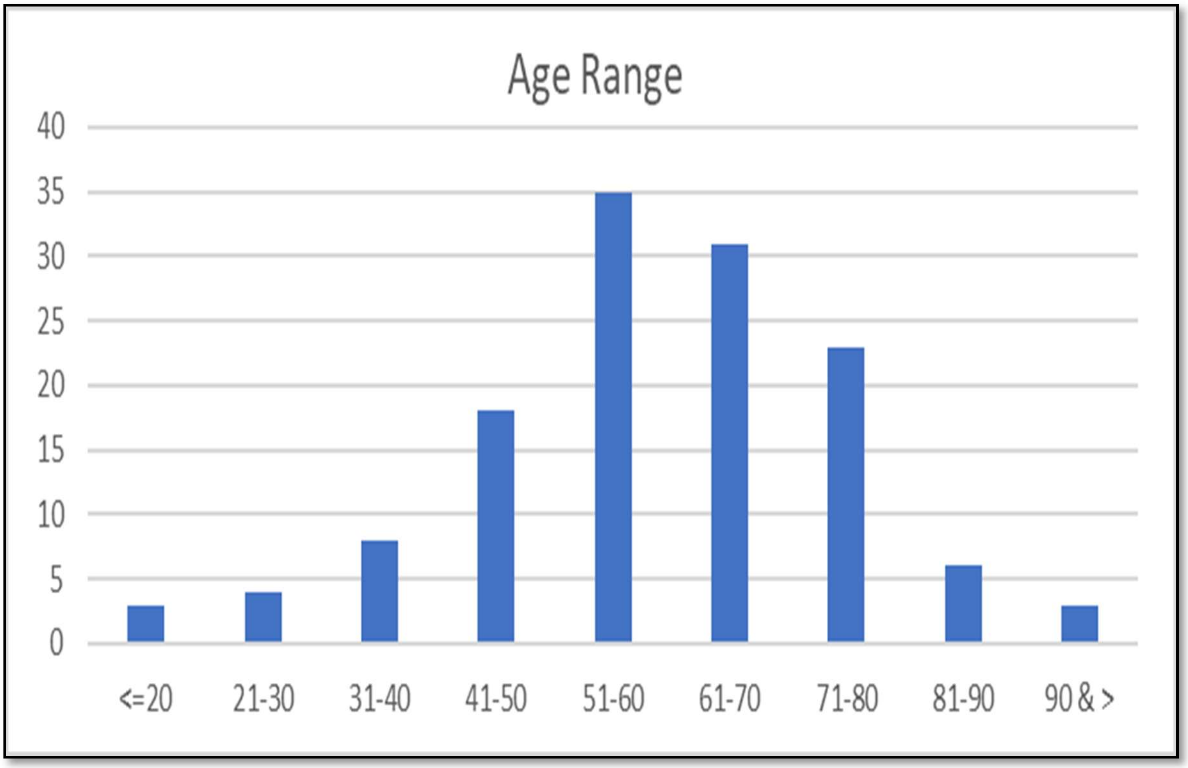

Figure 8 Age distribution of stroke patients

3. HTN frequency

Among 131 patients, 77 (58.8%) have high blood pressure. on the other hand, 54 (41.2%) do not have any blood pressure.

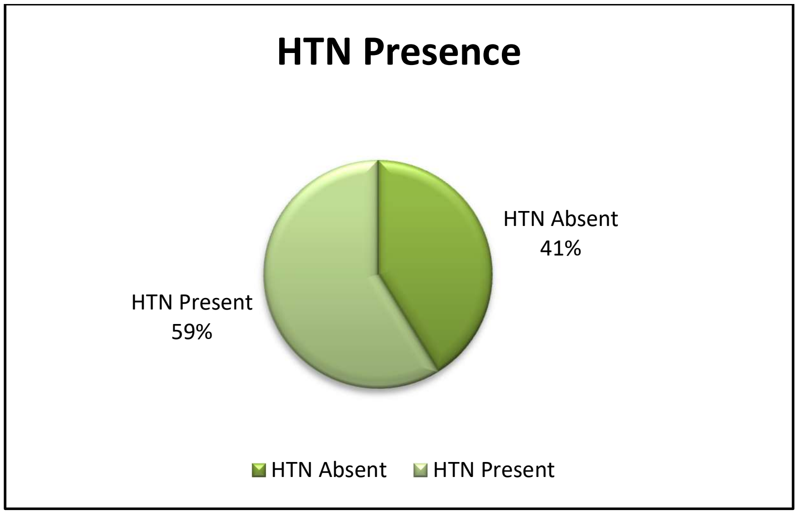

Figure 9 Presence of High Blood Pressure

High Blood Pressure was present in 52 (58.43%) Male and 25 (59.25%) female. Similarly, 17 (40.48%) male and 37 (41.57%) had no Hypertension. There is no difference of presence or absence of Hypertension in relation with sex.

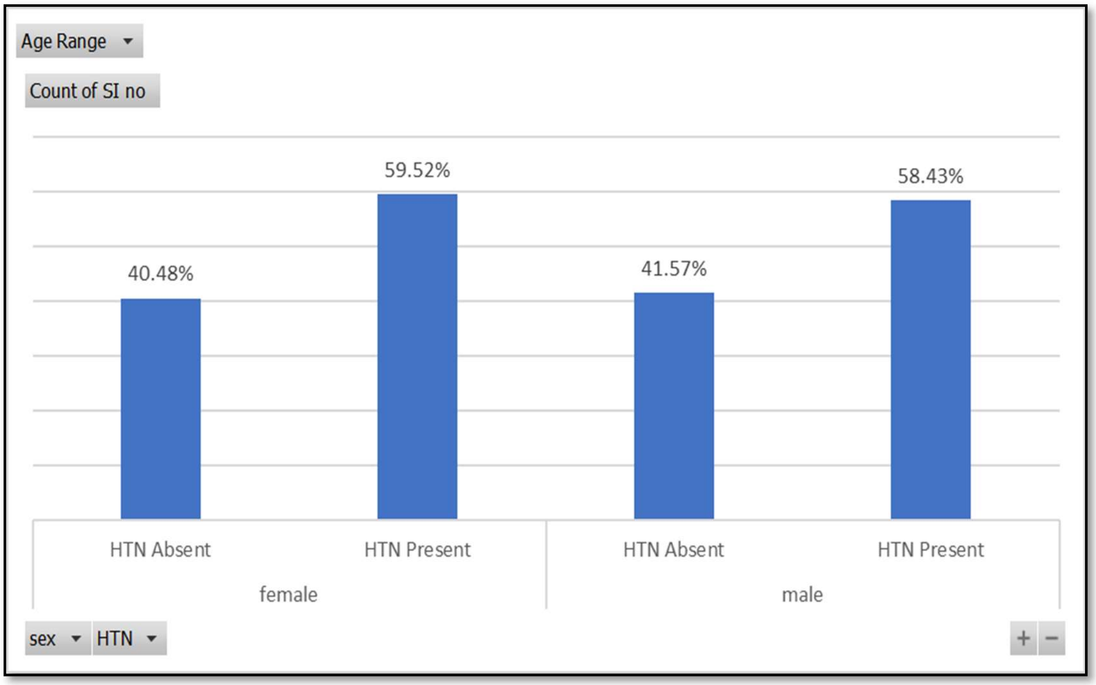

Figure 10 Hypertension and sex orientation

On the other hand, this study found that hypertension was absent in the dominant in the age group and the percentage of the presence is higher in the ages more than 50 years.

Table 10 Prevalence of Hypertension with different age group

HTN	Sample Nos.	% within category
<=20	**3**	**2.29%**
HTN Absent	3	100.00%
21-30	**4**	**3.05%**
HTN Absent	4	100.00%
31-40	**8**	**6.11%**
HTN Absent	6	75.00%
HTN Present	2	25.00%
41-50	**18**	**13.74%**
HTN Absent	11	61.11%
HTN Present	7	38.89%
51-60	**35**	**26.72%**
HTN Absent	13	37.14%
HTN Present	22	62.86%
61-70	**31**	**23.66%**

HTN	Sample Nos.	% within category
HTN Absent	11	35.48%
HTN Present	20	64.52%
71-80	**23**	**17.56%**
HTN Absent	5	21.74%
HTN Present	18	78.26%
81-90	**6**	**4.58%**
HTN Absent	1	16.67%
HTN Present	5	83.33%
90 & >	**3**	**2.29%**
HTN Present	3	100.00%
Grand Total	**131**	**100.00%**

4. **Diabetes Frequency**

Table 11 Presence of DM

Diabetes	Frequency	Percent	Valid Percent	Cumulative Percent
Absent	75	57.3	57.3	57.3

Present	56	42.7	42.7	100.0
Total	131	100.0	100.0	

56 patients have diagnosed Diabetes among 131 patients with ischemic stroke which consists about 42.7%.

5. **Right and Left handedness**

Among 131 patients only 2 patients are found lefthanded which consist of only 1.5 % of total population. Both are men and one was farmer, and another person also belongs to low socio-economic background.

Table 12 Right & Left Handedness

Rt/Lt Handed	Frequency	Percent	Valid Percent	Cumulative Percent
Right	129	98.5	98.5	98.5
Left	2	1.5	1.5	100.0
Total	131	100.0	100.0	

6. **Diagnosis with Right and Left hemiparesis**

All 131 patients have aphasia along with stroke within 14 days. However, among them few patients have right or left sided hemiparesis. 40 patients (30.5%) showed right sided hemiparesis and 22 patients (16.8%) had left sided hemiparesis, whereas 69 patients (52.7%) did not have any hemiparesis.

Table 13 Frequency of clinical presentations

Type of Diagnosis	Frequency	Percent	Valid Percent	Cumulative Percent
Stroke with Aphasia	69	52.7	52.7	52.7
Stroke with Aphasia RSH	40	30.5	30.5	83.2
Stroke with Aphasia LSH	22	16.8	16.8	100.0
Total	131	100.0	100.0	

From the analysis it can be stated that the common clinical presentation after stroke is Aphasia. Hemiparesis is the second most common presentation after stroke. Right sided hemiparesis is more common in patients than left sided hemiparesis.

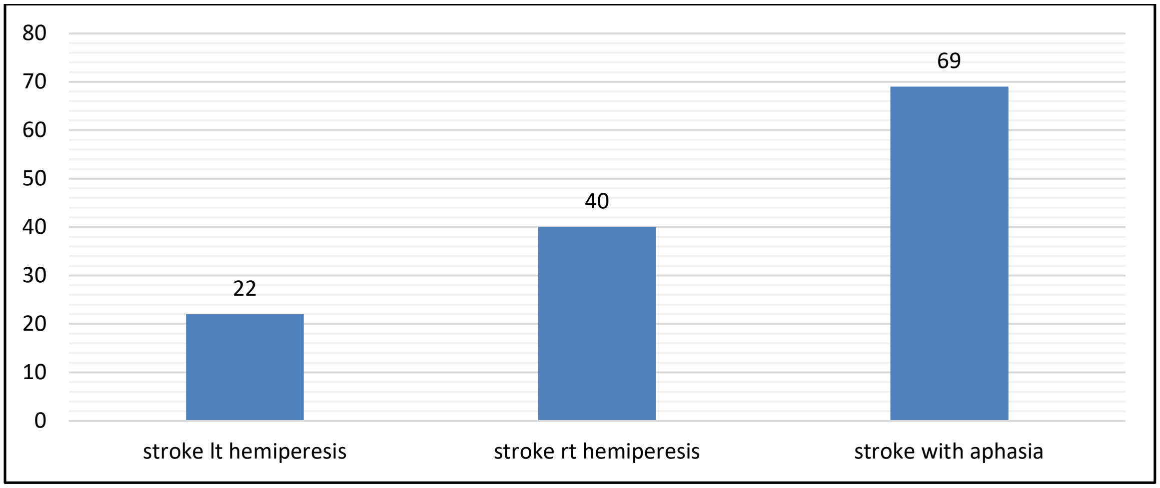

Figure 11 Graphical representation of type of aphasia diagnosis

7. Frequency rate of aphasia type

Mainly three type of aphasia is categorized though the newly developed tool. Among all subjects mostly are found to have Broca's Aphasia which consist of 105 patients (80%). Whereas rest two aphasias are Wernicke's and global which are about 2 (1.5%) and 24 (18.3%) respectively.

Table 14 Frequency rate of Aphasia type

Aphasia type	Frequency	Percent	Valid Percent	Cumulative Percent
Broca's	105	80.2	80.2	80.2
Wernicke's	2	1.5	1.5	81.7

Global	24	18.3	18.3	100.0
Total	131	100.0	100.0	

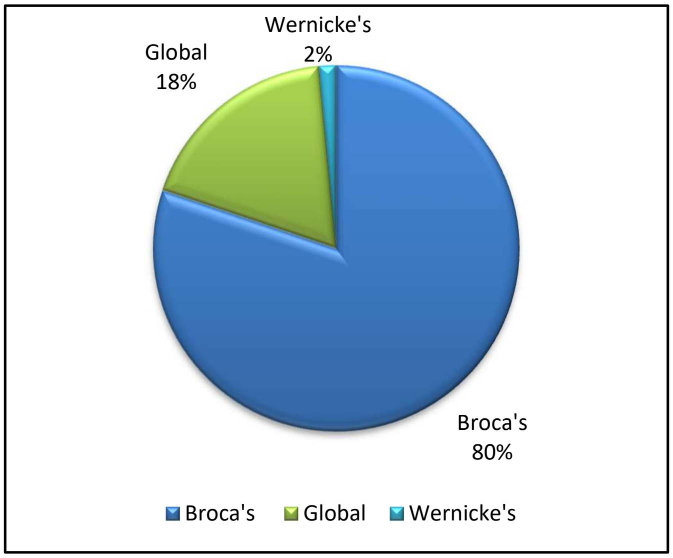

Figure 12 Distribution of Aphasia type in the study population

In this study the most common type of aphasia is found in the Bengali population is Broca's aphasia and the least common type is Wernicke's aphasia.

8. <u>Frequency rate of Broca's severity</u>

To access the severity of Broca's aphasia a severity grading has been done. All the patients have been classified in to five groups. Mainly the severity of Broca's aphasia has been classified as mild, moderate, and severe group. However, there are another two groups, the first one is for those who does not have Broca's aphasia patients with global and Wernicke's Aphasia. The last group is identified as resolving group who experiences aphasia in any form of severity, but they have already recovered well at the time of speech and language assessment.

Table 15 Aphasia Severity Grading

Severity Grading	Frequency	Percent	Valid Percent	Cumulative Percent
Non-Broca's	25	19.1	19.1	19.1
Mild	59	45.0	45.0	64.1
Moderate	9	6.9	6.9	71.0
Severe	7	5.3	5.3	76.3
Resolving	31	23.7	23.7	100.0
Total	131	100.0	100.0	

Among 131 patients 25(19.1%) have none other than Broca's Aphasia. 31 (23.7%) patients are resolving. Rest of the patients are classified under the severity groups. 59(45%) patients have mild Broca's, 9 (6.9%) patients have moderate and 7 (5.3 %) only have severe Broca's aphasia. However, most of the patients about 50% suffer from mild speech impairment. Near about a quarter of patients start recovering by themselves just after the onset of stroke.

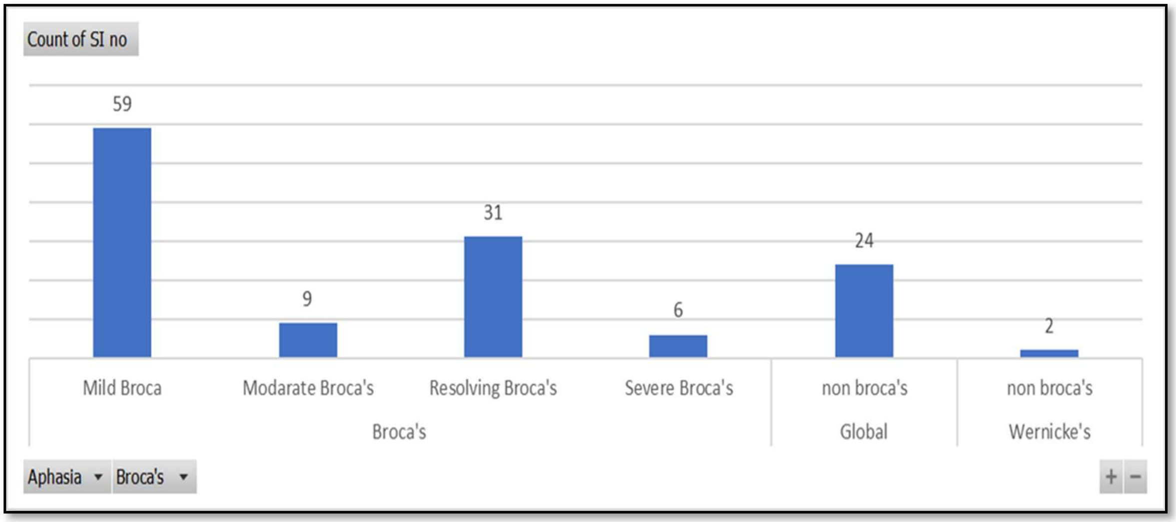

Figure 13 Severity grading of Aphasia

In the severity grading of patients with Broca's aphasia, 31 (29.52%) were resolving, 59 (56.19%) with mild Broca's Aphasia, 9 (8.57%) with moderate and 7(6.66%) had severe Broca's Aphasia.

9. CT/ MRI

Neuroimaging was performed by multi-slice 16 CT scan in 106 patients (80.9%) and 25 patients (19.1%) had MRI by 1.5 tesla MRI machine.

Table 16 Frequency rate of CT & MRI in study population

CT/MRI	Frequency	Percent	Valid Percent	Cumulative Percent
CT	106	80.9	80.9	80.9
MRI	25	19.1	19.1	100.0

Total	131	100.0	100.0	

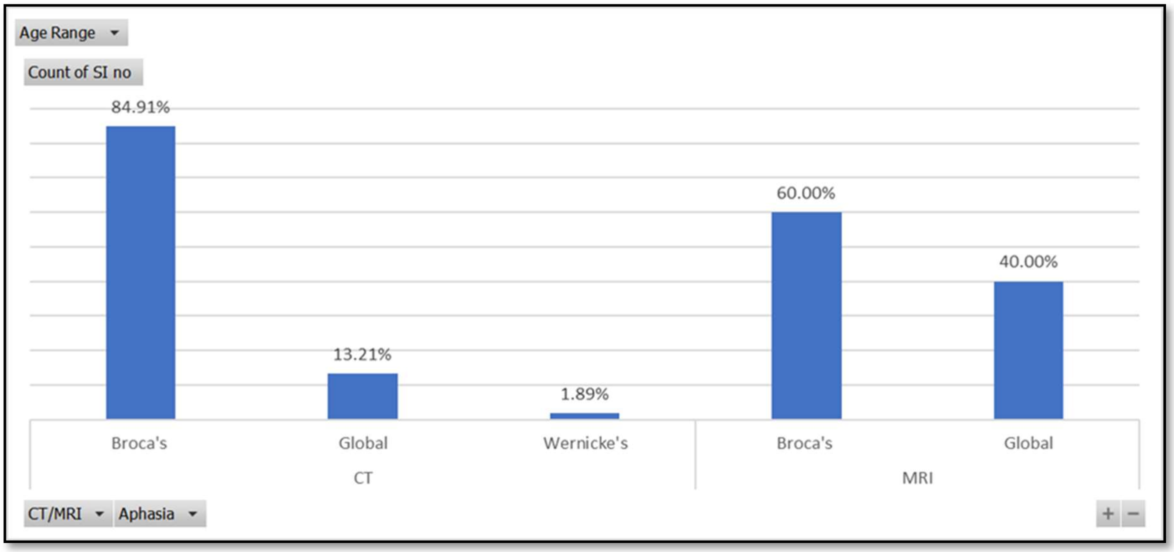

Figure 14 Distribution rate of CT and MRI scan in different type of Aphasia Patient

CT scan had been used mostly for Broca's Aphasia (84.91%) and for all patients of Wernicke's Aphasia (1.89%). Only a few patients of Global Aphasia (13.21%) had CT scan. On the other hand, most of the patients with Global Aphasia had MRI scan (60.0%). MRI is expensive and only advised when the patients was critically ill, hospital admitted and had concomitant other health issues. Usually, patients with Global aphasia had poor GCS and sometimes unconscious. They were more recommended for MRI scans.

10. <u>Frequency rate of Lesion size</u>

In this study, lacunar infract was found in 21 patients (16%) and 110 patients (84.0%) showed larger lesions.

Table 17 Lesion size frequency

Lesion Size	Frequency	Percent	Valid Percent	Cumulative Percent
Less than 15 mm	21	16.0	16.0	16.0
More than 15 mm	110	84.0	84.0	100.0
Total	131	100.0	100.0	

Table 18 Distribution of lesion size with Broca's severity grading

Serial	Severity grade	Lesion size less than 15mm		Lesion size more than 15 mm	
		N	%	N	%
1	Resolving	17	54.8	14	45.2
2	Mild	4	6.8	55	93.2
3	Moderate	0	0	9	100
4	Severe	0	0	7	100

54.8% patient of resolving group had lacunar lesion. Similarly, 6.8 % patients with mild Broca's Aphasia had lacunar lesion. Whereas all the patients with moderate and severe Broca's Aphasia showed larger lesion more than 15 mm in size. P value is 0.000 which is significant.

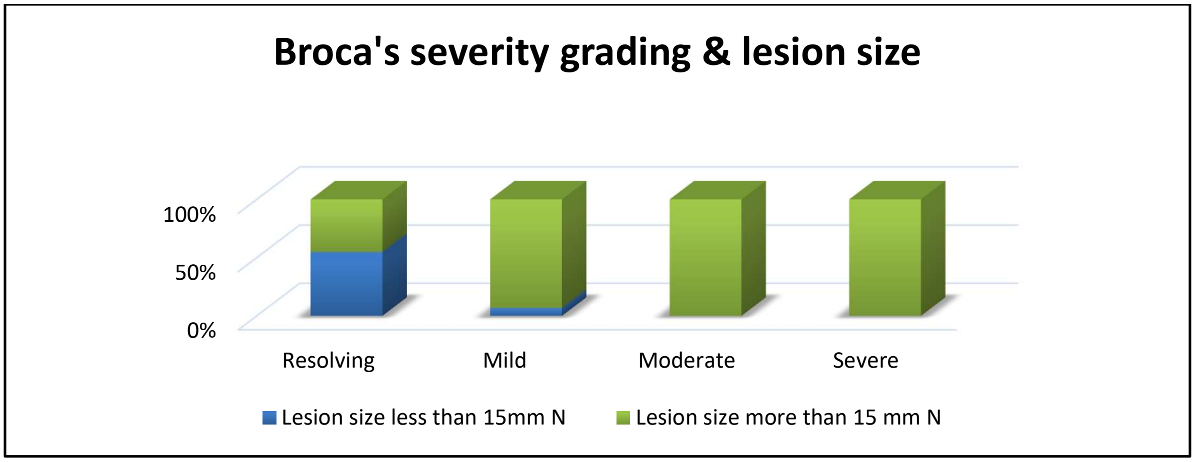

Figure 15 Correlation with Broca's severity grading and lesion size in CT/MRI

11. <u>Frequency rate of Lesion side</u>

Among 131 patients 74 (56%) patients' lesions in either right or left side and about 57 (43.5%) patients had both sided lesions (See Figure 16). Left hemispheric stroke found more than the right hemispheric stroke, 50 (38.2%) and 24 (18.3 %) respectively (See figure 16).

Figure 16 Lesion in Both frontal lobe

Table 19 Distribution of brain lesion side in stroke patients

Lesion side	Frequency	Percent	Valid Percent	Cumulative Percent
Right	24	18.3	18.3	18.3
Left	50	38.2	38.2	56.5
Both	57	43.5	43.5	100.0
Total	131	100.0	100.0	

12. <u>Relation with GCS scale</u>

Most of the patinets with Broca's and Wernicke's aphasia showed to have better GCS. The lowest GCS score of these patients were 12, whereas most of them havd 14 or 15 GCS. On the other hand, GCS is poor in patients with Golobal aphasia, 8/9 was found (See Figure 16).

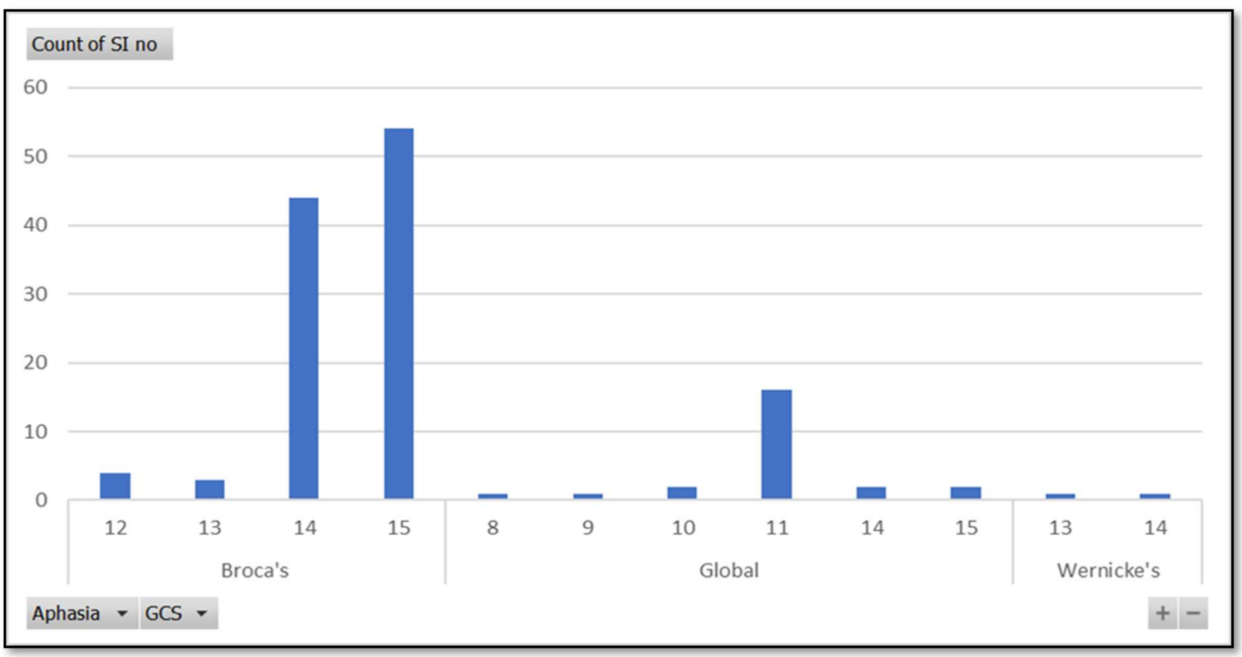

Figure 17 Relation of GCS and type of Aphasia

13. Frequency rate of involved Brain areas

Table 20 Brain area 1: Right Capsulo-ganglionic Area

Right Capsuloganlionic area					
Lesion		Frequency	Percent	Valid Percent	Cumulative Percent
	Absent	120	91.6	91.6	91.6
	Present	11	8.4	8.4	100.0
	Total	131	100.0	100.0	

Almost 120 (91.6%) patients do not have any lesion on the right capsuloganlionic region whereas only 11 patients (8.4 %) have lesion on that site.

Table 21 Brain area 2: Left Capsulo-ganglionic Area

Left Capsulo-ganlionic Area					
Lesion		Frequency	Percent	Valid Percent	Cumulative Percent
	Absent	114	87.0	87.0	87.0
	Present	17	13.0	13.0	100.0
	Total	131	100.0	100.0	

Almost 114 (87%) patients do not have any lesion on the left Capsulo-ganglioni c region whereas only 17 patients (13 %) have lesion on that site.

Table 22 Brain area 3: Both Capsulo-ganglionic Area

Both Capsuloganlionic					
Lesion		Frequency	Percent	Valid Percent	Cumulative Percent
	Absent	119	90.8	90.8	90.8
	Present	12	9.2	9.2	100.0
	Total	131	100.0	100.0	

Almost 119 (90.8%) patients do not have any lesion on both Capsulo-ganglionic region whereas only 12 patients (9.2 %) have lesion on that site.

Among these three sites right, left and both Capsulo-ganglionic most lesions are present in left capsuloganlionic region and least in the right side.

Table 23 Brain area 4: Right Para-ventricular Area

Right Para-venticular Area					
Lesion		Frequency	Percent	Valid Percent	Cumulative Percent
	Absent	114	87.0	87.0	87.0
	Present	17	13.0	13.0	100.0
	Total	131	100.0	100.0	

Almost 114 (87%) patients do not have any lesion on the right Para-venticular region whereas only 17 patients (13 %) have lesion on this site.

Table 24 Brain area 5: Left Para-venticular Area

Left Para-venticular Area					
Lesion		Frequency	Percent	Valid Percent	Cumulative Percent
	Absent	111	84.7	84.7	84.7
	Present	20	15.3	15.3	100.0
	Total	131	100.0	100.0	

Almost 111 (84.7%) patients do not have any lesion on the left para-venticular region whereas only 20 patients (15.3 %) have lesion on this site.

Table 25 Brain area 6: Both Para-ventricular Area

Both Para-venticular Area					
Lesion		Frequency	Percent	Valid Percent	Cumulative Percent
	Absent	119	90.8	90.8	90.8
	Present	12	9.2	9.2	100.0
	Total	131	100.0	100.0	

Almost 119 (90.8%) patients do not have any lesion on both para-venticular region whereas only 12 patients (9.2 %) have lesion on this site. Among these three sites right, left and both para-venticular area most lesions are present in left para-venticular region and least in the right side.

Table 26 Brain area 7: Right Centrum semiovale Area

Rt centrum semiovale					
Lesion		Frequency	Percent	Valid Percent	Cumulative Percent
	Absent	124	94.7	94.7	94.7
	Present	7	5.3	5.3	100.0
	Total	131	100.0	100.0	

Almost 124 (94.7%) patients do not have any lesion on the right centrum semiovale region whereas only 7 patients (5.3 %) have lesion on this site.

Table 27 Brain area 8: Left Centrum semiovale Area

Lt Centrum Semiovale					
Lesion		Frequency	Percent	Valid Percent	Cumulative Percent
	Absent	125	95.4	95.4	95.4
	Present	6	4.6	4.6	100.0
	Total	131	100.0	100.0	

Almost 125 (95.4%) patients do not have any lesion on both centrum semiovale region whereas only 6 patients (4.6 %) have lesion on this site.

Table 28 Brain area 9: Both Centrum semiovale Area

Both Centrum Semiovale					
Lesion		Frequency	Percent	Valid Percent	Cumulative Percent
	Absent	126	96.2	96.2	96.2
	Present	5	3.8	3.8	100.0
	Total	131	100.0	100.0	

Almost 126 (96.2%) patients do not have any lesion on both centrum semiovale region whereas only 5 patients (3.8 %) have lesion on this site.

Among these three sites right, left and both centrum semiovale maximum no of lesions are present in right centrum semiovale region and least in both sides along. However, the frequency of lesion is low comparing to the capsuloganlionic and periventricular regions.

Table 29 Brain area 10: Generalized brain atrophy and periventricular ischemic change

G. Peri Ischemic Change					
Lesion		Frequency	Percent	Valid Percent	Cumulative Percent
	Absent	78	59.5	59.5	59.5

	Present	53	40.5	40.5	100.0
	Total	131	100.0	100.0	

Generalized peri-ischemic change is found in almost 40 % of total population affected by stoke in this study. 53 (40.5%) patients suffer from generalized peri-ischemic changes. Whereas 78 (59.5%) do not have any lesion in that site. However, generalized peri ischemic change is quite common at the old age. The average age is found above 60 years (See figure 18).

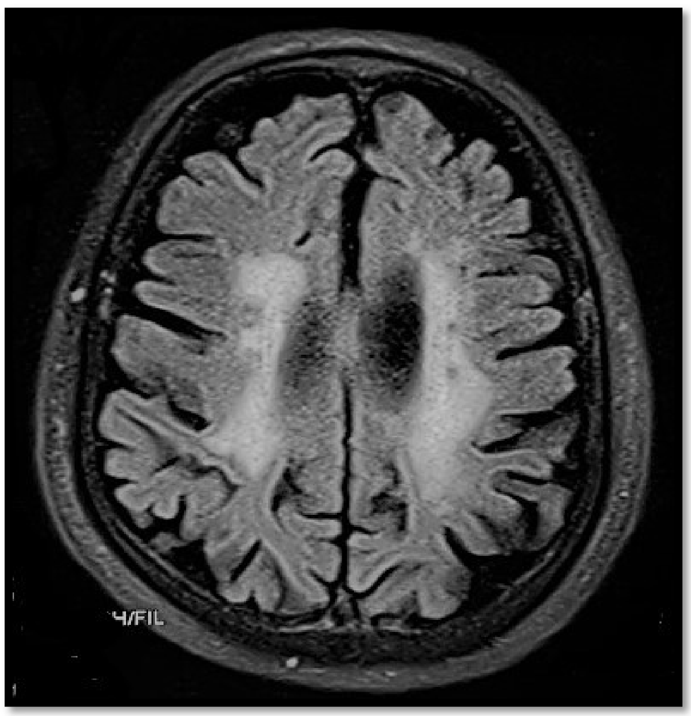

Figure 18 Generalized brain atrophy in MRI

Table 30 Brain Area 11: Right Frontal Lobe

Right Frontal lobe					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Absent	120	91.6	91.6	91.6
	Present	11	8.4	8.4	100.0
	Total	131	100.0	100.0	

Total 120 patients (91%) do not have lesion in the right frontal lobe. On the other hand, only 11 patients (8.4%) have lesion on the right frontal lobe. Broca's center is situated in the frontal lobe. As most of the patients of this study is righthanded is expected that the dominant language center will be on the left side. Again, due to cross aphasia, some patient might have lesion on the right side being righthanded. However, patient with global aphasia also supposed to have big lesion and according to literature both the Broca's and Wernicke's center might be affected from the lesion mainly due to occlusion of middle cerebral artery. In another hypothesis researcher explained that as the predominant language center is on the left side of brain, right frontal lesion causes more personality disorders than language disorders.

Table 31 Brain Area 12: Left Frontal Lobe

Left Frontal lobe				
	Frequency	Percent	Valid Percent	Cumulative Percent

	Absent	115	87.8	87.8	87.8
	Present	16	12.2	12.2	100.0
	Total	131	100.0	100.0	

Among all 131 patients only16 patients have lesion on the left frontal lobe which is about 12.2% of all. However, 115 patients (87.8 %) patients do not have any lesion in the left frontal lobe. Comparatively more lesion is found to be in the left side than the right. As 129 patients are right-handed, more patients are expected to have left dominant hemisphere.

Table 32 Brain Area 13: Right Basal Ganglia & Capsule

Right Basal Ganglia & Capsule					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Absent	120	91.6	91.6	91.6
	Present	11	8.4	8.4	100.0
	Total	131	100.0	100.0	

Almost 120 (91.6%) patients do not have any lesion on the right basal ganglia and in internal capsule area whereas only 11 patients (8.4 %) have lesion on this site.

Table 33 Brain Area 14: Left Basal Ganglia & Capsule

Lt B G & Capsule					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Absent	125	95.4	95.4	95.4
	Present	6	4.6	4.6	100.0
	Total	131	100.0	100.0	

Almost 125 (95.4%) patients do not have any lesion on the left basal ganglia and in internal capsule area whereas only 6 patients (4.6 %) have lesion on this site.

Table 34 Brain Area 15: Both Basal Ganglia & Capsule

Both B G & Capsule					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Absent	130	99.2	99.2	99.2
	Present	1	.8	.8	100.0
	Total	131	100.0	100.0	

Almost 130 (99.2%) patients do not have any lesion on both basal ganglia and in internal capsule area whereas only 1 patient (0.8 %) have lesion on this site.

Among these three sites right, left and both basal ganglia (See Figure 19) and in internal capsule area maximum number of lesions are present in right basal ganglia and in internal capsule area and least in both sides along. However, the frequency of lesion is not at all comparing to the other areas (See figure 19).

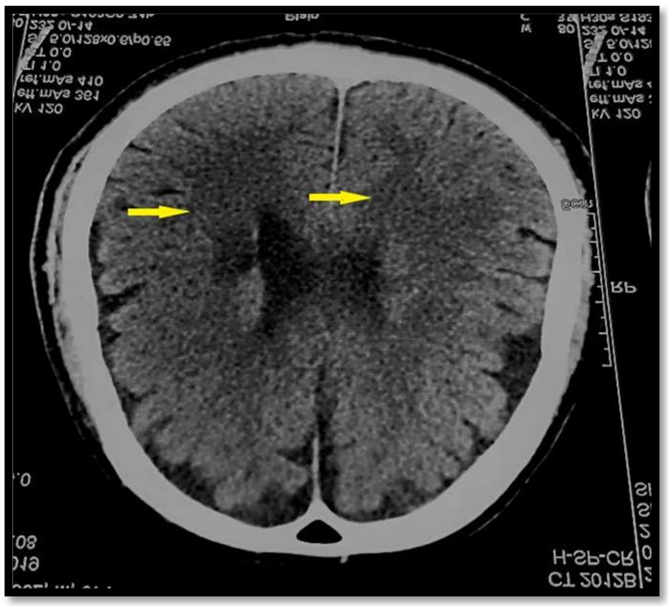

Figure 19 Infracts in both Capsulo-ganglionic and para-venticular locations (CT)

Table 35 Brain Area 16: Pons

Pons					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Absent	122	93.1	93.1	93.1
	Present	9	6.9	6.9	100.0

	Total	131	100.0	100.0	

Almost 9 (6.9%) patients have lesion on the pons whereas only 122 patients (93.1 %) do not have any lesion on it.

Table 36 Brain Area 17: Left Middle Cerebral Artery

Left MCA					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Absent	118	90.1	90.1	90.1
	Present	13	9.9	9.9	100.0
	Total	131	100.0	100.0	

Almost 13 patients (9.9 %) have lesion on the left Middle Cerebral (MCA) territory and 118 (90.1%) patients do not have any lesion in left MCA territory.

Table 37 Brain Area 18: Right Middle Cerebral Artery

Right MCA					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Absent	129	98.5	98.5	98.5
	Present	2	1.5	1.5	100.0
	Total	131	100.0	100.0	

Almost 02 patients (1.5 %) have lesion on the right MCA territory and 129 (98.5%) patients do not have any lesion in right MCA territory.

Comparing right and left middle cerebral artery more lesions are to be found in the left middle cerebral artery which is completely evident by the current available literature. Previous literature also suggest that future studies should be done on the intima- medial complex and the velocity of blood on left MCA as lesions are legally high in the areas of brain supplied by this artery due to the arterial pathology (See Figure 20).

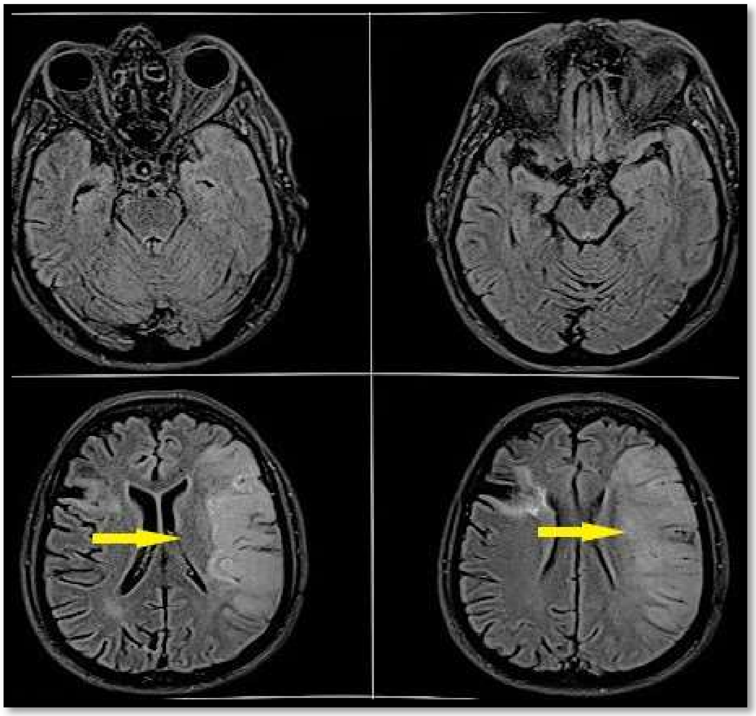

Figure 20 Infraction in left MCA territory

Table 38 Brain Area 19: Right Thalamus

Right Thalamus					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Absent	125	95.4	95.4	95.4
	Present	6	4.6	4.6	100.0
	Total	131	100.0	100.0	

Among 131 patients only 6 patients (4.6%) have lesion in the right Thalamus. Rest 125 patients (95.4%) do not have any lesion in the right thalamus.

Table 39 Brain Area 20: Left Thalamus

Lt thalamus					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Absent	119	90.8	90.8	90.8
	Present	12	9.2	9.2	100.0
	Total	131	100.0	100.0	

In case of left Thalamus about 12 patients (9.2%) show lesion on the left thalamus which is double comparing to the right side. Rest 119 patients (90.8%) do not have any lesion on the left side. Left thalamus is frequently affected than right thalamus.

Table 40 Brain Area 21: Insular Cortex

Insular cortex					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Absent	130	99.2	99.2	99.2
	Present	1	.8	.8	100.0
	Total	131	100.0	100.0	

Only 1 patient (0.8%) has lesion on the Insular cortex among 131 patients.

Table 41 Brain Area: 22 Sylvian Fissure

Sylvian fissure					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Absent	128	97.7	97.7	97.7
	Present	3	2.3	2.3	100.0
	Total	131	100.0	100.0	

Among 131 patients only 3 patients (2.3%) have lesion in the sylvian fissure. Rest 128 patients (97.7%) do not have any lesion in the sylvian fissure.

Table 42 Brain Area 23: Occipito-Parietal Region

Occipito-Parietal					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Absent	125	95.4	95.4	95.4
	Present	6	4.6	4.6	100.0
	Total	131	100.0	100.0	

Among total 131 patients, 6 patients (4.6%) have lesion in the Occipito parietal area, and the rest 125 patients (95.4%) patients do not have any lesion in this area (See Figure 21)

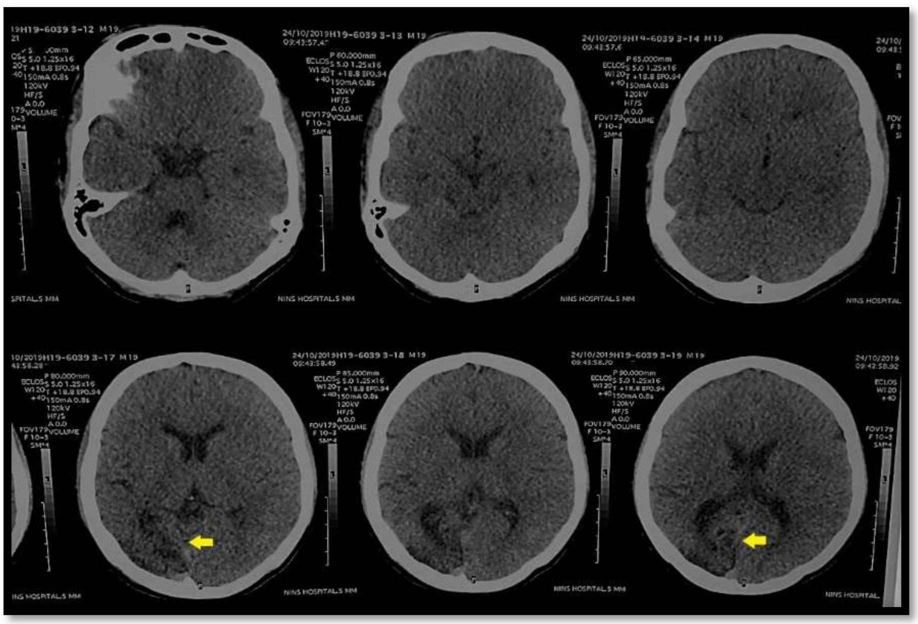

Figure 21 Infracts in right Occipito-parietal region

5.2 Significant Association with variables

I. *Significant Association with Lesion size and Aphasia type*

Table 43 Relation of Lesion size and Aphasia type

Aphasia type and Lesion Size Crosstabulation					
			Lesion Size		Total
			Less than 15 mm	More than 15 mm	
Type	Broca's	Count	21	84	105
		% within Type	20.0%	80.0%	100.0%
	Wernicke's	Count	0	2	2
		% within Type	0.0%	100.0%	100.0%
	Global	Count	0	24	24
		% within Type	0.0%	100.0%	100.0%
Total		Count	21	110	131
		% within Type	16.0%	84.0%	100.0%

Chi-Square Tests			
	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.193[a]	2	**.045**

Likelihood Ratio	10.242	2	.006
Linear-by-Linear Association	6.002	1	.014
N of Valid Cases	131		

The above table describes total 21 patients (16%) have lacunar lesion and 110 patients (84%) have larger lesions among total 131 patients. In case of 105 patients with Broca's aphasia only 21 patients (20%) have lacunar lesion and 84 patients (80%) have larger lesion. On the other hand, no lacunar lesion is noted in patients with Wernicke's and Global aphasic patients. 2 patients (100%) with Wernicke's aphasia and 24 patients (100%) with Global Aphasia show larger lesions.

Lesion size is big in 100% Wernicke's and Global Aphasia. However, 80% Broca's have large lesions. The P value is 0.045. Lacunar lesion were only visualized with 20% of patient with Broca's Aphasia. Rest of the patients with Broca's, Wernicke's and Global have larger lesions on the scans. Global regarded as the most severe type of aphasia in terms of prognosis. Wernicke's aphasia is next to it. All the patients with Global and Wernicke's aphasia showed larger lesion in the brain. Whereas, non-fluent aphasia, Broca's aphasia had both larger and lacunar lesion. Lesion size is statistically associated with type of the Aphasia.

Table 44 Distribution of lesion size with Aphasias

Lesion size	Percentage
Lacunar	**16.03%**
Broca's	16.03%
Large	**83.97%**

Broca's	64.12%
Global	18.32%
Wernicke's	1.53%

Only the patients with Broca's aphasia have lacunar lesions, which consists of 16.03%. On the other hand, 83.97% patients have larger lesion. Among them maximum number of patients 64.12% belong to Broca's aphasia, 18.3% had Global and 1.53% Wernicke's aphasia.

II. Significant Association Lesion size and Aphasia severity

Table 45 Association of the size of the lesion and the severity grading

Broca's severity grading and Lesion Size Crosstabulation					
			Lesion Size		Total
			Less than 15 mm	More than 15 mm	
Broca's	No Broca's	Count	0	25	25
		% within Broca's	0.0%	100.0%	100.0%
	Mild	Count	4	55	59
		% within Broca's	6.8%	93.2%	100.0%
	Moderate	Count	0	9	9
		% within Broca's	0.0%	100.0%	100.0%

	Severe	Count	0	7	7
		% within Broca's	0.0%	100.0%	100.0%
	Resolving	Count	17	14	31
		% within Broca's	54.8%	45.2%	100.0%
Total		Count	21	110	131
		% within Broca's	16.0%	84.0%	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	46.263[a]	4	.000
Likelihood Ratio	43.389	4	.000
Linear-by-Linear Association	35.187	1	.000
N of Valid Cases	131		

Among 131 patients according to the severity of Broca's aphasia they have been classified in three groups. The groups are Mild Broca's, Moderate Broca's, and Severe Broca's aphasia. There is another group of patients who suffered from speech difficulties at the onset of disease and at the time of assessment they are feeling better and explain their current situation without any severe difficulties. They are categorized as resolving cases. Again, among all patients, 24 patients have Global Aphasia, and 2 patients have Wernicke's aphasia are categorized as "No Broca's Aphasia".

However, 25 patients (100%) have lesions more than 15mm in size. In case of Mild Broca's Aphasia 4 patients (6.8%) have smaller lesions but 55 patients (93.2%) have larger lesions. Similarly, in case of Moderate Broca's all the 9 patients (100%) have larger lesions. Same result is observed for the Severe Broca's aphasic patients. Total, 7 patients (100%) have larger lesions in the brain. Lastly, total 31 patients (100%) of resolving group have lesions less than 15 mm in 17 patients (54.85%) and more than 15 mm sized lesion in 14 patients (45.2%). In total, 21 patients (16%) have smaller lesions and 110 patients (84.0%) have larger lesions. P value is 0.000. Therefore, a significant association is noted with size of lesion with the severity and prognosis of the aphasia. 54% patients with resolving Broca's have smaller size lacunar lesions. Patients with lacunar lesions have good prognosis.

III. Significant association of lesion size with Broca's aphasia severity

Table 46 Association of lesion size and severity grading of Aphasia

Serial	**Severity grade**	**Lesion size less than 15mm**		**Lesion size more than 15 mm**	
		N	%	N	%
1	Resolving	17	54.8	14	45.2
2	Mild	4	6.8	55	93.2
3	Moderate	0	0	9	100
4	Severe	0	0	7	100

54.8% patient of resolving group have lacunar lesions. Similarly, 6.8 % patients with mild Broca's aphasia have lacunar lesions. Whereas all the patients with moderate and severe Broca's Aphasia showed larger lesion more than 15 mm in size. P value is significant 0.000.

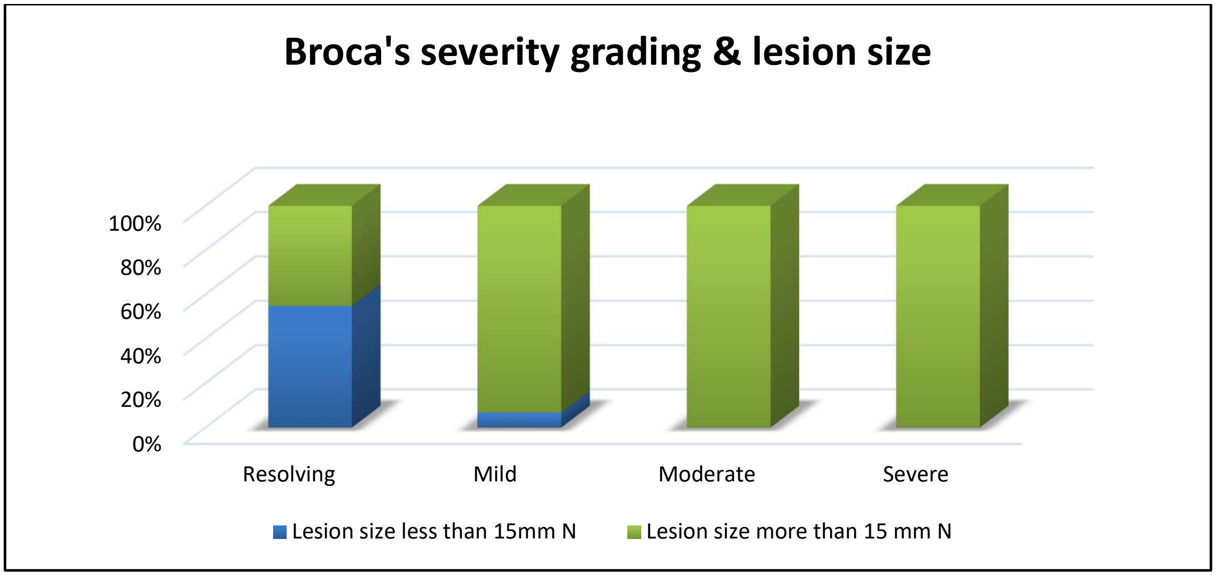

Figure 22 Correlation with Broca's severity grading and lesion size in CT/MRI

For Broca's aphasia most of the patients have larger lesion but 20% showed lacunar lesion. In case of severe and moderate there is no lacunar lesion. In the other hand, lacunar lesion is only found in mild and revolving cases. Most of the lacunar lesion is associated with resolving Broca's. Broca's severity is highly associated with lesion size in the brain.

IV. Significant association with lesion side and Aphasia

Table 47 Association with Aphasia type with lesion side

Aphasia type and Lesion side Crosstabulation						
			Lesion side			Total
			Right	Left	Both	
Type	Broca's	Count	21	34	50	105
		% within Type	20.0%	32.4%	47.6%	100.0%
	Wernicke's	Count	1	1	0	2

		% within Type	50.0%	50.0%	0.0%	100.0%
	Global	Count	2	15	7	24
		% within Type	8.3%	62.5%	29.2%	100.0%
Total		Count	24	50	57	131
		% within Type	18.3%	38.2%	43.5%	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.694[a]	4	**.046**
Likelihood Ratio	10.116	4	.039
Linear-by-Linear Association	.293	1	.588
N of Valid Cases	131		

Among the total 131 the Broca's, Wernicke's and the Global aphasia are respectively 105, 2 and 24. Among 105 patients with Broca's aphasia 21 patients (20%) show lesion on the right, 34 patients (32.4%) on the left and 50 (47.6%) patients have lesions both on right and left side. Overall, almost of the patient about 47.6% patients have lesions on both sides. Similarly, the only two patients with Wernicke's aphasia one shows lesion on the right side and other on the left side. So, there is a homogenous distribution with the side of the lesion in the Wernicke's aphasia does not show any statistical association with side. Lastly, of 24 patients with Global aphasia, 2 (8.3%) patients have lesion on right, 15 (62.5%) patients on the left and rest 7 (29.2%) patients have lesion on both sides. In the summary, lesions are more seen in Global aphasia more on left side and Broca's aphasia more on both sides. P value 0.046. Among these 131 patients' significant association is noted among the type of aphasia and with the side of the lesion. The p value revealed 0.046. In Global Aphasia more lesion is found in left side, ischemic change was noted in left MCA territory which is supported by many international articles throughout the whole world (El-Tallawy et al., 2019). It is also evident that anterior cerebral artery and the posterior cerebral artery do not show any significant change between right and left side, but middle cerebral artery does. Further research is suggested by many researchers with a focus on the intema-medial structure and the velocity of blood in the middle cerebral artery. However, in case of Broca's aphasia both sides were involved instead of a single side.

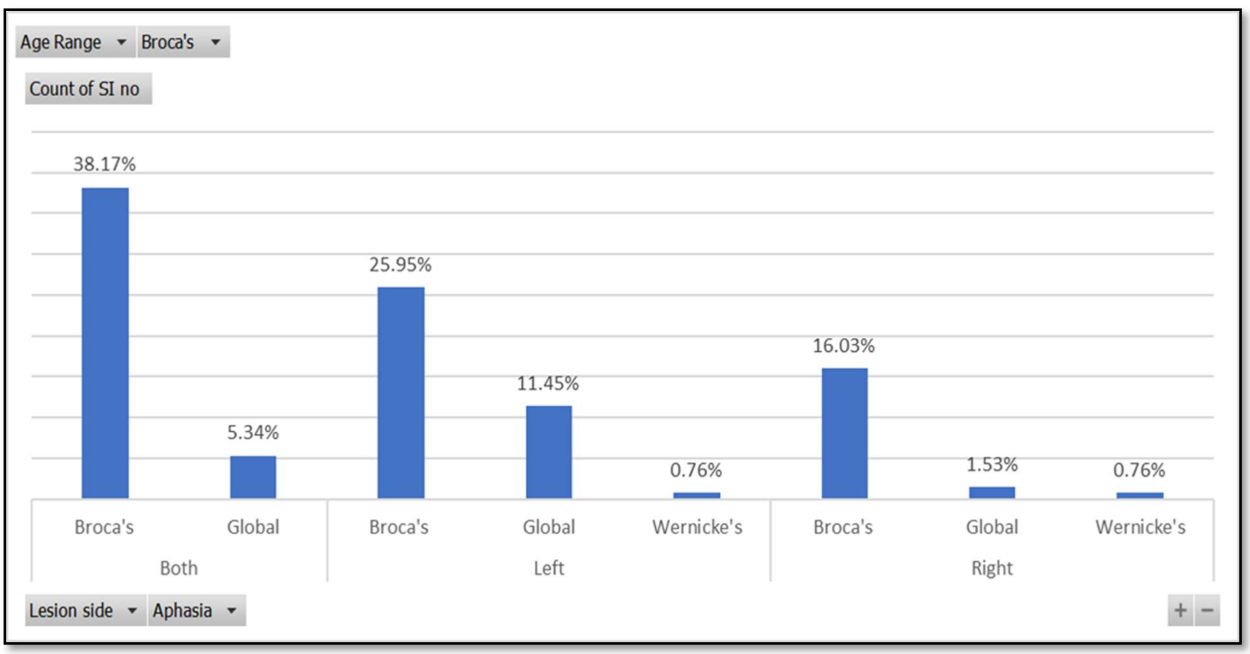

Figure 23 Distribution of the lesion side in various type of Aphasia

V. Significant association with lesion side & clinical presentation:

Table 48 Association of Clinical presentation with lesion side

Ischemic St. Aphasia * Lesion side Crosstabulation						
			Lesion side			Total
			Right	Left	Both	
Ischemic Stroke Aphasia	Stroke with Aphasia	Count	17	12	40	69
		% within Ischemic St. Aphasia	24.6%	17.4%	58.0%	100.0%
	Stroke with Aphasia RSH	Count	0	34	6	40
		% within Ischemic St. Aphasia	0.0%	85.0%	15.0%	100.0%
	Stroke with Aphasia LSH	Count	7	4	11	22
		% within Ischemic St. Aphasia	31.8%	18.2%	50.0%	100.0%
Total		Count	24	50	57	131

	% within Ischemic St. Aphasia	18.3%	38.2%	43.5%	100.0%

Chi-Square Tests			
	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	55.112[a]	4	**.000**
Likelihood Ratio	60.680	4	.000
Linear-by-Linear Association	1.237	1	.266
N of Valid Cases	131		

All patients suffering from right sided hemiparesis show lesion on the left side and the P value is significant 0.00 whereas patients with left sided hemiparesis show lesion in right & left side of the brain even in both sides together. There are 69 patients who have only stroke with speech impairment. The rest two groups have stroke and aphasia along with right sided hemiparesis which consist of 49 patients and the last group of patients having hemiparesis on the left side which consists of only 22. From the result patients only with aphasia without hemiparesis have lesion on the right side 17 (24.6%) and on the left side 12 (17.4%). Lesions on both sides are found in more than half patient which is 40 (58.0%). Similarly, for the patients with stroke with Aphasia along with left sided hemiparesis shows lesion on the right, left and on both sides, which are 24 (18.3%), 50 (38%) and 57 (43.5%) respectively. Moreover, the group of patients show a bit different presentation. Patient with stroke with right sided hemiparesis show no solitary lesion on the right side. They only have lesion on the left side in 34 (85%) patients and rest 6 (15%) have lesion on both hemispheres.

VI. Significant association with lesion side and behavioural change

Table 49 Association of the behavioural change and the lesion side

Lesion side * Irritability Crosstabulation					
			Irritability		Total
			Absent	Present	
Lesion side	Right	Count	14	10	24
		% within Lesion side	58.3%	41.7%	100.0%
	Left	Count	50	0	50
		% within Lesion side	100.0%	0.0%	100.0%
	Both	Count	54	3	57
		% within Lesion side	94.7%	5.3%	100.0%
Total		Count	118	13	131
		% within Lesion side	90.1%	9.9%	100.0%

Chi-Square Tests			
	Value	Df	Asymp. Sig. (2-sided)

Pearson Chi-Square	33.947[a]	2	**.000**
Likelihood Ratio	28.624	2	.000
Linear-by-Linear Association	16.124	1	.000
N of Valid Cases	131		

Among the total 131 patients, 24 patients have lesions on the right side. Among them 10 patients (41 %) have irritability and behavioral change and rest 14 patients (58.3%) do not have such changes. Similarly, 57 patients (100 %) with both sided brain lesions, only 3 patients (5.3%) show behavioral changes. However, most of the patients about 54 (97.4%) do not show any behavioral changes. On the other hand, none of the rest 50 patients (100 %) with left sided brain lesion in frontal lobe show any behavioral change or irritability (See figure 24).

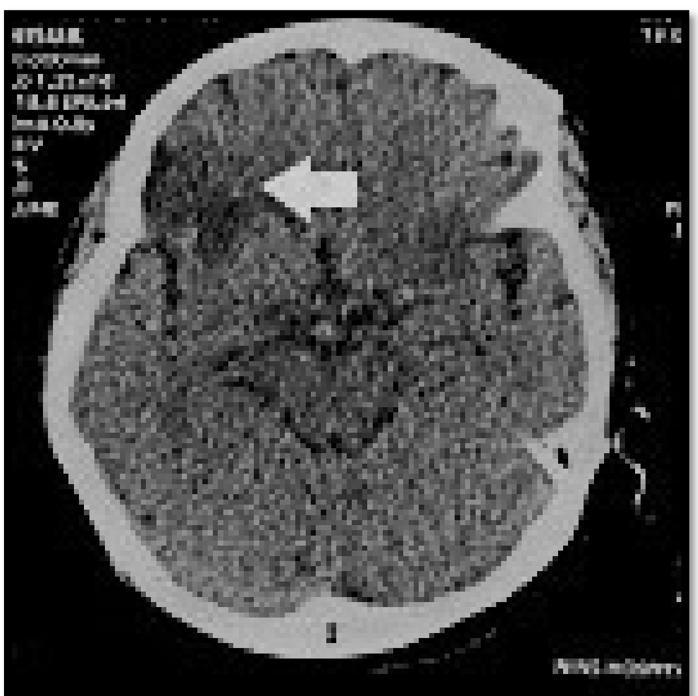

Figure 24 CT Image showing infract in the right frontal lobe

The P value is 0.000 and there is significant association with the behavioral change and lesion side.

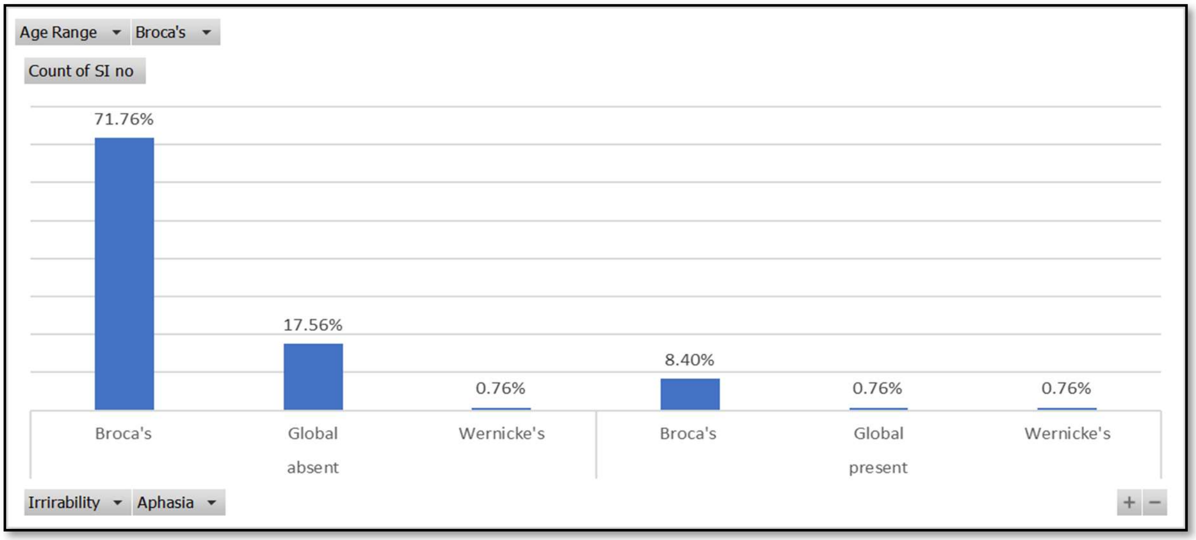

Figure 25 Relation of irritability with various aphasias

VII. No association with lesion side and Broca's severity

Table 50 association with Broca's severity and side of lesion

Severity grading and Lesion side Crosstabulation						
			Lesion side			Total
			Right	Left	Both	
Broca's	No Broca's	Count	3	15	7	25
		% within Broca's	12.0%	60.0%	28.0%	100.0%
	Mild	Count	12	17	30	59
		% within Broca's	20.3%	28.8%	50.8%	100.0%
	Moderate	Count	1	3	5	9

		% within Broca's	11.1%	33.3%	55.6%	100.0%
	Severe	Count	1	3	3	7
		% within Broca's	14.3%	42.9%	42.9%	100.0%
	Resolving	Count	7	12	12	31
		% within Broca's	22.6%	38.7%	38.7%	100.0%
Total		Count	24	50	57	131
		% within Broca's	18.3%	38.2%	43.5%	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.451[a]	8	**.391**
Likelihood Ratio	8.354	8	.400
Linear-by-Linear Association	.099	1	.753
N of Valid Cases	131		

Among 131 patients, 25(100%) patients, 3 patients (12%) have lesions on the right, 15 patients (60.0%) on the left and 7 patients (28 %) on both sides. In case of Mild Broca’s aphasia of 59 patients, 12 patients (20.3%) have lesions on the right, 17 patients (28.8%) on the left and 30 patients (50.8 %) on both sides. Similarly, in case of Moderate Broca’s all the 9 patients (100%), 1 patient (11.1%) has lesion on the right, 3 patients (33.3%) on the left and 5 patients (55.6 %) on both sides. Same result is observed for the Severe Broca's Aphasic patients. Total, 7 patients (100%) 1 (14.3%) patients have lesion on the right, 3 patients (42.9%) on the left and 3 patients (42.9 %) on both sides. Lastly, of 31 patients (100%) of resolving group have lesions 7 patients (22.6%) have lesion on the right, 12 patients (38.7%) on the left and 12 patients (38.7 %) on both sides. In total, 24 patients (18.3%) have lesions on the right side, 50 patients (38.2%) on the left and 57 patients (43.5%) have lesions on both sides. P value is 0.391 which is not statistically significant. Therefore, no significant association is noted with side of lesion with the severity and prognosis of the aphasia.

VIII. Significant association with Lesion sites and Aphasia

Table 51 Association of lesion site with aphasia type

Brain Areas	Broca's	Global	Wernicke's	Grand Total
Right Capsuloganlionic	9	2		**11**
Left Capsuloganlionic	16	1		**17**
Both Capsuloganglionic	9	3		**12**
Right Paraventricular	14	3		**17**
Left Paraventricular	19	1		**20**
Both Paraventricular	9	3		**12**
Right Centrum Semiovale	6	1		**7**
Left Centrum Semiovale	5	1		**6**

Brain Areas	Broca's	Global	Wernicke's	Grand Total
Both Centrum Semiovale	4	1		**5**
G. atrophy and Peri Ischemic Change	47	5	1	**53**
Right Frontal Lobe	10	1		**11**
Left Frontal Lobe	12	4		**16**
Right Basal Ganglia	9	1	1	**11**
Left Basal Ganglia	6			**6**
Both Basal Ganglia	1			**1**
Pons	6	3		**9**
Left MCA		13		**13**
Right MCA	1	1		**2**
Right Thalamus	4	1	1	**6**
Left Thalamus	10	2		**12**
Insular cortex	1			**1**
Sylvian Fissure	1		2	**3**
Occipito Parietal	4	2		**6**

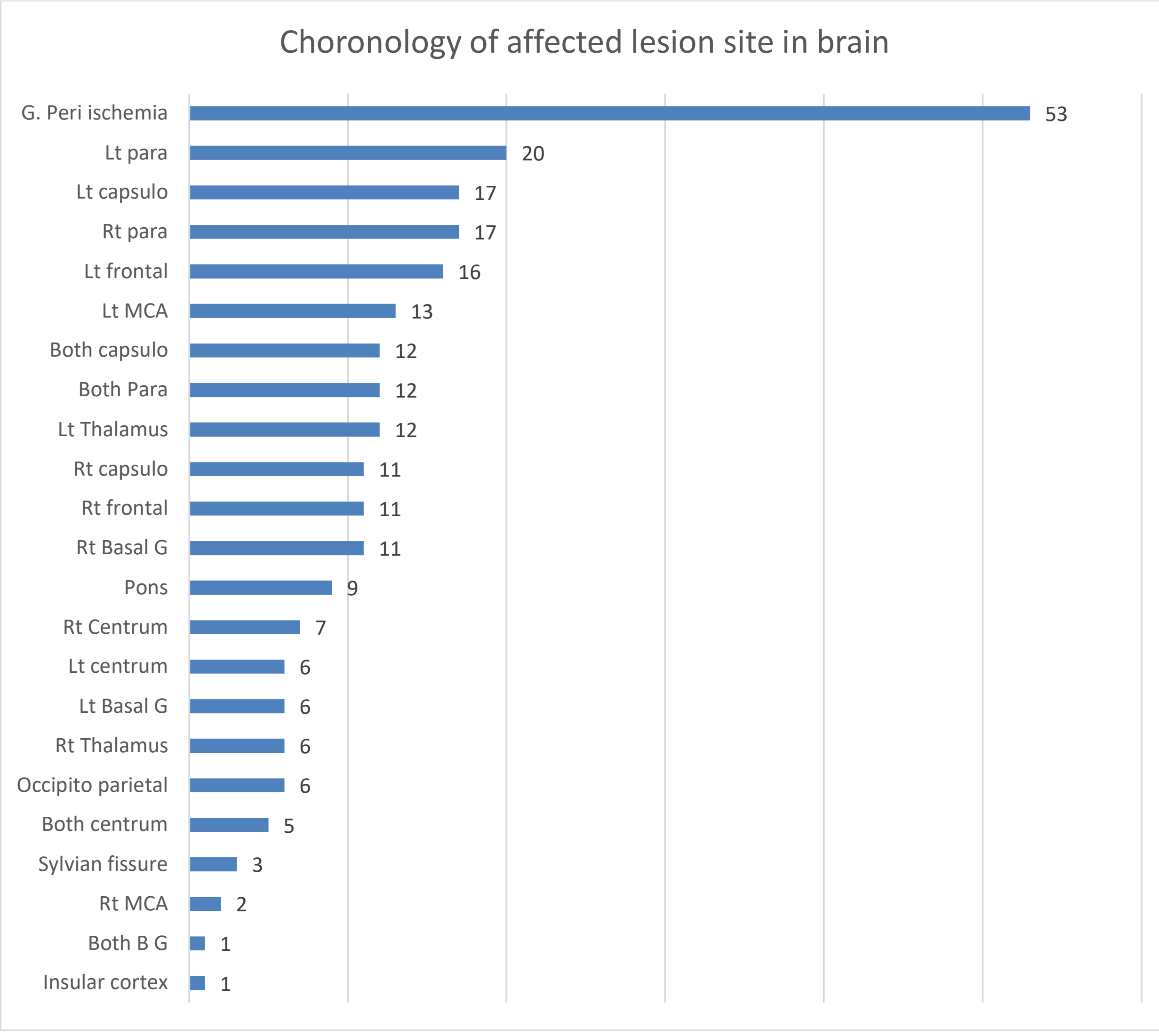

Figure 26 Chronological presentation of affected lesion site in the brain

Maximum lesions are noted in Generalized brain atrophy and periventricular ischemic changes of brain.

IX. Association with lesion site and aphasia type:

Table 52 Relation between aphasia type and right capsulo ganglionic area

Aphasia Type & Right Capsulo-ganlionic					
			Rt Capsulo-ganlionic		Total
			Absent	Present	
Type	Broca's	Count	96	9	105
		% within Type	91.4%	8.6%	100.0%
	Werneck's	Count	2	0	2
		% within Type	100.0%	0.0%	100.0%
	Global	Count	22	2	24
		% within Type	91.7%	8.3%	100.0%
Total		Count	120	11	131
		% within Type	91.6%	8.4%	100.0%

Chi-Square tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.188[a]	2	**.910**
Likelihood Ratio	.355	2	.837

Linear-by-Linear Association	.006	1	.936
N of Valid Cases	131		

Among 131 patients 105 have Broca's aphasia. Only 9 patients (8.9%) have lesions in the right capsule-ganglionic area and rest 96 patients (91.4%) with Broca's aphasia do not have any lesion on that area. Two patients with Wernicke's aphasia do not have any lesion in this area. Lastly, among 24 patients with Global Aphasia, only 2 patients (8.3%) have lesion in the right capsule-ganglionic area and rest 22 patients (91.7%) with Global aphasia do not have any lesion in this area. P value is 0.910. Therefore, lesion in the right capsule-ganglionic area does not show any significant association with the type of aphasia.

Table 53 Relation between Aphasia type and left Capsuloganglionic area

Aphasia type and Left Capsulo-ganglionic					
			Lt Capsuloganlionic		Total
			Absent	Present	
Type	Broca's	Count	89	16	105
		% within Type	84.8%	15.2%	100.0%
	Wernicke's	Count	2	0	2
		% within Type	100.0%	0.0%	100.0%
	Global	Count	23	1	24
		% within Type	95.8%	4.2%	100.0%

Total	Count	114	17	131
	% within Type	87.0%	13.0%	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.423[a]	2	**.298**
Likelihood Ratio	3.174	2	.205
Linear-by-Linear Association	2.243	1	.134
N of Valid Cases	131		

Among 131 patients 105 have Broca's aphasia. Only 16 patients (15.2%) have lesions in the left capsule-ganglionic area and rest 89 patients (84.8%) with Broca's aphasia do not have any lesion on that area. Two patients with Wernicke's Aphasia do not have any lesion in this area. Lastly, among 24 patients with Global Aphasia only 1 patient (4.2%) have lesion in the left capsule-ganglionic area and rest 23 patients (95.8%) with Global aphasia do not have any lesion on that area. P value is 0.298. Therefore, lesion in the left capsule-ganglionic area does not have any significant association with the type of aphasia.

Table 54 Relation between aphasia type and both ganglionic area

Aphasia type and Both Capsulo-ganglionic		
	Both Capsulo-ganglionic	Total

			Absent	Present	
Type	Broca's	Count	96	9	105
		% within Type	91.4%	8.6%	100.0%
	Wernicke's	Count	2	0	2
		% within Type	100.0%	0.0%	100.0%
	Global	Count	21	3	24
		% within Type	87.5%	12.5%	100.0%
Total		Count	119	12	131
		% within Type	90.8%	9.2%	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.567[a]	2	**.753**
Likelihood Ratio	.721	2	.697
Linear-by-Linear Association	.305	1	.581
N of Valid Cases	131		

Among 131 patients 105 have Broca's aphasia. Only 9 patients (8.6%) have lesions in both capsule-ganglionic area and rest 96 patients (91.4%) with Broca's aphasia do not have any lesion on that area. Two patients with Wernicke's Aphasia do not have any lesion in this area. Lastly, among 24 patients with Global Aphasia only 3 patients (12.5%) have lesion in the both capsule-ganglionic area and rest 21 patients (87.5%) with Global aphasia do not have any lesion on that area. In summary, total 12 patients have lesion both in the right and left capsulo-ganglionic areas and 119 do not have any and the P value is 0.753. Therefore, lesion in the both capsule-ganglionic area does not have any significant association with the type of aphasia.

Table 55 Relation between aphasia type and Right Paraventricular area

Aphasia type and Right Paraventricular					
			Rt Paraventricular		Total
			Absent	Present	
Type	Broca's	Count	91	14	105
		% within Type	86.7%	13.3%	100.0%
	Wernicke's	Count	2	0	2
		% within Type	100.0%	0.0%	100.0%
	Global	Count	21	3	24
		% within Type	87.5%	12.5%	100.0%
Total		Count	114	17	131
		% within Type	87.0%	13.0%	100.0%
Chi-Square Tests					

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.315[a]	2	**.854**
Likelihood Ratio	.573	2	.751
Linear-by-Linear Association	.027	1	.870
N of Valid Cases	131		

Among 131 patients 105 have Broca's aphasia. Only 14 patients (13.3%) have lesions in right paraventricular area and rest 91 patients (86.7%) with Broca's Aphasia do not have any lesion on that area. Two patients with Wernicke's aphasia do not have any lesion in this area. Lastly, among 24 patients with Global Aphasia only 3 patients (12.5%) have lesion in the right paraventricular area and rest 21 patients (87.5%) with Global aphasia do not have any lesion on that area. In summary, total 17 patients (13%) have lesion in the right paraventricular area and 114 patients (87.0%) do not have any lesion there. P value is 0.854. Therefore, lesion in right paraventricular area does not have any significant association with the type of aphasia.

Table 56 Relation between aphasia type and left paraventricular area

Aphasia type and Left Paraventricular					
			Lt Paraventricular		Total
			Absent	Present	
Type	Broca's	Count	86	19	105

		% within Type	81.9%	18.1%	100.0%
	Wernicke's	Count	2	0	2
		% within Type	100.0%	0.0%	100.0%
	Global	Count	23	1	24
		% within Type	95.8%	4.2%	100.0%
Total		Count	111	20	131
		% within Type	84.7%	15.3%	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.296[a]	2	**.192**
Likelihood Ratio	4.348	2	.114
Linear-by-Linear Association	3.085	1	.079
N of Valid Cases	131		

Only 19 patients (18.1%) of total 105 Broca's aphasia have lesions in the left paraventricular area and rest 86 patients (81.9%) with Broca's aphasia do not have any lesion on that area. Two patients with Wernicke's aphasia do not have any lesion in this area. Lastly, among 24 patients with Global Aphasia only 1 patient (4.2%) has lesion in the left paraventricular area and rest 23 patients (95.8%) with Global aphasia do not have any lesion on that area. In summary, total 20 patients

(15.3%) have lesion in the left paraventricular area and 111 patients (84.7%) do not have any lesion there and the P value is 0.192. Therefore, lesion in left paraventricular area does not have any significant association with the type of aphasia.

Table 57 Relation between aphasia type and both Para venticular area

Aphasia type and both Para-venticular					
			Both para-venticular		Total
			Absent	Present	
Type	Broca's	Count	96	9	105
		% within Type	91.4%	8.6%	100.0%
	Wernicke's	Count	2	0	2
		% within Type	100.0%	0.0%	100.0%
	Global	Count	21	3	24
		% within Type	87.5%	12.5%	100.0%
Total		Count	119	12	131
		% within Type	90.8%	9.2%	100.0%

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.567[a]	2	**.753**

Likelihood Ratio	.721	2	.697
Linear-by-Linear Association	.305	1	.581
N of Valid Cases	131		

Only 9 patients (8.6%) of total 105 Broca's aphasia have lesions in both paraventricular area and rest 96 patients (91.4%) with Broca's aphasia do not have any lesion on that area. Two patients with Wernicke's aphasia do not have any lesion in this area. Lastly, among 24 patients with Global aphasia about 3 patients (12.5%) have lesion in both paraventricular area and rest 21 patients (87.5%) with Global Aphasia do not have any lesion on that area. In summary, total 12 patients (9.2%) have lesion in both paraventricular area and 119 patients (90.8%) do not have any lesion there and the P value is 0.753. Therefore, lesion in both paraventricular areas do not have any significant association with the type of aphasia (See figure 27).

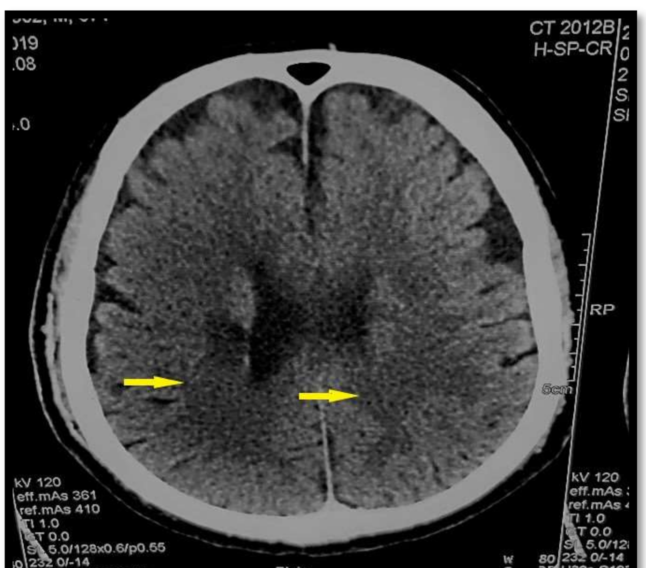

Figure 27 Infracts in both Capsulo-ganglionic and para-venticular areas

Table 58 Relation between aphasia type and Right centrum semiovale

Aphasia type and Right centrum semiovale					
			Rt centrum semiovale		Total
			Absent	Present	
Type	Broca's	Count	99	6	105
		% within Type	94.3%	5.7%	100.0%
	Wernicke's	Count	2	0	2
		% within Type	100.0%	0.0%	100.0%
	Global	Count	23	1	24
		% within Type	95.8%	4.2%	100.0%
Total		Count	124	7	131
		% within Type	94.7%	5.3%	100.0%

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.207[a]	2	**.902**
Likelihood Ratio	.318	2	.853
Linear-by-Linear Association	.112	1	.738

N of Valid Cases	131		

Only 6 patients (5.7%) of total 105 Broca's aphasia have lesions in the right centrum semiovale area and rest 99 patients (94.3%) with Broca's aphasia do not have any lesion on that area. Two patients with Wernicke's aphasia do not have any lesion in this area. Lastly, among 23 patients with Global aphasia only 1 patient (4.2%) have lesion in the right centrum semiovale area and rest 23 patients (95.8%) with Global Aphasia do not have any lesion on that area. In summary, total 7 patients (5.3%) have lesion in the right centrum semiovale area and 124 patients (94.7%) do not have any lesion there and the P value is 0.902. Therefore, lesion in the right centrum semiovale area does not have any significant association with the type of aphasia.

Table 59 Relation between aphasia type and Left centrum semiovale

Aphasia type and Left centrum semiovale					
			Lt centrum semiovale		Total
			Absent	Present	
Type	Broca's	Count	100	5	105
		% within Type	95.2%	4.8%	100.0%
	Wernicke's	Count	2	0	2
		% within Type	100.0%	0.0%	100.0%
	Global	Count	23	1	24
		% within Type	95.8%	4.2%	100.0%

Total	Count	125	6	131
	% within Type	95.4%	4.6%	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.113[a]	2	**.945**
Likelihood Ratio	.205	2	.903
Linear-by-Linear Association	.024	1	.876
N of Valid Cases	131		

Only 5 patients (4.8%) of total 105 Broca's aphasia have lesions in the left centrum semiovale area and rest 100 patients (95.2%) with Broca's aphasia do not have any lesion on that area. Two patients with Wernicke's aphasia do not have any lesion in this area. Lastly, among 23 patients with Global Aphasia only 1 patient (4.2%) have lesion in the left centrum semiovale area and rest 23 patients (95.8%) with Global aphasia do not have any lesion on that area. In summary, total 6 patients (4.6%) have lesion in the left centrum semiovale area, and 125 patients (95.4%) do not have any lesion there and the P value is 0.945. Therefore, lesion in the left centrum semiovale area does not have any significant association with the type of aphasia.

Table 60 Relation between aphasia type and both centrum semiovale

Type * Both centrum semiovale					
			Both centrum semiovale		Total
			Absent	Present	
Type	Broca's	Count	101	4	105
		% within Type	96.2%	3.8%	100.0%
	Wernicks	Count	2	0	2
		% within Type	100.0%	0.0%	100.0%
	Global	Count	23	1	24
		% within Type	95.8%	4.2%	100.0%
Total		Count	126	5	131
		% within Type	96.2%	3.8%	100.0%

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.087[a]	2	**.957**
Likelihood Ratio	.163	2	.922
Linear-by-Linear Association	.003	1	.957

N of Valid Cases	131		

Among 131 patients about 105 have Broca's aphasia. Only 4 patients (3.8%) have lesions in both centrum semiovale area and rest 101 patients (96.2%) with Broca's aphasia do not have any lesion on that area. 2 patients (100%) with Wernicke's aphasia do not have any lesion in this area. Lastly, among 23 patients with Global aphasia only 1 patient (4.2%) have lesion in both centrum semiov ale area and rest 23 patients (95.8%) with Global Aphasia do not have any lesion on that area. In summary, total 5 patients (3.8%) have lesion in both centrum semiovale area and 126 patients (96.2%) do not have any lesion there and the P value is 0.957. Therefore, lesion in both centrum semiovale area does not have any significant association with the type of aphasia.

Table 61 Relation between aphasia type and Generalized atrophy of brain

Aphasia type and G. atrophy &Peri Ischemic Change					
			G. Peri Ischemic Change		Total
			Absent	Present	
Type	Broca's	Count	58	47	105
		% within Type	55.2%	44.8%	100.0%
	Wernicke's	Count	1	1	2
		% within Type	50.0%	50.0%	100.0%
	Global	Count	19	5	24
		% within Type	79.2%	20.8%	100.0%
Total		Count	78	53	131
		% within Type	59.5%	40.5%	100.0%

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.720[a]	2	**.094**
Likelihood Ratio	5.062	2	.080
Linear-by-Linear Association	4.446	1	.035
N of Valid Cases	131		

Among 131 patients about 105 have Broca's aphasia. 47 patients (44.8%) have generalized peri ischemic change and rest 58 patients (55.2%) with Broca's aphasia do not have any definite change on that area. Among 2 patients (100%) with Wernicke's aphasia, 1 patient shows generalized peri ischemic change and other patients do not have any change. Lastly, among 23 patients with Global aphasia 5 patients (20.8%) have generalized peri ischemic change and rest 19 patients (79.2%) with Global aphasia do not have any lesion on that area. In summary, total 53 patients (40.5%) have generalized peri ischemic change in the brain and 78 patients (59.5%) do not have any change there. P value is 0.094 which is not significant but maximum number patients with Broca's aphasia showed lesion in this area (See Figure 28).

Figure 28 Generalized brain atrophy and peri-ishemic change (CT)

Table 62 Relation between aphasia type and right frontal lobe

Aphasia type and Right Frontal lobe					
			Rt frontal lobe		Total
			Absent	Present	
Type	Broca's	Count	95	10	105
		% within Type	90.5%	9.5%	100.0%
	Wernicke's	Count	2	0	2
		% within Type	100.0%	0.0%	100.0%
	Global	Count	23	1	24
		% within Type	95.8%	4.2%	100.0%
Total		Count	120	11	131
		% within Type	91.6%	8.4%	100.0%

Chi-Square Tests			
	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.915[a]	2	**.633**
Likelihood Ratio	1.193	2	.551
Linear-by-Linear Association	.790	1	.374

N of Valid Cases	131		

Among 131 patients about 105 have Broca's aphasia. Only 10 patients (9.5%) have lesions in right frontal lobe and rest 95 patients (90.5%) with Broca's aphasia do not have any lesion on that area. 2 patients (100%) with Wernicke's aphasia do not have any lesion in this area. Lastly, among 24 patients with Global aphasia only 1 patient (4.2%) have lesion in the right frontal lobe and rest 23 patients (95.8%) with Global aphasia do not have any lesion on that area. In summary, total 11 patients (8.4 %) have lesion in right frontal lobe and 120 patients (91.6%) do not have any lesion there and the P value is 0.633. Therefore, lesion in the right frontal lobe do not have any significant association with the type of aphasia.

Table 63 Relation between aphasia type and Left Frontal Lobe

Aphasia type and Left Frontal lobe					
			Lt frontal lobe		Total
			Absent	Present	
Type	Broca's	Count	93	12	105
		% within Type	88.6%	11.4%	100.0%
	Wernicke's	Count	2	0	2
		% within Type	100.0%	0.0%	100.0%
	Global	Count	20	4	24
		% within Type	83.3%	16.7%	100.0%

Total	Count	115	16	131
	% within Type	87.8%	12.2%	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.782[a]	2	.676
Likelihood Ratio	.987	2	.610
Linear-by-Linear Association	.420	1	.517
N of Valid Cases	131		

Only 12 patients (11.4%) of total 105 Broca's aphasia have lesions in left frontal lobe and rest 93 patients (88.6%) with Broca's aphasia do not have any lesion on that area. 2 patients (100%) with Wernicke's aphasia do not have any lesion in this area. Lastly, among 24 patients with Global aphasia only 4 patients (16.7%) have lesion in the left frontal lobe and rest 20 patients (83.3%) with Global aphasia do not have any lesion on that area. In summary, total 16 patients (12.2 %) have lesion in right frontal lobe and 115 patients (87.8%) do not have any lesion there and the P value is 0.676. Therefore, lesion in the left frontal lobe do not have any significant association with the type of aphasia.

Table 64 Relation between aphasia type and right basal ganglia and capsule

Aphasia type and Right Basal Ganglia & capsule					
			Rt B. G & capsule		Total
			Absent	Present	
Type	Broca's	Count	96	9	105
		% within Type	91.4%	8.6%	100.0%
	Wernicke’s	Count	1	1	2
		% within Type	50.0%	50.0%	100.0%
	Global	Count	23	1	24
		% within Type	95.8%	4.2%	100.0%
Total		Count	120	11	131
		% within Type	91.6%	8.4%	100.0%

Chi-Square Tests			
	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.063[a]	2	.080
Likelihood Ratio	3.037	2	.219
Linear-by-Linear Association	.235	1	.628

N of Valid Cases	131		

Only 9 patients (8.6 %) of total 105 Broca's aphasia have lesions in the right basal ganglia and capsule and rest 96 patients (91.4%) with Broca's aphasia do not have any lesion on that area. Among 2 patients (100%) with Wernicke's aphasia, one show lesion on the right basal ganglia and capsule and the other patient is free from lesion on that area. Lastly, among 24 patients with Global aphasia only 1 patient (4.2%) have lesion in the right basal ganglia and capsule and rest 23 patients (95.8%) with Global Aphasia do not have any lesion on that area. In summary, total 11 patients (8.4 %) have lesion in right frontal lobe and 120 patients (91.6%) do not have any lesion there and the P value is 0.080. Therefore, lesion in the right basal ganglia and internal capsule have no association with the type of aphasia.

Table 65 Relation between aphasia type and left basal ganglia and capsule.

Aphasia type and Left Basal Ganglia & Capsule					
			Lt B G & Capsule		Total
			Absent	Present	
Type	Broca's	Count	99	6	105
		% within Type	94.3%	5.7%	100.0%
	Wernicks	Count	2	0	2
		% within Type	100.0%	0.0%	100.0%
	Global	Count	24	0	24

		% within Type	100.0%	0.0%	100.0%
Total		Count	125	6	131
		% within Type	95.4%	4.6%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.557[a]	2	.459
Likelihood Ratio	2.725	2	.256
Linear-by-Linear Association	1.509	1	.219
N of Valid Cases	131		

Only 6 patients (5.7 %) of total 105 Broca's aphasia have lesions in the left basal ganglia and capsule and rest 99 patients (94.3%) with Broca's aphasia do not have any lesion on that area. 2 patients (100%) with Wernicke's aphasia do not have any lesion in this area. Lastly, among 24 patients with Global aphasia (100 %) do not have any lesion on that area. In summary, total 6 patients (4.6 %) have lesion in the left basal ganglia and capsule and 125 patients (95.4%) do not have any lesion there and the P value is 0459. Therefore, lesion in the left basal ganglia and capsule do not have any significant association with the type of aphasia.

Table 66 Relation between aphasia type and both basal ganglia and capsule

Aphasia type and Both Basal Ganglia & Capsule					
			Both B G & Capsule		Total
			Absent	Present	
Type	Broca's	Count	104	1	105
		% within Type	99.0%	1.0%	100.0%
	Wernicke's	Count	2	0	2
		% within Type	100.0%	0.0%	100.0%
	Global	Count	24	0	24
		% within Type	100.0%	0.0%	100.0%
Total		Count	130	1	131
		% within Type	99.2%	0.8%	100.0%

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.250[a]	2	.883
Likelihood Ratio	.444	2	.801
Linear-by-Linear Association	.242	1	.623

N of Valid Cases	131		

Only 1 patient (1.0 %) of total 105 Broca's aphasia has lesion in both basal ganglia and capsule and rest 104 patients (99.0%) with Broca's aphasia do not have any lesion on that area. 2 patients (100%) with Wernicke's aphasia do not have any lesion in this area. Lastly, among 24 patients with Global Aphasia (100 %) do not have any lesion on this area. In summary, total 1 patient (0.8 %) has lesion in both basal ganglia and capsule and 130 patients (99.2%) do not have any lesion there and the P value is 0.883. Therefore, lesion in both basal ganglia and capsule do not have any significant association with the type of aphasia.

Table 67 Relation between aphasia type and pons

Aphasia type and Pons					
			Pons		Total
			Absent	Present	
Type	Broca's	Count	99	6	105
		% within Type	94.3%	5.7%	100.0%
	Wernicks	Count	2	0	2
		% within Type	100.0%	0.0%	100.0%
	Global	Count	21	3	24
		% within Type	87.5%	12.5%	100.0%
Total		Count	122	9	131

	% within Type	93.1%	6.9%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.556[a]	2	.459
Likelihood Ratio	1.489	2	.475
Linear-by-Linear Association	1.293	1	.256
N of Valid Cases	131		

Only 6 patients (5.7%) of total 105 Broca's aphasia have lesions in the pons and rest 99 patients (94.3 %) with Broca's aphasia do not have any lesion on that area. 2 patients (100%) with Wernicke's aphasia do not have any lesion in this area. Lastly, among 24 patients with Global aphasia only 3 patients (12.5 %) have lesion in the left frontal lobe and rest 21 patients (87.5 %) with Global aphasia do not have any lesion on that area. In summary, total 9 patients (6.9 %) have lesions in right frontal lobe and 122 patients (93.1 %) do not have any lesion there and the P value is 0.459. Therefore, lesion in the pons does not have any significant association with the type of aphasia.

Table 68 Relation between aphasia type and left MCA

Aphasia type and Left MCA					
			Left MCA		Total
			Absent	Present	
Type	Broca's	Count	105	0	105
		% within Type	100.0%	0.0%	100.0%
	Wernicke's	Count	2	0	2
		% within Type	100.0%	0.0%	100.0%
	Global	Count	11	13	24
		% within Type	45.8%	54.2%	100.0%
Total		Count	118	13	131
		% within Type	90.1%	9.9 %	100.0%

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	64.344[a]	2	.000
Likelihood Ratio	51.627	2	.000
Linear-by-Linear Association	62.264	1	.000
N of Valid Cases	131		

Among 131 patients about 105 (100%) have Broca's aphasia and not a single patient has lesion in the left MCA territory. Similarly, 2 patients (100%) with Wernicke's aphasia do not have any lesion in this territory. Lastly, among 24 patients with Global aphasia 13 patients (54.2%) have lesion in the MCA territory and rest 11 patients (45.8%) with Global aphasia do not have any lesion on that territory. In summary, total 13 patients (9.9 %) have lesions in MCA territory and 118 patients (90.1 %) do not have any lesion there and the P value is 0.000. Therefore, lesion in the MCA have a significant association with the type of aphasia. Global aphasia is highly associated with the lesion in the left MCA territory and this finding correlates with already existing literature as well (See figure 29).

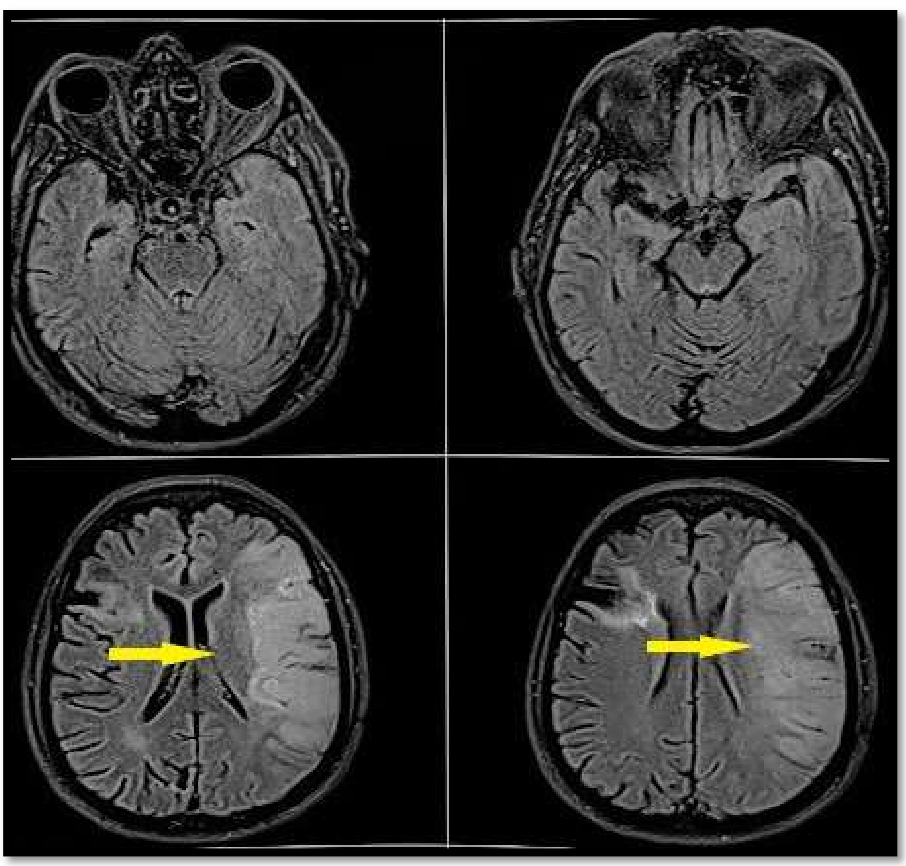

Figure 29 Infraction in Left MCA territory (MRI)

Table 69 Relation between aphasia type and right MCA

Aphasia type and Right MCA					
			Right MCA		Total
			Absent	Present	
Type	Broca's	Count	104	1	105
		% within Type	99.0%	1.0%	100.0%
	Wernicke’s	Count	2	0	2
		% within Type	100.0%	0.0%	100.0%
	Global	Count	23	1	24
		% within Type	95.8%	4.2%	100.0%
Total		Count	129	2	131
		% within Type	98.5%	1.5%	100.0%

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.374[a]	2	.503
Likelihood Ratio	1.085	2	.581
Linear-by-Linear Association	1.279	1	.258

N of Valid Cases	131		

Only 1 patient (1.0%) of total 105 Broca's aphasia have lesion in the right middle cerebral artery territory and rest 104 patients (99.0%) with Broca's aphasia do not have any lesion on that area. 2 patients (100%) with Wernicke's aphasia do not have any lesion in this area. Lastly, among 24 patients with Global aphasia only 1 patient (4.2%) have lesion in the left frontal lobe and rest 23 patients (95.8 %) with Global aphasia do not have any lesion on that area. In summary, total 2 patients (1.5 %) have lesions in right middle cerebral artery territory and 129 patients (98.5%) do not have any lesion there and the P value is 0.503. Therefore, lesion in the right middle cerebral artery territory does not have any association with the type of aphasia (See Figure 30).

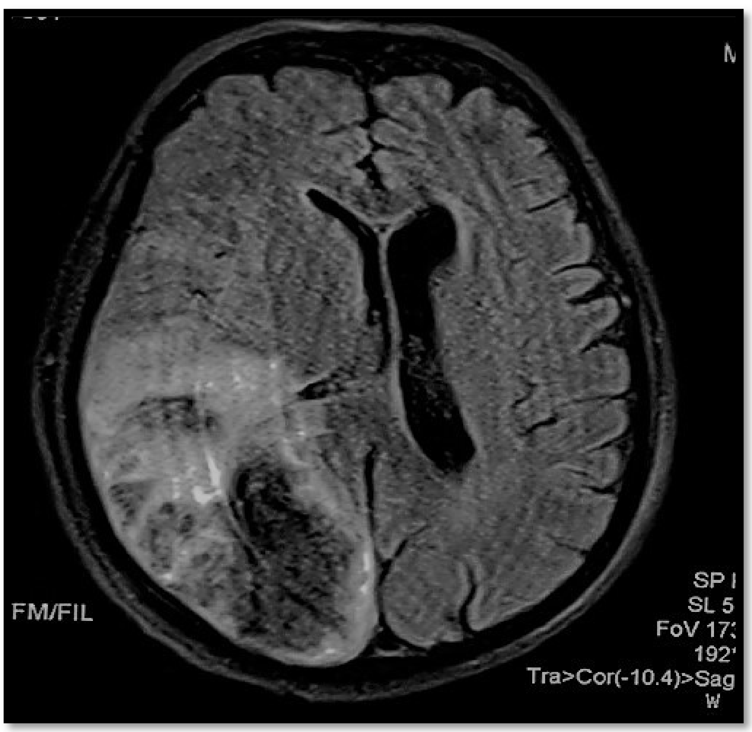

Figure 30 Infract in Right temporo-parietal and occipital area (MRI)

Table 70 Relation between aphasia type and right Thalamus

Aphasia type and Right thalamus					
			Rt thalamus		Total
			Absent	Present	
Type	Broca's	Count	101	4	105
		% within Type	96.2%	3.8%	100.0%
	Wernicke's	Count	1	1	2
		% within Type	50.0%	50.0%	100.0%
	Global	Count	23	1	24
		% within Type	95.8%	4.2%	100.0%
Total		Count	125	6	131
		% within Type	95.4%	4.6%	100.0%

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.593[a]	2	.008
Likelihood Ratio	3.649	2	.161
Linear-by-Linear Association	.145	1	.703
N of Valid Cases	131		

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is .09.

Only 04 patients (3.8 %) of total 105 Broca's aphasia have lesions in the right thalamus and rest 101 patients (96.2%) with Broca's aphasia do not have any lesion on that area. 2 patients (100%) with Wernicke's aphasia, 1 patient show lesion in the right Thalamus and other patient do not have any lesion in this area. Lastly, among 24 patients with Global aphasia only 1 patient (4.2%) have lesion in the right Thalamus and rest 23 patients (95.8 %) with Global aphasia do not have any lesion on that area. In summary, total 6 patients (4.6 %) have lesion in right thalamus and 125 patients (95.4%) do not have any lesion there and the P value is 0.008. Therefore, lesion in the right thalamus show a significant association with the type of aphasia.

Table 71 Relation between aphasia type and left Thalamus

Aphasia type and Left thalamus					
			Lt thalamus		Total
			Absent	Present	
Type	Broca's	Count	95	10	105
		% within Type	90.5%	9.5%	100.0%
	Wernicke's	Count	2	0	2
		% within Type	100.0%	0.0%	100.0%
	Global	Count	22	2	24
		% within Type	91.7%	8.3%	100.0%

Total	Count	119	12	131
	% within Type	90.8%	9.2%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.238[a]	2	.888
Likelihood Ratio	.421	2	.810
Linear-by-Linear Association	.051	1	.822
N of Valid Cases	131		

Only 10 patients (9.5 %) of total 105 Broca's aphasia have lesions in the left thalamus and rest 95 patients (90.5 %) with Broca's aphasia do not have any lesion on that area. 2 patients (100%) with Wernicke's aphasia do not have any lesion in this area. Lastly, among 24 patients with Global aphasia only 2 patients (8.3 %) have lesion in the left thalamus and rest 22 patients (91.7%) with Global aphasia do not have any lesion on that area. In summary, total 12 patients (9.2 %) have lesion in the left thalamus and 119 patients (90.8%) do not have any lesion there and the P value is 0.888. Therefore, lesion in the left frontal lobe does not have any significant association with the type of aphasia.

Table 72 Relation between aphasia type and Insular cortex

Aphasia type and Insular cortex					
			Insular cortex		Total
			Absent	Present	
Type	Broca's	Count	104	1	105
		% within Type	99.0%	1.0%	100.0%
	Wernicke's	Count	2	0	2
		% within Type	100.0%	0.0%	100.0%
	Global	Count	24	0	24
		% within Type	100.0%	0.0%	100.0%
Total		Count	130	1	131
		% within Type	99.2%	0.8%	100.0%

Chi-Square Tests			
	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.250[a]	2	.883
Likelihood Ratio	.444	2	.801
Linear-by-Linear Association	.242	1	.623

N of Valid Cases	131		

Only 1 patient (1.0 %) of total 105 Broca's aphasia have lesions in the insular cortex and rest 104 patients (99.0 %) with Broca's aphasia do not have any lesion on that area. 2 patients (100%) with Wernicke's aphasia do not have any lesion in this area. Lastly, among 24 patients (100%) with Global aphasia show no lesion in the insular cortex. In summary, only 1 patient (0.8 %) has lesion in the insular cortex and 130 patients (99.2%) do not have any lesion there and the P value is 0.883. Therefore, lesion in the left frontal lobe does not have any significant association with the type of aphasia.

Table 73 Relation between aphasia type and Sylvian fissure

Aphasia type and Sylvian fissure					
			Sylvian fissure		Total
			Absent	Present	
Type	Broca's	Count	104	1	105
		% within Type	99.0%	1.0%	100.0%
	Wernicke's	Count	0	2	2
		% within Type	0.0%	100.0%	100.0%
	Global	Count	24	0	24
		% within Type	100.0%	0.0%	100.0%
Total		Count	128	3	131

	% within Type	97.7%	2.3%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	86.736[a]	2	**.000**
Likelihood Ratio	17.292	2	.000
Linear-by-Linear Association	.411	1	.522
N of Valid Cases	131		

Only 1 patient (1.0 %) of total 105 Broca's aphasia has lesion in the sylvian fissure and rest 104 patients (99.0 %) with Broca's aphasia do not have any lesion on that area. 2 patients (100%) with Wernicke's aphasia do have lesions in this area. Lastly, among 24 patients (100%) with Global aphasia have no lesion in the sylvian fissure. In summary, total 3 patients (2.3 %) have lesions in sylvian fissure and 128 patients (97.7 %) do not have any lesion there and the P value is 0.000. Therefore, lesion in the sylvian fissure have a significant association with the type of aphasia. It is observed that 100 % patient with Wernicke's aphasia have lesion on this site. Anatomically, sylvian fissure is the area deep down to the lateral sulcus which separates frontal, parietal lobe from temporal lobe and also this the anatomical location of the Wernicke's area that is responsible for the comprehension of the language.

Table 74 Relation between aphasia type and Occipito Parietal

Aphasia type and Occipito-Parietal					
			Occipito-Parietal		Total
			Absent	Present	
Type	Broca's	Count	101	4	105
		% within Type	96.2%	3.8%	100.0%
	Wernicke's	Count	2	0	2
		% within Type	100.0%	0.0%	100.0%
	Global	Count	22	2	24
		% within Type	91.7%	8.3%	100.0%
Total		Count	125	6	131
		% within Type	95.4%	4.6%	100.0%

Chi-Square Tests			
	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.012[a]	2	.603
Likelihood Ratio	.967	2	.617
Linear-by-Linear Association	.841	1	.359

N of Valid Cases	131		

Only 4 patients (3.8 %) of total 105 Broca's aphasia have lesions in the occipitoparietal region and rest 101 patients (96.2 %) with Broca's aphasia do not have any lesion on that area. 2 patients (100%) with Wernicke's aphasia do not have any lesion in this area. Lastly, among 24 patients with Global aphasia only 2 patients (8.3 %) have lesion in the Occipito- parietal and rest 22 patients (91.7%) with Global aphasia do not have any lesion on that area. In summary, total 6 patients (4.6 %) have lesions in the Occipito parietal region, and 125 patients (95.4%) do not have any lesion there and the P value is 0.603. Therefore, lesion in the left frontal lobe does not show any significant association with the type of aphasia.

In a nutshell, significant Association in noted among Wernicke's aphasia and sylvian fissure and Global aphasia and left MCA territory. However, Broca's aphasia is associated with various sites but does not show any significant association with particular areas.

Table 75 Association of the brain lesions site with the types of Aphasia

Serial	Sites	Broca's	Wernicke's	Global	P value
1	Rt capsule-ganglionic	9	0	2	0.910
2.	Left capsule-ganglionic	16	0	1	0.298
3.	Both capsule-ganglionic	9	0	3	0.753
4.	Rt para-ventricular	14	0	3	0.845
5.	Lt para-ventricular	19	0	1	0.192

Serial	Sites	Broca's	Wernicke's	Global	P value
6.	Both para-ventricular	9	0	3	0.753
7.	Rt Centrum semiovale	6	0	1	0.902
8.	Lt Centrum semiovale	5	0	1	0.945
9.	Both Centrum semiovale	4	0	1	0.957
10.	G. peri ischemic change	47	1	5	0.094
11.	Rt Frontal lobe	10	0	1	0.633
12.	Lt Frontal lobe	12	0	3	0.676
13.	Rt Basal G. & Capsule	9	1	1	0.080
14	Lt Basal G. & Capsule	6	0	0	0.459
15	Both Basal G. & Capsule	1	0	0	0.883
16	Pons	6	0	3	0.459
17	Left MCA	0	0	13	0.000
18	Right MCA	1	0	1	0.503
19	Right Thalamus	4	1	1	0.008
20	Left Thalamus	10	0	2	0.888

Serial	Sites	Broca's	Wernicke's	Global	P value
21	Insular Cortex	1	0	0	0.883
22	Sylvian fissure	1	2	0	0.000
23	Occipito Parietal	4	0	2	0.603

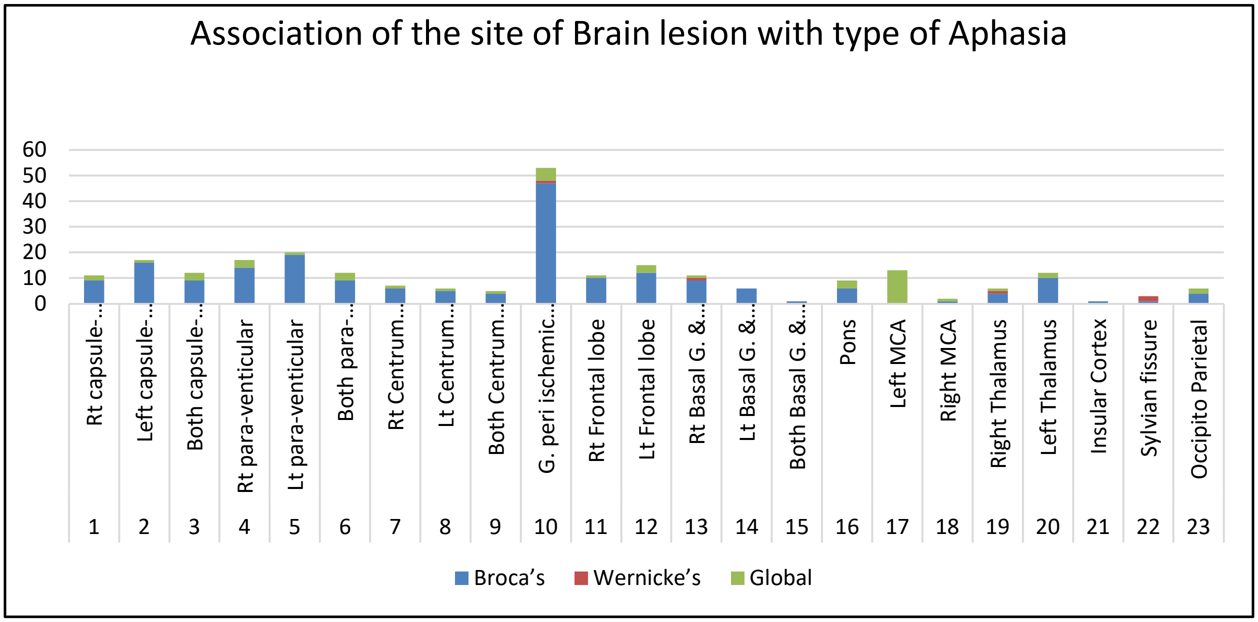

Figure 31 Association of the site of Brain lesion with type of Aphasia

X. No association with Handedness and Aphasia & Hemiparesis:

The study reveals that 69 righthanded patients do not have any hemiparesis. 22 right-handed patients have right sided hemiparesis and 2 lefthanded patients also have right sided hemiparesis. On the other hand, the rest 22 righthanded patients only have left sided hemiparesis. In short, all the righthanded patients shows LSH whereas LSH are present both right and lefthanded. P value 0.099 is not significant.

Table 76 Association of handedness and clinical presentation of stroke with aphasia

Ischemic St. Aphasia * Rt/Lt Hand Crosstabulation					
			Rt/Lt Hand		Total
			Right	Left	
Ischemic St. Aphasia	Stroke with Aphasia	Count	69	0	69
		% within Ischemic St. Aphasia	100.0%	0.0%	100.0%
	Stroke with Aphasia RSH	Count	38	2	40
		% within Ischemic St. Aphasia	95.0%	5.0%	100.0%
	Stroke with Aphasia LSH	Count	22	0	22
		% within Ischemic St. Aphasia	100.0%	0.0%	100.0%
Total		Count	129	2	131
		% within Ischemic St. Aphasia	98.5%	1.5%	100.0%

Chi-Square Tests			
	Value	Df	Asymp. Sig. (2-sided)

Pearson Chi-Square	4.621[a]	2	**.099**
Likelihood Ratio	4.816	2	.090
Linear-by-Linear Association	.458	1	.498
N of Valid Cases	131		

5.3 Interpretation

For many years there is a dilemma about the finding of neuroimaging and clinical correlation of post stroke aphasia. In this study male were found to have more aphasia 67.9 % than female 32.1%.

Most of patients, almost 80% had Broca's Aphasia. 18.3 % had Global aphasia and The rest only 1.5% patients had Wernicke's aphasia. -which were different from existing literature.

Among 105 patients with Broca's Aphasia, 47 patients (44.8%) showed generalized brain atrophy and peri ventricular ischemic change and rest 58 patients (55.2%) did not have any definite change on that area. and the P value found 0.094 which is not significant but suggestive. On the other hand, 2 patients (100%) with Wernicke's Aphasia had lesions in sylvian fissure and p value is significant, 0.000. Similarly, 1 patient (50%) had lesion in right thalamus with significant P value 0.008. Lastly, among 24 patients with Global Aphasia 13 patients (54.2%) had lesions in the left middle cerebral artery territory with a P value is significant 0.000.

-

Wernicke’s aphasia is associated with sylvian fissure. Typically, Wernicke's area is considered to reside in the cortex of posterior section of the superior temporal gyrus (STG) commonly of the left cerebral hemisphere, surrounding a large groove called the lateral sulcus or Sylvian fissure, near the junction between the parietal and temporal lobes. Global aphasia is mainly found in left MCA territory perfusion defects and few on the right MCA (See Figure 32). However, Broca’s aphasia is found in broad range of areas.

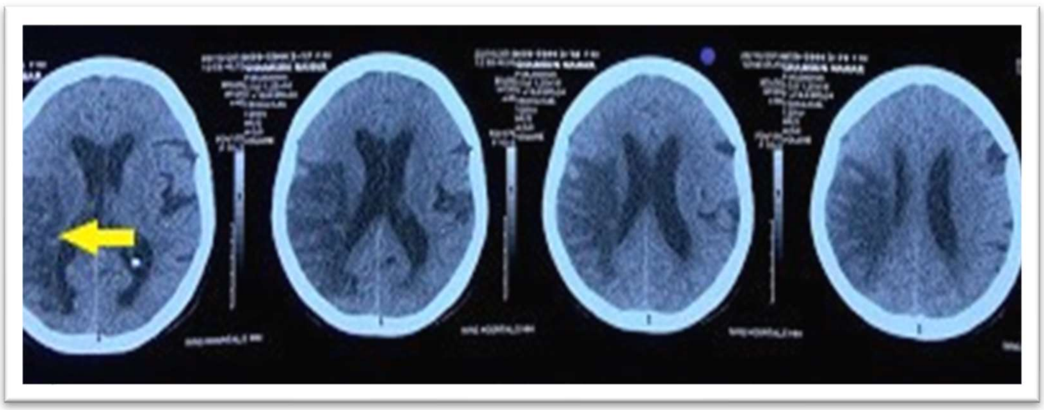

Figure 32 Sequential CT images showing right MCA territory defect

Among Them no significant association is found in severity assessment. However, Severity depends on the size of the lesion irrespective of location.

Aphasia along its severity depends on lesion size in brain. Lesion size is a good predictor of severity grading of post ischemic Broca’s aphasia. Hemiparesis coincides with lesion in the opposite side of the brain. Handedness is not always determinant of dominant hemisphere. Right sided lesion initiates behavioural changes or irritability. If not assessed or treated or described to family members creates devastating but avoidable consequences. Family members who cannot understand their behavioural changes.

5.4 Social stigmata and related problems for Bangladesh

The human cerebrum is not symmetrical. It has two hemispheres, right hemisphere, and left hemisphere. However, they are asymmetrical both structurally and functionally. Cerebral lateralization has been found to have an important role for different motor purposes including handedness (Gutwinski et al., 2011). Recent epidemiological and neurobiological research has described scientifically.

Majority population of this world is right-handed while a minority are left-handed. They are also called ambidextrous. The percentage of ambidextrous vary in different cultures and different countries (Perelle & Ehrman, 2005). Among the world, in all human cultures and societies, left-handedness is found in approximately 5% to 25.9%. Similarly, left handedness is more common in men than in women (McKeever, 2000). Another studies have specified that the rate of left-handedness is approximately 13% in males and 11% in females (Gilbert & Wysocki, 1992). Handedness is stigmatized in most of the countries across the whole world like the sexual orientation, religion, skin color, social cultural believes. Just a few years ago, until the 20th century, even in the Europe, left-handedness was regarded as symbol of inferiority and was mostly undesired. Handedness has a long historic background and always discriminating people form the very ancient time. Even this racism documented by Braun (1941, p. 665) in medical journal in Germany -

> We can only conclude that the right side generally does correspond to what is right. Physically or otherwise uncoordinated persons are called *gauche* [orig. *linkisch*, 'leftish'], and we may well think that something about them just is not right.

Literatures reveal that now they have become more liberal in handedness. Though, just a few years back, in was common to force the lefthanded children to write with right hand until 1960. However, the rest of the world has not yet adopted the culture to spare the lefthanded to use left hand according to their structure. In some religion biased country and some conservative culture, even today, the left hand is considered impure, being the hand that is used for wiping one's behind, while all other superior and useful works are assigned to the right hand (Carter-Saltzman, 1980).

Handedness has been studied for many years now. Different theories and several causes have been identified the reasons of being handedness. Though scientist have been proposed several facts, yet the determinants of human handedness are not clearly known. However, studies showed hand preference or handedness is heritable and hand preference is influenced by genetic, hormonal, developmental and cultural factors. Lefthanded parents have comparatively more chances of having more lefthanded children (Llaurens, Raymond, & Faurie, 2009).

Developmental factors are related to the handedness in humans. Some hypothesis revealed that pathological condition or diseases might be the cause of left-handedness. They have explained so because it has been observed that patients suffering from epilepsy, meningitis , schizophrenia and mental retardation , other central nervous disorders are often found to have at least two folds more left handers (Satz, Orsini, Saslow, & Henry, 1985). The scientific explanation behind it is the injury or insult of the brain at an early age may cause the individual to switch to the opposite hand for various activities (Llaurens et al., 2009) . Hormonal factor influences handedness. High levels of testosterone during fetal development might be the reason for disruption of neural development. It might cause a number of physiological changes in growth and development may result in an increased likelihood of anomalous dominance, i.e. left-handedness and/or weak lateralization (Geschwind & Behan, 1982). Complicated pregnancy and birth risk factors ca also be another important factor that might attributed to left handedness.

On the contrary, all the theory that is described earlier, conflicting findings are also found in different studies. One study describes that left-handedness is overestimated after childhood meningitis or in schizophrenic patients (Dragovic & Hammond, 2005; Ramadhani et al., 2006). Also, one study indicated that left-handedness at the age of five years was almost two times more likely in infants who had required resuscitation after delivery (Ramadhani et al., 2006). Similarly, 25 potential risk factors for pregnancy have been analyzed and almost no association is found with left handedness. Among these 25 stressors only maternal age had a weak association with left-handedness (Bailey & McKeever, 2004). Other factor that is proved a potential risk factor is maternal viral infections. Season of birth is also analyzed whether they have any effect on handedness. Two studies one with small samples found some association (Martin & Jones, 1999) . On the other hand , a study with large patient group , more than 15 000 subjects found no evidence of a relationship between handedness and season of birth (Cosenza & Mingoti, 1995). Another interesting study was conducted among the Chinese students in 1980 and only less than 1% are found to be left-handed. Exceptional result but reliability is poor as it is expected the minimum number should be within between 10 and 12% (Kushner, 2013).

The big question arouses, why there were so less left-handed in Chaina? Actually, the Chinese are terribly negative to left handers. Their social and historical background even forced that to change or hide left-handedness since childhood. Even in the old days there were punishments to cure left handedness. Religion also have influence on it. Same scenario is also available in many other countries like India and most of the Muslim countries.

Certainly in earlier days and even todays, sinistrality is a problem for children learning how to write (Flatt, 2008). In America, a plastic surgeon reported that in his early age he was forced to write with right hand by tied his left hand in the back. There are few myths are available regarding left handedness that they might have developmental and immune disorders, die younger, have more diseases, and are even considered inept. However, none of these predictions have been proven (Rohrich, 2001).

Ben Franklin had a very disappointing left-handed childhood and as an adult his grief was documented by Barsley (1967) cited in Flatt (2008, p. 304) -

> If by chance I touched a pencil, a pen, or a needle I was bitterly rebuked; and more than once I have been beaten for being awkward and wanting a graceful manner. I am with profound respect, Sirs, your obedient servant. THE LEFT HAND.

In another study, by {Mehta, 2007 #191@@author-year} have examined that there is role of left handedness on total knee arthroplasty (TKA) outcomes. The right-handed surgeon did 728 primary TKAs while standing on the side of the operative extremity was 377 on the right and 351 on the left. It was found that the right Knee showed significantly better results than the left (Mehta & Lotke, 2007). So, there is a scientific significance of being left-handed indeed.

Another study also reported by Moloney, Bishay, Ivory, and Pozo (1994) that pre-operative radiographs of 265 patients consecutively treated with sliding hip screws were reviewed and conclude that the main reason of most of the technical failures of the sliding hip screw occur because of poor positioning of the screw. The right-handed surgeons are responsible for it commonly when it is on the left side.

Chapter Six

DISCUSSION

Stroke is the one of leading cause of death and disability in the world. Lifestyle modification and development of awareness can be helpful for reduction the mortality and morbidity of stroke. Hemiparesis and aphasia are the most common morbidity resulting from stroke. Medical and surgical management and therapy is available tons of research work are ongoing on the stroke management. However, aphasia is not yet as focused as the medical and surgical management are focused in context to ongoing research. Apparently, aphasia is not a life-threatening condition, but it affects the quality of life greatly. A research from western world showed among 2500 patients with aphasia where only lucky 60 patients were referred to the speech and language therapist. The scenario of Bangladesh is even worse. Speech and language therapy are only about to rise in this country. More research should be performed for Bengali speaking patients to establish this subject.

After stroke patients are usually taken to accident & emergency department for quick management. A neuroimaging is performed just at that moment for confirmation of stroke. Type of stroke, lesion size and site are also determined through the imaging procedure. On the other hand, if the patient is having aphasia no assessment is done, not even the type of aphasia is mentioned. Its only written in the form that patient is having ‘speech difficulties’.

It is quite known that a baseline assessment or diagnosis is always helpful for all the future management and prognosis of the disease. If a quick and easy tool is used in this circumstances that might be always helpful for a baseline aphasia assessment. As we all know, aphasia shows diversity and changes from one type to other type with the course of time. In this perspective the initial aphasia assessment is a mandatory requirement for further research of Bengali speaking patients.

However, it is always difficult to adopt a new trend in routine practice. However, the result of today's research will be tomorrow's practice. Especially when it is an emergency room, it next to impossible to think about any research. Saving patient's life is the main moto of that room. If a tool can be introduced in that setup that will not cost any extra time or effort and in addition may give a diagnosis of the baseline aphasia, might fit in the situation.

With that view a Smart Aphasia Assessment tool have been developed to fit in that situation in Bangla. It will categorize the main three types of aphasia in two minutes. As, the feasibility test showed that Broca's aphasia is mostly found in 1-4 weeks of initial stroke, a severity assessment is also done for Broca's aphasic patients. Again, there is no opportunity for Global aphasia to perform any severity assessment and Wernicke's aphasia is extremely rare in the Neurology Department in Bangladesh. It is sad but truth that aphasic problem is not handled by the clinician and lack of awareness of the family members, most of the Werneck's aphasias are identified as psychiatric patient by the family member and are taken to psychiatric hospital. However, they are in a different management system with new plan of treatment plans. Even they come back to neurology that takes a long time.

There is no such smart tool is found in the literature for the Bengali population. One of the reasons can be that most of the research on aphasia is going on in America and Europe. The facilities they have in the casualty we do not have here in Bangladesh. They might have the setup to evaluate a baseline assessment by speech and language pathologist in the emergency. The previous research showed it is difficult to apply the same in our country in these current situations. Population density is too high and few tertiary centers in the capital such as Dhaka Medical College, BSMM University and National Institute of Neuroscience Hospital are dealing with all the stroke patients of the whole country.

Now the validation is required for the new smart tool. Neuroimaging is the only way to validate this tool initially. CT, MRI, and functional imaging are the options. CT and MRI imaging is available technique for stoke patients at least in these tertiary centers. Patients are sent to the emergency room to the imaging room. CT scan is performed for 80% of the stroke patients. On the other hand, complicated 20% referred for an MRI scan as it is expensive and time consuming. Functional imaging is not at all performed in anywhere in the world for stroke confirmation as it is a highly specialized department with always in scarcity of radio isotopes specially in Bangladesh and finally these images produce more functional information and less anatomical information which is more required for stroke patients.

As we know, brain has few speech and language centers. They are namely Broca's and Werneck's center situated in the left inferior frontal gyrus and left posterior superior temporal gyrus, respectively. Any injury or insult in these areas may suspect to have respective type of Aphasia. Stroke causes injury to the brain cortex. However, it can only be determined by the CT scan or MRI scan where the injury is situated. For example, a patient was diagnosed Werneck's Aphasia by the Smart Assessment Tool. The next step would be the Imaging that will clarify the site of injury in the brain center and that can validate the acceptance of the New smart tool. However, comprehension of imaging is not as simple as assumed. CT scan and MRI are most complex imaging technique, and imaging describes cross sections of 100 slices accurately. As the result the language of interpretation of those imaging is quite different from the anatomical names. The left inferior frontal gyrus is written with different name in CT scan reporting according to FDA and few other authorities. It is also true that every patient is a new book. Not all the patients with same lesion show same presentations.

In these circumstances, an association is tried to make with the finding of smart tool and the reporting of CT or MRI scans of the same patients that performed immediate afterwards. When a patient is diagnosed as Broca's aphasia then the imaging is also correlated which area is affected for that patient.

In this research a retrospective quantitative study has been performed among 120 patients with features of acute stroke with aphasia in the two biggest Government hospitals in Emergency ward, Neuro-medicine, Neuroradiology and Medicine department. The hospitals are Dhaka Medical College Hospital and National Institute of Neurosciences Hospital.

In the emergency setup of a hospital the clinically diagnosed stroke patients has been clinically assessed the variables, age, sex, HTN, DM, GCS, handedness, hemiparesis right/left. Simultaneously speech and language problem has been assessed by the newly developed Smart Aphasia Assessment Tool and has been categorized accordingly.

After the clinical assessment necessary initial clinical management have been given by the clinicians. Then according to clinical assessment clinical referral were provided in the neuroradiology imaging department for performing CT scan or MRI. The scan has been reported by the recognized neuroradiologist of respective institute and provided a report following standard reporting protocol format. All the scans in favor of acute ischemic stroke without any other pathology have been taken for these studies. If the imaging reveled any other concomitant pathology has been discarded for this study.

Lesion side, size, sites are the main variables in the CT and MRI reports and have been analyzed by HPSS software. Pearsons Chi-square test is done to see the association of aphasia type and severity with brain perfusion defect or lesion side, size, and sites. However, the accuracy of aphasia diagnosis assessed, and the validity of the smart assessment tool is checked through these CT and MRI findings. No official data has been published yet about the demography of post stroke aphasia in Bangladesh yet.

In this study, we found of total 131 patients of whom 89 (67.9 %) male and 42 (32.1%) female. In modern world, in the year of gender equity, male and female should be regarded equal in many ways. However, the equation is as similar as in epidemiology of stoke, in terms of stroke risk and symptoms. The good news for women is that they generally live longer than men. Nowadays, the longevity of the woman is higher. Similarly, the risk for stroke is higher in women. The incidence is directly proportional to increasing age. One study defined that the age of 50 years, the female: male population ratio is 1.01, but this increases to 1.19 at 70 years, 1.56 at 80 years, and 2.70 at 90 years. However, the most unfortunate fact is that functional outcomes and also quality of life after stroke are consistently poorer in women even with all the appropriate treatment and management (Reeves et al., 2008).

Apparently, the result does not match with the literature irrespective of correlation of age analysis. Bangladesh is an underdeveloped country. The female and their development are still lag behind with the rest of the world. Their social and familial status is still not as equal as man. Bangladesh is a male dominant country for many years. As a result, when a male is diseased, the most priority is given in that matter and all the steps are taken for the proper management of that disease. However, for woman just the opposite scenario is more common specially in the villages. They are neglected and are not taken to the hospital as frequently as the male patients are usually brought. In that context, the ratio might be lower in female than in male. This is the reason of the changed ratio of Bangladesh for sure. In the western world there is equal participation and importance of male and female for treatment and management. No social discrimination is present. As a result, the ratio presented by them is more accepted than the ratio found in our country which is surrounded by so many stigmata, discrimination, and social taboos.

Again, among 89 male and less than a half female, it has been observed that the mean age for male was 60.35 and mean age for the female is 60.88. A decade ago, it was published that middle-aged people suffering from stroke is about 33%. Nowadays, middle age is defined within 40-69 years old, and the number has increased 33 to 38%. Among all non-modifiable factors, age is one undeniable factor which is very unsafe as the incidence rate of stroke after 55 years is going almost double in every 10 years of increasing age. Again it is said that maximum number of stroke about three-quarters takes places after the age of 65 years (Yousufuddin et al., 2017). Unfortunately, one third of the patients with increased age suffer from long term disability. However, the women suffer more in terms long term disability. These comorbidities increase the frequency of re-admission in the hospital, functional recovery as well as the cost burden of a nation (Ripley et al., 2007). It is not true that the young are not suffering stroke. However, a young brain is more prone to recover well due to the plasticity of the brain. In case of old patient, they loss the natural phenomenon of brain recovery or brain plasticity. As a result, they suffer more. Aging is an important factor. It has influences and association with physiological changes in cerebral vasculature, silent cerebrovascular disease, stroke risk factors, comorbidities and even with therapeutic implications. Age is also very important for the mortality due to stroke as well (Yousufuddin & Young, 2019). Macro-vasculature and micro-vasculature shoes structural and functional changes with increasing age, as well as, become less suitable for the prevention of the cerebrovascular disease. Again, silent stroke is much higher than the symptomatic stroke. Silent stroke occurs only in the old patient, on top of those suffering from diabetes too. Age is so important, even the management guideline is completely depending on it. Aspirin is prohibited over 70 years and statin cannot be used over 75 years for the primary prevention of cerebrovascular diseases. Whereas these two therapies have potential benefited group of therapy that can only be used below the recommended age group (Stone et al., 2014).

However, among all patients, 58.8% of them suffer from Hypertension which is remarkably close to the international statics of HTN (69%) regarding stroke and hypertension which is approximately 64%. Hypertension is the most prevalent risk factor for stroke (Wajngarten & Silva, 2019). Approximately, 64% patients have been suffering from high blood pressure is proved by at least 30 studies (Valery L. Feigin, Bo Norrving, & George A. Mensah, 2017) . Though stroke is two types mainly. Ischemic & hemorrhagic. Among them most common type is the ischemic stroke all around the world, is about 87% approximately (Benjamin et al., 2018). Blood pressure need to be controlled for the prevention of stroke. There is controversy how much blood pressure needs to be reduced for the proper management and prevention of stroke. The American Guidelines for Management of Hypertension in the Systolic Blood Pressure Intervention Trial (SPRINT) strongly recommended that 10 mm reduction of blood pressure both in systolic and diastolic might be very helpful for the old patients, for example 140/90 mmHg to 130/80 mmHg (Bundy et al., 2017; Williamson et al., 2016).

The European Guidelines for the Management of Arterial hypertension is also suggesting the same as the above-mentioned American guideline. They suggest that lowering systolic BP to <140 mmHg for all patient groups, including independent older patients, with a target of 130 mmHg for most patients if tolerated. If the patients are incredibly old, too low blood pressure might not be very suitable for him. However, the European guidelines recommend against the reduction of systolic BP to <120 mmHg because this is less beneficial for the patients and might cause harm (B. Williams et al., 2018).

In this context, too low blood pressure never causes any harm to the patient with ischemic stroke, and it is unlikely a cause of ischemic stroke too. On the other hand, some literature said that excess reduction of blood pressure might be harmful rather than any benefit for the patients (Qaseem et al., 2017). Similarly, 56 patients have diagnosed Diabetes among 131 patients with ischemic stroke which consists about 42.7%. Almost 24.7–56.2% of stroke patients has been proven to known diabetes which is proven by HbA1c and from the history as it was taken from the patients (Lau, Lew, Borschmann, Thijs, & Ekinci, 2019). A meta-analysis of 39 studies is estimated that approximately one-third of all stroke patients have diabetes. The rate is higher in ischemic compared with haemorrhagic stroke which is respectively 33% and 26%. Not only stroke occurrence but the comorbidity is also associated with the presence of diabetes. For example, length of hospital stay, readmission rates are higher in diabetic patient than the patients without diabetes (W. Cao et al., 2015). Similarly, the mortality is also higher in diabetes patients. On contrary, few other studies, multiple randomized controlled trial have proven just the opposite finding saying there is no association among the post stroke mortality and morbidity in diabetes patients than the non-diabetic patients (Control et al., 2009; Mattila & de Boer, 2010; Ray et al., 2009).

Stroke or cerebrovascular disease is quite common in people with diabetes. Surprisingly, diabetes is modifiable risk factor for cardiovascular disease, particularly atherosclerosis and for cerebrovascular disease. Interestingly, even strict glycemic control has not shown any proven outcomes in either primary or secondary prevention in stroke disease (Hewitt, Castilla Guerra, Fernández-Moreno, & Sierra, 2012).

Handedness is one of the debated issues since many years. Similarly, in this study we found that among 131 patients only 2 patients are found lefthanded which consist of only 1.5 % of total population. Both are men and one was farmer, and another person also belongs to low socioeconomic background. This result is quite similar to a Chinese study that was conducted by Kushner (2013) with some Chinese university students where lefthanded were found only less than 1%. Is it acceptable or it is essential to identify the issues that are producing this unacceptable data? Issues are now quite clear, but it might not be easy to eliminate those from society in the blink of an eye. These are all ritual; religious believe moreover social stigmata and taboo. Left handedness is sign of inferiority and called lefties. In a Muslim country some religious ritual must be done with right hand like greeting and holding religious books irrespective of one’s handedness. Again, some social norms are also there, like eating or drinking must be done with right hands. For female, it is stricter than in male. No man in the illiterate society even want to marry a lefthanded woman.

These issues are quite reflected in this result. No woman patient is found to be lefthanded. They are not willing to give the true history or even they have been trying to convert their handedness from left to right, has really converted themself to practiced right hander. Though they were manufactured differently.

There is evidence that more than 90% people are habituated to perform all the difficult and complex manual tasks usually by the right hand (Gilbert & Wysocki, 1992; Kushner, 2013; Peters, Reimers, & Manning, 2006). On the other hand, very smaller number of people comparing with the right handed group, roughly 10% prefer to use the left hand. However, approximately 1% people even do not show any preference for left or right hand. They are called 'ambidextrous' people (de Kovel, Carrión-Castillo, & Francks, 2019).

The scientific explanation of hand preference is that the two hemispheres of the human cerebrum are not symmetrical and tend to be specialized with different functions. Cerebral lateralization develops early in the development of human being, and it is one of the unpredictable factors for developing all the cognitive functions. One of the most important examples of cerebral lateralization is presence of predominant language centers in the brain and the other important evidence is in this factor, the handedness. Handedness doesn't only mean the preference or strength of specific side but it is also include the fine motor skills, for example the operation of computers and medical devices that go along with it (Gutwinski et al., 2011).

Nevertheless, hemiparesis means weakness in either side of the body. It is one of the post stroke symptoms. In this study among total 131 patients, 69 patients, more than half of the patients, do not show any hemiparesis. 52 patients have hemiparesis. Among them 40 (30%) patients show right sided hemiparesis and only 22 (16.8%) patients show left sided hemiparesis. However, the frequency rate was not similar that has been observed in the other studies. One of the studies conducted with 350 ischemic stroke patients with hemiparesis showed, 167 had with left sided hemiparesis LHS and 183 had right sided hemiparesis. There was no significant difference in the distribution frequency of ischemic type between the two sided hemiparesis. Another study found that left-sided lesions cause greater impairment of voluntary movement. Right-sided lesions were found less fatal in context of presenting symptoms like gait. On the other hand, no evidence is still found that there is any correlation between lesion side and cognitive function. Some of the stroke patients suffer with hemiplegia. Complete paralysis of one side of the body is called hemiplegia. Usually, it is caused by damage to some part of the brain that disrupts the connection between the brain and the muscles on the affected side. Damage to the right side of the brain affects the left side of the body, and damage to the left side of the brain affects the right side of the body. The first and foremost cause of hemiparesis and hemiplegia is stroke. Cortico-spinal tract injury results hemiplegia. The other causes of hemiplegia are spinal cord injury, e.g., specifically Brown-Sequard Syndrome, traumatic brain injury, ICSOL affecting the brain.

However, though it is said that hemiparesis /hemiplegia occurs due to the injury or damage of the opposite side of the brain. Exception is there and explained in a study by Inatomi, Nakajima, Yonehara, and Ando (2017) where patients with acute ischemic stroke were prospectively examined. Among 8360 patients, ipsilateral hemiparesis was detected in 14 patients. They consist about 0.17%, more than half were man and the age range were about 71±6 years. They had some explosion on the favour of the findings. The patients with ipsilateral hemiparesis had a past history of stroke on the contralateral side. Thus, they already have existing motor deficits on the contralateral side from earlier lesions. Moreover, functional neuroimaging findings indicated an active crossed corticospinal tract in all of the examined patients. Both these findings suggest the involvement of the uncrossed corticospinal tract contralateral to stroke lesions as the compensatory motor system after stroke (Inatomi et al., 2017).

In this study, mainly three types of aphasia are categorized though the newly developed tool. Among all subjects mostly are found to have Broca's aphasia which consist of 105 patients (80%). Whereas rest two aphasias are Wernicke's and Global which are about 2 (1.5%) and 24 (18.3%).

Another study revealed that 270 patients were suffering with post stroke aphasia. They found the frequency of various aphasia were global 32%, Broca's 12%, isolation 2%, transcortical motor 2%, Wernicke's 16%, transcortical sensory 7%, conduction 5% and anomic 25%. They did the aphasia assessment after 1 year and found the frequency rate is different. They were global 7%, Broca's 13%, isolation 0%, transcortical motor 1%, Wernicke's 5%, transcortical sensory 0%, conduction 6% and anomic 29% (Pedersen et al., 2004). In this study, they provide the assessment of aphasia just after the first ever acute stroke and then after 1 year. They had seen a significant change in the aphasia diagnosis especially change in the course of the disease. From the observation they had stated that aphasia changes into the less severe form in course of time. But the time interval of aphasia assessment was very prolonged period, 1 year. In this study, the imaging was done from 0-14 days of the onset of disease. This might be the reason of having more Broca's Aphasia. Few other reasons are there. For example, transcortical motor and anomic aphasia are not classified separately as the brain centers could not be identified though CT scan alone. As a result, they are added on these group. These might have increased the number of Broca's aphasia. Another most important reason of getting more Broca's aphasia is most of the Wernicke's aphasia is misdiagnosed as psychiatric case and referred to the mental hospital. This is a common practice here as the emergency clinician is not bothered to do any speech assessment at all, so they do not keep the problem of Wernicke's always in their mind. Unfortunately, the two patients found having Wernicke's aphasia came from mental hospital in the neuroradiology department to have CT scan for routine treatment procedure in the psychiatric hospital. Luckily, from the imaging they have been diagnosed having a ischemic stroke with irrelevant fluent speaking.

In case of recovery, the observations are non-fluent aphasia turned into fluent aphasia but never reverse. Severe aphasia turned into milder form. Most of the Global aphasia turned into Broca's mostly. Women always have more severe type of aphasia. According to Kertesz and McCabe (1977) the maximum recovery is noted in the Broca's Aphasia and minimum or bad prognosis is mostly observed in the global aphasia. Another study by Sarno and Levita (1971) also supports the same theory. Demeurisse et al. (1980) found no difference between Broca's and Wernicke's aphasia but found less recovery in global aphasia.

Again, in this study, to evaluate the severity of Broca's aphasia a severity grading has been done. All the patients have been classified into five groups. Mainly the severity of Broca's aphasia has been classified as mild, moderate, and severe group. However, there are another two groups, the first one is for those who does not have Broca's aphasia, rather the patients have Global and Wernicke's aphasia. The last group is identified as resolving group who experiences aphasia in any form of severity, but they have already recovered well at the time of speech and language assessment. Among 131 patients, 25(19.1%) patients have none other than Broca's aphasia or non-Broca's aphasia. 31 (23.7%) patients are resolving. Rest of the patients are classified under the severity groups. 59(45%) patients have mild Broca's, 9 (6.9%) patients moderate and 7 (5.3 %) only severe Broca's aphasia. However, most of the patients, about 50% patients suffers from mild speech impairment. Near about a quarter of patients are start recovering by themselves just after the onset of stroke.

Similarly, Neuroimaging is performed by multi-slice 16 CT scan in 106 patients (80.9%) and 25 patients (19.1%) have MRI by 1.5 tesla MRI machine. Imaging examinations is a vital need and play a crucial role in the management of stroke patients. The disadvantages of CT scan are the high radiation dose. However, the MRI is the more complicated and time-consuming technique but accurate and gold standard imaging test for the soft tissue (Vymazal et al., 2012). Availability, less time required, less expense are the main reasons that the unenhanced CT scan remains the initial imaging test of choice for evaluating an acute stroke patient. Moreover, CT scan can differentiate ischemic and haemorrhagic stroke. So, the easiest way to find out haemorrhage a CT scan is very helpful (Vymazal et al., 2012).

Rothrock, Lyden, Hesselink, Brown, and Healy (1987) conducted a study with 31 patients suspecting lacunae infract were underwent MRI examination to find out whether the lesion was new. The result was found that 18 patients were acute, and 13 were found having old lesions. The study concluded that about 23 patients were accurately diagnosed through the MRI scan than in CT scan. Also, the MRI scan has the ability to differentiate among the acute and the chronic lesion. For the smaller lesion, lacunar lesion, which is difficult to diagnose through CT scan, can easily be done with MRI scan where it is available. MRI scan is just one of the best choice of options where available. However, no study can suggest replacing CT scan for is avidity and feasibility.

In some countries, they do not even have a choice to do even an unenhanced CT scan for all the stroke, like our country. Similarly, in a study of Sub Africa, among 1688 participants 1048 (62.1%) got the chance of having a brain imaging with an unenhanced CT scan. The death rate of non-CT vs. CT groups was 27.5% vs. 16.4% which was found statistically very significant (Lekoubou, Nkoke, Dudzie, & Kengne, 2016).

From this evidence, it is proven, imaging is essential for stroke detection. Though MRI is best for soft tissue imaging but many countries still struggling just to have any neuroimaging for stoke detection, even an unenhanced CT scan. As a result, for many people CT vs MRI debate is completely useless. It carries no value where there are not enough facilities to provide. On the contrary, some countries have the privilege to do even multiple functional imaging. So imaging is not need based, but availability based.

Lacunar infract is found only in 16% of patients. The smaller sized lesion less than 15-20 mm but the clinical course is paradoxical. They show good prognosis in short time; mortality is low at the acute stage. Even they recovered well from the symptoms very well at the time of hospital discharge. Unfortunately, they carry some long-term disadvantages with them for life. The recurrence, death rate and rate of dementia is higher in those patients with the progression of the time (Arboix & Martí-Vilalta, 2009). Lacunar infarcts or small subcortical infarcts, not more than 15mm to 2 cm, small single penetrating artery occlusion causes the lacunar-infract too. Hypertension and diabetes are the most notable and treatable risk factor (Chen, Wen, Anstey, & Sachdev, 2009). Lacunar infract is also noted in the healthy individual too. The prevalence of lacunar infarcts in healthy individuals has been reported variously from 5% to as high as 48% in different age groups.

However, among 131 patients 74 (56%) patients had lesion in either right or left side and about 57 (43.5%) patients had both sided lesions. Left hemispheric stroke found more than the right hemispheric stroke, 50 (38.2%) and 24 (18.3 %) respectively. Most of the literature support this ratio. However, another study published by Hedna et al. (2013) found that left-hemispheric strokes (54%) were more common than right-hemispheric strokes (46%). Other studies also saying about the hemispheric differences in stroke outcome (Fink et al., 2002; Hernández et al., 2003; Naess, Waje-Andreassen, Thomassen, & Myhr, 2006; Woo et al., 1999). It is established that the left sided hemiparesis is more common, severe with poor prognosis. However, the incidence of left sided lesion only significant when it is in the middle cerebral artery territory. If the area predominantly supplied by the middle cerebral artery is deducted the ratio is not quite different from left or right sided stroke. However, the explanation is the difference in the structural architecture of the intima and medial layer of the vessels or might be the velocity of the blood in that vessels causes this disruption and damages. Theories such as intima-media complex variation and velocity differences in the left carotid artery accounting for greater stroke incidence in the LH need further validation (Hedna et al., 2013).

Yet many right-handed patients and most of the lefthanded patients about 70% predominantly have their language center located in the left hemisphere. The other 30% of left-handed patients process language on the right or in both hemispheres. Handedness has a great impact in the neurological disease presentations and understanding the true pathology behind the disease proceeding. Any problem that affects the brain manifests differently depending on whether you are right-handed or left-handed.

The motor area of one side controls the opposite side of the bodies. As a result, for a lefthanded person, stroke in the non-dominant right side cause more harm to the dominant left side of the body as his right side is already weak than the left and unable to compensate anything. Similarly, the reverse is not exceedingly difficult to manage. For the left-handed, a stroke on the left side of brain would affect the non-dominant right side of body which can easily adapt the weakness on the non-dominant side of the body because most of the time it is compensated by the dominant side. However, a non-dominant stroke can still have a significant effect.

The study reveals that 69 righthanded patients do not have any hemiparesis. 22 right-handed patients have right sided hemiparesis and 2 lefthanded patients also have right sided hemiparesis. On the other hand, the rest 22 righthanded patients only have left sided hemiparesis. In short, All the righthanded patients shows LSH. Whereas LSH are present both right and lefthanded. P value 0.099 approaching significance or highly suggestive. This is in keeping with existing medical knowledge as lefthanded people have codominant hemispheres whereas righthanded people have dominant left hemispheres.

Nevertheless, hand dominance has been cited as an important factor in the performance of motor skills (Provins, 1997). Studies report between 45–50% of individuals sustain a left hemisphere lesion and therefore right-side hemiparesis (Annett, 1996; Brosseau et al., 2001; Macciocchi, Diamond, Alves, & Mertz, 1998; Sze, Wong, Lum, & Woo, 2000). Since up to 80% of people are right hand dominant (Annett, 1996), a significant proportion of individuals who experience a stroke will have their dominant hand affected. However, The effect of paralysis on the dominant hand and QOL in patients with subacute stroke was not significantly different from the effect of paralysis on the non-dominant hand (Nam et al., 2014). If the dominant hand is affected by stroke, individuals demonstrate less impairment. The peripheral changes post stroke that could contribute to the dominant hand having less impairment. Findings suggest that re-enforcement of paretic arm use in both unilateral and bilateral tasks may lessen impairment and reduce musculoskeletal changes post stroke (Harris & Eng, 2006).

The hypothesis that left-side lesions cause greater impairment of voluntary movement (represented by gait and functional independence) than do right-side lesions was supported. However, no evidence that right-side lesions cause greater impairment of spatial attention and posture maintenance than do left-side lesions was found (Voos & Ribeiro do Valle, 2008).

In fact, after the work of Carter-Saltzman (1980); Damasio (1992) and others in the ninety's decade, now we know that, although about 95% of right-handers do have left-hemisphere dominance for language functions, only around 19% of left-handers have right hemisphere language dominance, with another 20% showing have left-hemisphere language dominance . The **insular cortex,** on the other word "Island of Reil" is located just below and within the lateral sulcus of the brain. In 1809 , Johann Chrstian Reil discovered and the area can be seen from surface view (Uddin, Nomi, Hébert-Seropian, Ghaziri, & Boucher, 2017).

The lateral sulcus also called the Sylvian fissure (See Figure 25, 26, 27), divides the frontal and parietal lobes superiorly from the temporal lobe inferiorly. The insular cortex is located immediately deep to the lateral sulcus or Sylvian fissure. "Wernicke's area" is identified as an anatomical area at the left the lower posterior left sylvian fissure. On the other hand, in 1976 Bogen and Bogen defined that a lesion in the Wernicke area will cause language comprehension deficit and they concluded that language comprehension is not highly localized, but involves large regions of the left temporal and inferior parietal lobe (Binder, 2015).

Very few data are available regarding aphasia epidemiology and demography in Bangladesh. Specially no study has conducted to evaluate the relative frequency rate of aphasia caused by vascular origin.

We found aphasia more in male (67.9%) than in female (32.1 %) after cerebrovascular accident keeping similarity with existing literature (El-Tallawy et al., 2019). However, many studies disagreed (Engelter et al., 2006; Kyrozis et al., 2009; Sinanovic et al., 2011), as the women generally live longer and incidence is directly proportional to increasing age (Reeves et al., 2008). On the other hand, few studies even denied about any relation at all with sex and aphasia (Kang et al., 2010). Bangladesh has a male predominant society, as a result less women are taken to the hospitals might be the only cause of such low incidence rate for female.

In this research, average age was found average 60 years both for male and female whereas most of the other studies found that maximum number of stroke, about three-quarters took place after the age of 65 years or even more (Ripley et al., 2007; Stone et al., 2014; Yousufuddin et al., 2017; Yousufuddin & Young, 2019). However, this might be due to the different life expectancy of people in different countries, for example 72.49 for Bangladesh, 78.69 for UAS and 83.94 for Japan (Kontis et al., 2017).

In this study, 77 (58.8 %) patients were hypertensive and 56 (42.7 %) were diabetic which were slightly higher than many previous studies (W. Cao et al., 2015; V. L. Feigin, B. Norrving, & G. A. Mensah, 2017; Wajngarten & Silva, 2019) . These two are the most prevalent risk factors for stroke and indirectly for aphasia (Benjamin et al., 2018; Binder, 2015; Lau et al., 2019; B. Williams et al., 2018; Williamson et al., 2016). On the contrary, multiple randomized controlled trial had proven there was no association among the post stroke morbidity in diabetes and the non-diabetic patients (Control et al., 2009; Mattila & de Boer, 2010; Ray et al., 2009).

Surprisingly, we found only 2 left-handed male patients which consist of only 1.5 % of total population. Similar result was noted in a Chinese study by Kushner et al. where lefthanded were found only less than 1% (Kushner, 2013). According to the research, about 85- 90% people are right handed and 10-15% are left handed and 1% without any hand preference called 'ambidextrous'(de Kovel et al., 2019; Gutwinski et al., 2011). In this study, the illiteracy and social stigmata, gender discrimination & religious taboo were reflected through this finding.

In this study, 100% patients had aphasia and 46.8% presented with hemiparesis. Fekadu et al. (2019) stated that commonest morbidity after stroke is aphasia 60.3% and hemiparesis 53.4%.

Most of the patient almost 80.9% underwent CT scan as it available, feasible, and cost effective. In this study, left hemispheric stroke was more than the left, 50 (38.2%) and 24 (18.3 %) respectively which was supported by Hedna et al. (2013). The left sided stroke is more common, severe and shows poor prognosis (Fink et al., 2002; Hernández et al., 2003; Naess et al., 2006; Woo et al., 1999).

The study revealed that most of the patients such as 80% with Broca's Aphasia and only 1.5% were found with Wernicke's aphasia was correlated with Yung et al (Yang et al., 2008). Unfortunately, the frequency rate of different aphasia did not agree with several other existing literature (Bohra et al., 2015; El-Tallawy et al., 2019; Lima et al., 2020). The number of patients with Wernicke's aphasia is low as most of the patients are sent to the psychiatric hospital for their irrelevant speech. However, the further research needs to be done on Broca's aphasia. The lesions are not confined only in the speech and language centers of the brain but found in the various sites. Further research with a larger sample group with a follow up assessment with Western Battery Aphasia (WBA) can overcome the limitation of this study.

Several type of language impairments is observed after an episode of stroke and aphasia type diversely changes with time (Feigin et al., 2015; Valery L. Feigin et al., 2017). Recovery from aphasia is mainly related and highly influenced by lesion location, size, and type of aphasia (Pedersen et al., 2004; Sinanovic et al., 2011). Nowadays, a wide range of language tests are available for the post-stroke care (Choi, Park, Ahn, Son, & Paik, 2015; Košťálová et al., 2008; Romero et al., 2012). Baseline aphasia assessment is a good predictor of prognosis. There was a high correlation between early and late aphasia scores. The severity of the initial aphasia strongly associated with long term prognosis which suggests those with mild aphasia at onset are the most likely to recover completely (Hersh et al., 2018). The informal assessment by local screening tools, subtests or non-standardized assessments over formal, standardized batteries is helpful for different language and culture (Hersh et al., 2018). H-SSAAT 19 was the foremost assessment tool developed which evaluated 12 basic components of linguistics only by asking 6 questions in Bengali Language.

The most reliable neuroimaging techniques for brain lesion evaluation is CT and MRI(Bates et al., 2003; Mah et al., 2014; Yew & Cheng, 2015). Clinically assessed speech impairment of the patients with H-SSAAT -19 were compared with Neuro-imaging diagnosis. 100% Wernicke's and 54.2% Global aphasia were diagnosed clinically by H-SSAAT 19 coincided with the Neuroimaging interpretation with significant p value 0.000. This finding also supported by existing literature (Binder, 2015; Henseler et al., 2014). Ischemic stroke affect large area in the left hemisphere are more prone to have global aphasia (Hillis, 2007). On the other hand, imaging only validated 20.95% clinically assessed Broca's aphasia which correlate with existing literature about the existence of lesion in multiple areas apart from Broca's centre (Bohra et al., 2015; Crosson et al., 2019; Fridriksson et al., 2015; Kreisler et al., 2000; Yang et al., 2008; Yourganov et al., 2015).

Neuroimaging also correlated the severity grading of Broca's aphasia. 54.8% patient of resolving group and 6.8 % with mild Broca's aphasia had lacunar lesion. Whereas, all the patients with moderate and severe Broca's aphasia show larger lesion more than 15 mm in size with a significant P value 0.000 (Musa-Mamman & Salisu-Abdullahi, 2015)

Finally, H-SSAAT 19 only identified Broca's, Wernicke's and Global aphasia keeping in the mind that other aphasia couldn't be validate through unenhanced CT or MRI (Buchsbaum et al., 2011). Further research can be done with large patients' group, categorized in all other types of aphasia and validate by both neuroimaging and Bangla version of WAB when referred to speech and language pathologist.

There is a dilemma about the finding of neuroimaging and clinical correlation of post stroke aphasia since many years (Fridriksson et al., 2015; Henseler et al., 2014; Willmes & Poeck, 1993; Yang et al., 2008; Yourganov et al., 2015). In this study male are found to have more aphasia 67.9 % than female 32.1%. Most of the patients, almost 80% had Broca's aphasia. The rest 18.3 % have Global aphasia and the rest only 1.5% patients have Wernicke's aphasia which is different from existing literature (Bohra et al., 2015; El-Tallawy et al., 2019; Lima et al., 2020). At the onset of disease, most of the patient usually suffer from Global aphasia with the most severe form. With time it turns into less severe form, e.g., Broca's aphasia or Anomic aphasia most likely due to brain lateralization, plasticity, or cross aphasia (Ashtary et al., 2006; Bakheit et al., 2007). The reason of having more Broca's aphasia might be due to the assessment after within 2 weeks of the stroke onset. The number of patients with Wernicke's aphasia is really low as most of the patients are sent to the mental hospital for their irrelevant speech. This was more common for the patients who only have aphasia without any other physical sign of stroke. A novel quick assessment tool H-S SAAT in Bangla language was applied for the bed side assessment of speech impairment as the available Bangla version of Western Aphasia Battery was time consuming. Thus, it is inappropriate for the use in the emergency setup (Flamand-Roze et al., 2011; Glize et al., 2017).

For the Broca's aphasia barely, lesions are found in the Broca's centre. Rather they were found in several areas of brain (Fridriksson et al., 2015). All patients with Wernicke's aphasia present lesion in the sylvian fissure (Blunk et al., 1981). Anatomically, sylvian fissure is the area deep down to the lateral sulcus which separates frontal, parietal lobe from temporal lobe and this the anatomical location of the Wernicke's area which is responsible for the comprehension of the language (Binder, 2015). Finally, Global aphasia is found highly associated with the lesion the left middle cerebral artery territory which is also supported by existing literature (See figure 33). It is also expected that the velocity of blood or the arrangement of intima- medial complex might be responsible for it (Hillis, 2007).

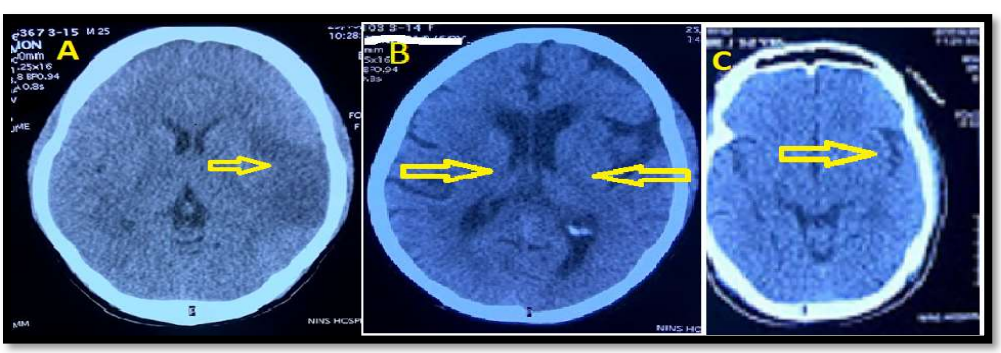

Figure 33 : Ischemic change in MCA(A), Generalized Brain atrophy(B), Sylvian fissure(C).

This was the first study conducted with the post stroke aphasia patients applying a novel aphasia assessment tool in native Bengali language. A correlation has made with the interpretation of the neuroimaging techniques and clinical presentation of aphasia which might be a helpful direction for the clinician and speech language pathologist. The routine application of the novel aphasia assessment tool might be a useful, informative, base line document for the further long-term management of the patients. However, the application of functional imaging SPECT & PET in a larger patient population might be useful for further information (Heiss, 2017; Lewis et al., 2012; Oku et al., 2010) .

In this study we have found a significant association with the behavioral change and lesion side. It is established by literature that significant behavioral changes have been noted with brain injury. Specially there is a significant correlation is observed with frontal lobe damage and change in social behavior. When there is accident or damage in the frontal lobe due to cerebrovascular accident dramatic change is noted in the social behavior. Usually emotional expression, problem solving, and judgement are controlled by frontal lobe. This study also reveals that right side of the brain significantly controls the social behavior. Significant number of patients are showing irritable behavior those who have suffering for right sided brain injury.

On the other hand, no significant association is noted with side of lesion with the severity and prognosis of the aphasia. This study revealed that there is no association with severity of Broca's Aphasia and side of the lesion. The lesion on right side or in the left side have no significant effect on the severity grading of the Broca's aphasia.

One of the studies in the Korea found that Global aphasia is the most severe form of aphasia. In that study they classified aphasia severity by aphasia type and lesion location. They analyzed the severity according to the type of aphasia: 1) mild; anomic type, 2) moderate; Wernicke's, transcortical motor, transcortical sensory, conduction, and mixed transcortical types, 3) moderately severe; Broca's aphasia, and 4) severe; global aphasia. However, among 97 patients they found maximum number of patients were suffering for Global Aphasia and they were 27 in number whereas patients suffering from Broca's aphasia was 21 which was 3rd highest in number (Kang et al., 2010; Pedersen et al., 2004). Another study in Copenhagen by Pedersen et al. (2004) reveled that the frequencies of the different types of aphasia in acute first-ever stroke were global 32% and Broca's 12% initially and these figures are not substantially different from what has been found in previous studies of more or less selected populations. However, they also stated that one year after stroke, the following frequencies were found: global 7%, Broca's remain the same, 13%. However, the scenario found quite different in Bangladesh. In this study, maximum patients were suffering from Broca's aphasia. It can be explained that this study has performed after 2 weeks of stroke occurrence. The criteria of selection of patients were not acute stroke but evident ischemic stroke with language difficulty. Initially the patient might be suffering from Global aphasia but with time they recovered. As a result, more patients were found with Broca's aphasia. As a result, a severity assessment was done to evaluate patient with Broca's aphasia. The lesion size is associated with the severity whereas the side has no relationship with Broca's aphasia severity classification.

Finally, it can be stated that in this research work the null hypothesis is proven unrealistic. Nur-imaging is an objective and effective tool in the management of speech language assessment disorder in the management of post ischemic aphasia which was stated in the alternative hypothesis of this research.

Chapter Seven

CONCLUSIONS & RECOMMENDATION

Correlation of post ischemic aphasia and neuroimaging has been analysed for many years in many countries of different languages. A lot of countries have established their speech assessment tool in their native language. However, the outcome might be different when the assessment has been done on native languages. The H-SSAAT 19 is a novel, valid and reliable tool for detecting aphasia in patients with stroke. It may overcome the limitations and can be used routinely as a convenient baseline aphasia assessment tool for all Bangladeshi patients with stroke. A preliminary epidemiology of post-stroke aphasia has been established by assessing the frequency rate of various aspects of aphasia after cerebrovascular accidents. Right-handed male patients with Mild Broca's Aphasia were predominantly found after stroke, which was biased, to some extent by the sociocultural barriers of Bangladesh.

With imaging correlation significant association is noted among Wernicke's aphasia with lesion in the sylvian fissure & right thalamus and Global aphasia with lesion in the left MCA territory. In case of Broca's aphasia, most of the patients presented with generalized brain atrophy and periventricular ischemic changes. Moreover, lesions are noted throughout the brain along with Broca's area. However, in this study no significant correlation is found with Broca's aphasia with the site of the brain lesions.

Lesion size is a predictor of aphasia severity. More severe aphasia like Global and Wernicke aphasia is caused by larger lesions in the brain. And comparatively less severe aphasia like non fluent aphasia caused by smaller lacunar lesions and have more chances to recover after appropriate speech and language therapy.

Left hemisphere is mostly dominant for speech and language. On imaging analysis more lesions are found on the left side of the brain. Lesion side also correlates with presence of aphasia and hemiparesis. Contralateral sides are mostly involved in both conditions. Behavioural change and irritability are only noted when the right brain is affected. Handedness is not a determinant of the dominant hemisphere. Handedness also depends on childhood training and social aspects. Dominant hemisphere can be accurately determined by trans-cranial ultrasound.

However, in the future more patient's will be included in this study. MRI and functional imaging can be applied for every patient along with CT scans and can be compared to the finding. In case of aphasia assessment WBA can be applied along with H-SSAAT-19 when the patients are settled down after the acute stage of disease. At the end, more research should be done in the post ischemic aphasic patients to know the demography, to assess the patients with an assessment tool in native language and to establish a national guideline for the management of post ischemic aphasic patients.

Chapter Eight

FURTHER RESEARCH

In the future the study can be done with a large number of population group. More patients with left hander should be included in the study. Patients with Wernicke's aphasia needs more attention. They should be identified more carefully and should not be missed diagnosed as psychiatric illness. A greater number of patients with Wernicke's aphasia might produce more accurate results.

In case of methodology, all the patients shall undergo the new Bengali assessment tool as well as the most popular WAB-R simultaneously. Regarding H-SAAT 19 which is able assess only three types of aphasia, should include all types of the aphasia by a revised version. Apart from global, Broca's and Wernicke's aphasia, conduction and anomic aphasia is also quite common. In the future, at least these two types of aphasia need to be included in the baseline assessment tool.

Again, imaging assessment can be done with MRI, might produce better results. Functional Imaging like SPECT and PET can be applied as imaging tool if the resources can be arranged in the future. To identify dominant hemisphere in the brain the most advanced technique, Functional transcranial Doppler ultrasonography (fTCD) can be introduced in our country. Clinical assessment is sometimes can be biased when assessing hand preference of the patients. fTCD is one of the reliable techniques in case of assessing dominant hemisphere in the brain. Overall, the multidisciplinary approach needs to be focused in case of the management of post ischemic patents. Physician and speech & language pathologist needs to work hand in hand for the benefit of the aphasic patients.

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