CHAPTER II
LITERATURE REVIEW

2.1 Oral Hygiene

Oral hygiene is defined as the degree of the oral cavity is kept clean by daily oral self-care such as by brushing and flossing or, when necessary provided by a caregiver (Newman et al., 2006). Oral Hygiene is the key factor to maintaining good oral health, which is the ability to maintain a clean mouth, free of plaque and calculus. Oral Hygiene assessment is the process of determining the amount of hard tooth deposits (dental calculus) and soft tooth deposits (dental plaque biofilm) and motivation related to oral self-care in patients. Build-up of plaque and calculus can lead to tooth decay, destruction of gingiva, alveolar bones and tissues that surrounds and support the teeth. Clearly the maintenance of optimal oral hygiene by plaque control is important for the maintenance of quality of life and the health of the mouth (Darby and Walsh, 2010).

2.2 Plaque

Plaque is an accumulation of bacteria that forms the biofilm that adheres to the surfaces of teeth and other oral structures in absence of effective oral hygiene (Heasman, 2003). Clinically, plaque is defined as a structured, resilient, yellow-grayish substance that adheres tenaciously to the intraoral hard surfaces. Plaque is composed of bacteria in a matrix of salivary glycoproteins and extracellular
polysaccharides. Bacteria attachment to the tooth is mediated by receptors in the thin salivary coating of the tooth, termed the pellicle, in which makes it impossible to remove the plaque by only rinsing or the use of spray. This makes the plaque differentiated from other deposits that may be found on tooth surface, such as material alba and debris (Samaranayake, 2002; Newman, et al., 2006).

2.2.1 Plaque Classification

Plaque is generally classified as being supragingival or subgingival (Heasman, 2003). Supragingival plaque is located on the clinical crowns of the teeth, at or above the gingival margin. It forms as a soft, yellow-white layer on the tooth surface. Primarily, the plaque accumulates at the gingival margin where there is protection from the mechanical cleaning effect of the oral soft tissues. Every individual has varied in the rate of plaque formation and it is influenced by oral hygiene care, dietary composition, and salivary flow rates. Naked eye may not see the small amount of plaque but may be detected by running a periodontal probe around the gingival margin, or by the use of disclosing solution.

Subgingival plaque is found within the gingival sulcus or periodontal pocket, below the gingival margin. The plaque develops from the down growth of supragingival plaque into the gingival sulcus, or the plaque growth from the pocket itself. It cannot be seen directly unless the overlying gingiva is retracted. The subgingival plaque composition differs from that of supragingival plaque as a result of the unique conditions that exist in the gingival sulcus, which favour colonisation and growth of anaerobic bacteria (Heasman, 2003).
2.2.2 Plaque Composition

Plaque is composed primarily of microorganisms. One gram of plaque contains approximately $10^{11}$ bacteria. One individual may harbor 150 or more different species. Nonbacterial microorganisms found in plaque include Mycoplasma, yeasts, protozoa, and viruses (Lindhe, 2003). Bacteria in supragingival plaque are predominating by gram-positive cocci and short rod, whereas gram-negative rod and filaments, as well as spirochetes, predominate in the outer surface of the mature plaque mass. While bacteria in subgingival plaque depend on the environment, the tooth-associated plaque is dominated by gram-positive rods and cocci, whereas the tissue-associated plaque, dominated by gram-negative rods and cocci, large numbers of filaments, flagellated rods, and spirochetes. Some of the gram-positive cocci are *Streptococcus mitis* and *S. Sanguis*. Whereas *Actinomyces viscosus* and *A. Naeslundii* are gram-positive rods. Gram-negative cocci include *Streptococcus oralis* and *Streptococcus intermedius*. Meanwhile, *Porphyromonas gingivalis, Prevotella intermedia and Tannerella forsythia* are gram-negative rods. The microorganisms exist in intercellular matrix also contains a few host cells, such as epithelial cells, macrophages, and leukocytes (Newman, *et al.*, 2006).

An extracellular matrix consists of organic and inorganic components derived from plaque bacteria, saliva, and gingival crevicular fluid (GCF). Organic components include extracellular polysaccharides secreted by plaque, salivary glycoprotein (which are important in the initial adherence of bacteria to the tooth surface), desquamated oral epithelium cells and defence cells. The inorganic component comprises calcium and phosphorus from saliva (Heasman, 2003).
2.2.3 Plaque Formation

According to Samaranayake (2002), there is a complex process comprising a number of different stages of plaque formation starting from the formation of pellicle until the detachment process.

1. Pellicle formation

The acquired salivary pellicle which is a thin layer of salivary glycoproteins forms from adsorption of host and bacterial molecules to the tooth surface within minutes of exposure to the oral environment. Oral bacteria are initially attached to the pellicle and not directly to enamel.

2. Transport

By natural salivary flow, Brownian motion or chemotaxis, the bacteria approach the vicinity of the tooth surface prior to attachment. There are two types which are long-range interactions and short-range interactions. The long-range interactions involve physiochemical interactions between the microbial cell surface and the pellicle-coated tooth. Interplay of van der Waals forces and electrostatic repulsion produces a reversible phase of net adhesion. The short-range interactions consist of stereochemical reactions between adhesions on the microbial cell surface and receptors on the acquired pellicle. This is an irreversible phase in which polymer bridging between organisms and the surface helps to anchor the organism, after which the organisms multiply on the virgin surface. Multiplication times of plaque bacteria can vary considerably (from minutes to hours), both between different bacterial species and between members of species, depending on the environment conditions.
3. Coaggregation and coadhesion

Bacteria now attach on to the already attached first generation of cells. These may be bacteria of the same genus of different but compatible genera.

4. Biofilm formation

The process continues with a resultant confluent growth and the formation of a biofilm, which matures in complexity as time progress. A biofilm is defined as a complex, functional community of one or more species of microbes. The biofilm is not a flat compact structure resembling a piece of concrete. The aggregates of organism are arranged in columns or mushroom shaped structures interspersed with water channels that carry metabolites and bring in nutrients. The pioneer group of organisms that selectively colonize the salivary pellicle during plaque formation are Gram-positive cocci and Gram-positive rods. These are followed by Gram-negative cocci and Gram-negative rods, and finally by filaments, fusobacteria, spirils, and spirochaetes. On major component of a biofilm is the extracellular matrix which comprises microbial polysaccharides and additional layers of salivary glycoprotein. The climax community is termed for dynamic process of biofilm, in which, the metabolic products of the early plaque colonizers can alter the immediate environment, leading to new colonizers inhabiting the plaque, with a resultant gradual increase in microbial complexity, biomass and thickness. As a result the plaque biofilm mass reaches a critical size at which a balance between the deposition and loss of plaque bacteria is established (See Figure 2.1).
5. Detachment

The bacteria that colonize on climax community may detach and enter the planktonic phase (suspended in saliva) and be transported to new colonization sites, thus restarting the whole cycle.

Figure 2.1 Stages of biofilm formation (Wolfe, 2005)

2.2.4 Plaque Assessment

Index used to measure accumulation of plaque applies a numerical scale to assess the area of tooth surface that is covered by plaque. The common indexes used to measure the plaque accumulations are as followed (Carranza, et al., 2011):

Plaque measurement index focused on the gingival third of the tooth surface. A numerical scoring system of 0 to 5 was used. This modification is recognized as a reliable index for measuring plaque, using an estimate of the area of the tooth covered by plaque. Plaque assessed on the labial, and lingual surface of the Ramfjord Teeth after using a disclosing agent. This system of scoring plaque is relatively easy to use and the index obtained emphasizes the differences in plaque accumulation on tooth surface (Hiremath, 2011).

![Figure 2.2 The scoring system of Turesky-Modification of Quigley-Hein Plaque Index (Hiremath, 2011).](image)

2. Simplified Oral Hygiene Index (OHI-S)

The Simplified Oral Hygiene Index (OHI-S) by Greene and Vermillion, differs from the original OHI (The Oral Hygiene Index) in the number of the tooth surfaces scored (6 rather than 12), and the method of selecting the surfaces to be scored. The OHI-S, has two components, the Debris Index and the Calculus Index. Each of these indexes, in turn, is based on numerical determinations representing the amount of debris or calculus found on the preselected tooth surfaces (Darby and Walsh, 2010).
3. Silness-Löe Index

Each of the four surfaces of the teeth (buccal, lingual, mesial and distal) is given a score from 0-3. This index is often been used to determine the gingival condition associated with plaque accumulations. The scores from the four areas of the tooth are added and divided by four in order to give the plaque index for the tooth (Darby and Walsh, 2010). Assessment of Gingival Index by Löe and Silness is related to severity level of gingivitis, as following:

1) Gingiva index value 0,1-1,0 = Mild gingivitis
2) Gingiva index value 1,1-2,0 = Moderate gingivitis
3) Gingiva index value 2,1-3,0 = Severe gingivitis

4. O’ Leary Plaque Control Record

The Plaque Control Record was a simple method of recording the presence of plaque on individual tooth surfaces such as, mesial, distal, buccal and lingual. At the control appointment, suitable disclosing solution is painted on exposed tooth surfaces. The operator then examines each stained surface for soft accumulations. Index is calculated by dividing the number of plaque containing surfaces by total number of available surfaces (Darby and Walsh, 2010).

5. Patient Hygiene Performance Index (PHP) from Podshadley and Haley

The tooth surfaces are divided into 5 with vertical and horizontal line, vertical 1/3 of the mesial, middle and distal and horizontal 1/3 incisal, middle and gingival. There are only 2 types of scoring criteria, either 0, which represents no plaque, and 1, which means the present of plaque. PHP plaque score is obtained by total plaque in subdivision divide by the total surfaces examined.
6. Modified Navy Plaque Index

This index is used in accessing health education programs and individual’s ability to perform oral hygiene practices. The teeth to be examined are divided into 9 parts.

2.2.5 Plaque Control

Plaque control is the regular removal of dental plaque and the prevention of its accumulation on the teeth and adjacent gingival surfaces. The goal is thoroughly to maintain removal of plaque at least once daily to prevent periodontal diseases and caries. Therefore, regular use of oral hygiene practices is crucial for maintaining good oral hygiene (Lindhe, et al., 2003; Newman, et al., 2006).

The oral hygiene practices are divided to two techniques, mechanical and chemical (Jass, et al., 2003).

1. Mechanical

1) Manual brushing

The conventional toothbrush is the instrument most frequently used to remove dental plaque. The efficacy of brushing with regard to plaque removal is dictated by the design of the brush, the skill (methods) of the individual using the brush, and the frequency and duration of use.

2) Powered toothbrush

Powered toothbrushes rely primarily on mechanical contact between the bristle and the tooth to remove plaque. Patients who are poor brusher, children, and caregivers may benefit from using this powered toothbrush.
3) Interdental cleaning aids

Toothbrushing does not completely remove interdental plaque on the teeth. Common aids are dental floss and interdental cleaner, such as wooden tips (toothpick), interproximal brushes, and rubber tip stimulator.

2. Chemical

1) Dentifrices

Dentifrices aid in cleaning and polishing tooth surfaces. They are used mostly in the form of paste, but tooth powders and gels are also available.

2) Chemical plaque control with oral rinses

Solution of chlorohexidine digluconate oral rinse and non-prescription essential oil rinse are the two agents that have been accepted by American Dental Association (ADA) for treatment of gingivitis.

2.3 Tooth Brushing

Tooth Brushing is the action of using a toothbrush to clean the teeth. It should be carried out by every individual twice a day to keep the mouth clean. Brushing is an important part of dental care routine which is recommended to clean or remove the soft deposits on the surface of the teeth and gums. Tooth brushing can also reduce chances of developing gingival infections such as gingivitis or periodontitis by reducing the number of bacteria in oral cavity. Tooth brushing aims to protect the teeth by removing plaque from all accessible tooth surfaces especially in the interproximal and gum area, where bacteria resides the most (Newman, 2011).
Effective tooth brushing routine are stated below:

1. A gentle scrub technique by holding a tooth brush in 45 degree angle against your teeth at the gum line and scroll downward gently.
2. Use a soft to medium textured toothbrush and change every 3 months.
3. Hold toothbrush in a pen grip to avoid using excessive pressure
4. Use fluoride toothpaste and spit it out and rinse well.
5. Twice a day, approximately 3 minute for each.

Proper tooth brushing techniques are very important to maintain oral health, by following correct tooth brushing technique, plaque and food debris will be able to remove effectively and easily, in turn prevent the onset of dental caries.

In addition, there are other factors that affect the tooth brushing procedures, such as the frequency of brushing teeth brushing teeth, types of toothbrushes, skills of the patient, the patient’s age, knowledge of the patient, and the length of time consuming for tooth brushing (Newman, et al., 2006).

2.3.1 Brushing Technique

Many different types of tooth brushing methods are developed. The best methods are effective in removing plaque biofilm and debris, stimulate gingiva, and are able to deliver fluoridated dentrifice to the tooth surface. For adequacy in cleaning, 10 strokes are advised for each area (Killoy, et al., 1989).

The brushing technique can be used as combination or modification prophylactics measures in mental diseases, systemic diseases, or aging patients. According to Goldman and Cohen, the brushing technique chosen for each
individual depend on factors such as tooth anatomy, tooth arrangement, missing tooth, periodontal condition, presence of unfavourable prostheses and restorations (Goldman and Cohen, 2011).

To get maximum tooth brushing results, there are five points that need to be considered in the selection of the tooth brushing techniques, listed as followed (Coolidge and Hine, 2008):

1. Tooth brushing technique should be able to clean all the surface of the teeth and gums efficiently, especially the gingival margin and interdental.
2. The tooth brushing motions should not cause any damage to both soft and hard tissues, such as gum recession and tooth abrasion.
3. Simple, precise and easy tooth brushing technique.
4. Tooth brushing method should involve all regions and no missed areas.
5. Stimulate gingiva

In dentistry, tooth brushing is classified into various types based on the brush motions or movements (Darby and Walsh, 2010):

1. Vertical Technique

Vertical tooth brushing is done by positioning the tip of the bristles perpendicular to the buccal surface. Both jaws are closed, in an occlusion, then, the buccal surfaces of teeth are brushed with up and down movement. On the lingual surface and palatinal side of the teeth also brushed with a vertical movement. It was reported that, this kind of tooth brushing technique can cause abrasion of the teeth (Harris and Godoy, 1999; Lindhe, 2003; Newman, et al., 2006).
2. Horizontal Technique

The brush is placed on the teeth and moved along the line of dentition to the posterior region and pulled back again. This method of tooth brushing is used by everyone but is not beneficial in the long run as cervical abrasion is caused mainly due to this type of brushing for long duration (Harris and Godoy, 1999; Lindhe, 2003; Newman, et al., 2006).

3. Fones’ Circular Technique

This method is useful for small children or others with poor manual dexterity. Occlude the teeth then lightly press the bristles against the posterior teeth and the gingiva. Revolve the brush head in a fast, circular motion, using circles of
large diameter. Continue the circular motion, and slowly move the brush head toward the anterior until all facial surfaces have been brushed. With the mouth open, use the same circular motion on the lingual surfaces (Harris and Godoy, 1999; Lindhe, 2003; Newman, et al., 2006).

![Figure 2.5 Circular Technique](Hoag M. et al., 1990).

4. Rolling Technique

Place side of brush on the attached gingiva with the filaments directed apically. Press to flex the filaments. Roll the brush slowly down over the teeth. Repeat the entire stroke 5 times per tooth/group of teeth (Harris and Godoy, 1999; Lindhe, 2003; Newman, et al., 2006).

![Figure 2.6 Rolling Technique](Hoag M. et al., 1990).

Held the brush at the gingival towards apical (A), Roll down the brush towards occlusal (B)
5. Vibratory Technique

1) Charters Technique

This method is useful for patients with severe loss of interdental papilla height, fixed prosthetic appliances, previous gingival surgery as temporary cleaning of surgical wounds, or subsided ulcerative gingivitis. Perform the rolling stroke first to remove debris from the teeth. Direct the bristle tips toward the occlusal or incisal surface of the tooth. Gently rotate the handle, flexing the bristles and bringing them into contact with the interdental tissues and exposed proximal surfaces. Vibrate the handle of the brush with a slow, circular motion (Harris and Godoy, 1999; Lindhe, 2003; Newman, et al., 2006).

![Figure 2.7 Charters Technique](image)

Held the bristles towards occlusal and vibrate with a small circular motion (Hoag M. et al., 1990).

2) Modified Stillman Technique

Bristles are directed apically at 45 degrees to long axis of the tooth, press the bristles slightly so that it adheres at the gingival sulcus and embrasures. Vibrate the brush back and forth with short strokes for 10-15 strokes for each position and move to the next teeth. This technique also required an occlusal movement along with short horizontal strokes with
light pressure. It is usually indicates for massage and stimulation of gingiva in case of gingival recession, as well as cleaning the plaque and biofilm from cervical areas (Harris and Godoy, 1999; Lindhe, 2003; Newman, et al., 2006).

![Figure 2.8 Modified Stillman Technique](image1)

**Figure 2.8 Modified Stillman Technique**
Held the toothbrush in 45° and vibrate with a small circular motion (Hoag M. et al., 1990).

![Figure 2.9 Modified Stillman Technique](image2)

**Figure 2.9 Modified Stillman Technique**
Vibratory motion with slight pressure (1), towards occlusal (2) (Hoag M. et al., 1990).

3) Bass Technique
This method is useful for all types of dental conditions, especially periodontal problems. With bristles pointed at a 45-degree angle into the gingival sulcus, vibrate the brush gently back and forth about 20 times. Move the brush forward and repeat. This method is effective in cleaning cervical 1/3 & beneath gingival margins, and is recommended for both
healthy and disease periodontal in periodontal maintenance (Harris and Godoy, 1999; Lindhe, 2003; Newman, et al., 2006).

Figure 2.10 Bass Technique
(Killoy, et al., 1989).

6. Smith-Bell Technique

A physiological plaque removal technique. The bristles are placed at the height of the incisal edge or occlusal surfaces at an angle of 90 degrees, and moving in its action sweeping or cleaning of the gum. It is effective in supragingival cleansing but poor interproximal and sulcular cleansing (Lindhe, 2003; Newman, et al., 2006).

2.3.2 Trauma caused by Tooth Brushing

Trauma caused by tooth brushing should be avoided. The occurrence of trauma can be caused by brushing with a great pressure, the wrong placement of brush, the bristle is too hard, brushing the wrong direction (horizontally), long brushing time, and the properties of tooth paste which are too abrasive.

Brushing trauma can occur in (Checchi, et al., 1999):

1. Teeth

Presence of abrasion / wear of the teeth (See Figure 2.11)
2. Gum

Damage can be either superficial abrasions or gum recession. It can occur in a way that wrong placement of the brush with great pressure over a long period (See Figure 2.12)

Figure 2.11 Abrasion at Tooth Cervical
(Newman, et al., 2006)

Figure 2.12 Gingival Recession
(Newman, et al., 2006)

2.3.3 Tooth Brushing with Rolling Technique

Rolling Technique is a simple brushing technique which does not need much practicing. Brushing teeth with this technique are recommended for patients with normal gingival condition as daily self-care routine. It is simple, effective and can be used in all parts of the mouth. Roll technique has been approved by the ADA (American Dental Association) since the 1950s because it was an effective technique for cleaning the teeth and it stimulates gum.
In this technique, toothbrush bristles are held at a 45 degree angle against your teeth on the gums as far as possible from the occlusal surface (Figure 2.13a). The tip of the bristles is held toward the apical, and the side of the bristles are pressing gently on the gum until it turns pale. The tip of the bristles is then move slowly through the surface of the tooth and it creates a sweeping motions in relative arch (Figure 2.13b). At the time when bristles reach the clinical crown, the position is almost perpendicular to the surface of the enamel (Figure 2.13c). This movement is repeated 10 times in each area systematically to avoid miss areas. Occlusal surfaces cleaned with scrub method. (Darby and Walsh, 2010).

![Figure 2.13 Schematic Rolling Tooth Brushing Technique](Hoag and Pawlak, 1990)

(a) Bristles are held on the gums
(b) and (c) Sweep towards occlusal

One benefit of the rolling stroke method is that it is effective in plaque removal, easy to learn, requires less pressure than other tooth brushing techniques and good for gum stimulating, especially for those with sensitive gums. It was suggested to teach small children. They are able to brush their own teeth by using it and the ease of motion may make it a good choice for motor skills development. While more modern techniques are frequently used now, the rolling stroke method is still employed by many people (Rugg-Gunn and Macgregor, 1978).
2.4  Cerebrum

The cerebrum is the “seat of intelligence”. It provides us with the ability to read, write, and speak; to make calculations and compose music; and to remember the past, plan for the future, and imagine things that have never existed before (Tortora and Derrickson, 2009).

The cerebrum consists of an outer cerebral cortex and an internal region of cerebral white matter, and grey matter nuclei deep within the white matter (Tortora and Derrickson, 2009).

2.4.1  Cerebral Cortex

The cerebral cortex (cortex= rind or bark) is a region of gray matter that forms the outer rim of the cerebrum. Although only 2-4mm thick, the cerebral cortex contains billion of neurons. During embryonic development, when brain size increases rapidly, the gray matter of the cortex enlarges much faster than the deeper white matter. As a result, the cortical region rolls and folds upon itself. The folds are called gyri or convolutions. The deepest grooves between the folds are known as fissures, the shallower grooves between the folds are termed sulci (Tortora and Derrickson, 2009).

The most prominent fissure, the longitudinal fissure, separates the cerebrum into 2 halves called the left and right cerebral hemispheres (See Figure 2.14). The cerebral hemispheres are connected internally by the corpus callosum, a broad band of white matter containing axons that extend between the hemispheres. Each
The cerebral hemisphere can be further subdivided into four lobes. The lobes are named after the bones that cover them: frontal, parietal, temporal and occipital lobes. A major gyrus, the precentral gyrus, located immediately anterior to the central sulcus, contains the primary motor area of the cerebral cortex. Another major gyrus, the postcentral gyrus, which located immediately posterior to the central sulcus, contains the primary somatosensory area of the cerebral cortex. (Keith L. et al., 2010).

![Figure 2.14 Anatomical View of Cerebrum](Tortora and Derrickson, 2009)

Specific types of sensory, motor and integrative signals are processed in certain regions of cerebral cortex (Keith L. et al., 2010). Generally, sensory areas receive sensory information and are involved in perception, the conscious awareness of the sensation; motor areas control the execution of voluntary movements; and association areas deal with more complex integrative functions such as memory, emotions, reasoning, will, judgement, personality traits, and intelligence (Tortora and Derrickson, 2009).
2.5 Hemispheric Lateralization

Human brain's hemispheres operate both independently and in concert with each other. The two hemispheres communicate information, such as sensory observations, to each other through the thick corpus callosum that connects them. Although the brain is almost symmetrical on its right and left sides, subtle anatomical differences between the two hemispheres exist (Stephan, et al., 2003). For example, in about two-thirds of the populations, the planum temporale, a region of the temporal lobe that includes Wernicke’s area, is 50% larger on the left side than on the right side. This asymmetry appears in human fetus at about 30 weeks of gestation (Jones and Martin, 2009).

Although the two hemispheres share performance of many functions, each hemisphere also specializes in performing certain unique functions. This functional asymmetry is termed hemispheric lateralization. Many brain functions are lateralized, which allows for a “division of labor” between the two hemispheres. This is thought to be an important evolutionary adaptation that has boosted the brain’s efficiency (Brandler and Paracchini, 2014).

In the most obvious example of hemispheric lateralization, the left hemisphere receives somatic sensory signals from and controls muscles on the right side of the body, whereas the right hemisphere receives sensory signals from the controls muscles on the left side of the body. Because of this criss-cross wiring, damage to one side of the brain affects the opposite side of the body. There are several functional differences between the two cerebral hemispheres, which create most differences between them (Table 2.1) (Shulman, et al., 2010).
In general, the left hemisphere is dominant in language, processing what you hear and handling most of the duties of speaking. It's also in charge of carrying out logic and exact mathematical computations. When you need to retrieve a fact, your left brain pulls it from your memory (Jones and Martin, 2009).

The right hemisphere is mainly in charge of spatial abilities, face recognition and processing music. It performs some math, but only rough estimations and comparisons. The brain's right side also helps us to comprehend visual imagery and make sense of what we see. It plays a role in language, particularly in interpreting context and a person's tone (Jones and Martin, 2009).

### Functional Differences Between the Two Cerebral Hemispheres

<table>
<thead>
<tr>
<th>Left Hemisphere Functions</th>
<th>Right Hemisphere Functions</th>
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<tr>
<td>1. Receives somatic sensory signals from and controls muscles on the right side of the body</td>
<td>1. Receives sensory signals from the controls muscles on the left side of the body</td>
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<tr>
<td>2. Reasoning</td>
<td>2. Musical and artistic awareness</td>
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<tr>
<td>3. Numerical and scientific skills</td>
<td>3. Spatial and pattern perception</td>
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<tr>
<td>4. Spoken and written language</td>
<td>4. Recognition of faces and emotional content</td>
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<td>5. Ability to use and understand sign language.</td>
<td>5. Generating emotional content of language</td>
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<td>6. Discrimination of different smells</td>
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<td></td>
<td>7. Generating mental images of sight, sound, touch, taste and smell</td>
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Table 2.1 Functional Differences Between the Two Cerebral Hemispheres

(Shulman, et al., 2010).
The brain carefully balances and assigns control of certain functions to each side it is all nature's way of ensuring that the brain ultimately splits up tasks to maximize efficiency. Most people are right-hand dominant which is actually controlled by the left side of the brain (Bishop, 2001).

Patients with damage in the left hemisphere, often exhibit aphasia (language or speech disturbances that have resulted from brain damage), because Broca’s speech area, Wernicke’s area, and other language areas are located in the left cerebral of most people, regardless of whether they are left handed or right handed. Patients with damage in right hemisphere regions that correspond to Broca’s and Wernicke’s areas in the left hemisphere speak in monotonous voice, lost the ability to impart emotional inflection to what they say (Gutwinski, et al., 2011).

It has been proven that, the two concepts of brain lateralization for language and handedness are interconnected to a large degree (Bishop, 2001).

2.6 Handedness

Handedness is a vague term; most people in our society define handedness as the hand you use for writing. Within the scientific community, researchers define handedness based on different theoretical assumptions. For instance, some define handedness as the hand that performs faster or more precisely on manual tests, while others define it as the hand that one prefers to use, regardless of performance. Some think that there are two types of handedness either left or right, or either right or non-right (Forrester, et al., 2013).

There are indications that left-handedness may be associated with a smaller
lateralization of cognitive processing: 97% of right-handers have their motor speech area located exclusively in the left hemisphere. On the other hand, motor speech processing is located exclusively in the left hemisphere only in 60% of left-handers, while 30% have bihemispheric processing and 10% have right hemisphere processing (Gutwinski, et al., 2011).

Studies have shown that the corpus callosum, the largest structure connecting the left and right hemispheres (commissure), of left-handers tends to be larger (Corballis, Hattie and Fletche, 2009). Therefore, this may be a sign of a greater connectivity between hemispheres and may be associated with certain cognitive skills. In fact, a greater inter-hemispheric connectivity could be associated with the reported observations that left-handers can have better motor skills, mathematical skills or higher creativity (Rhoda, 2012).

2.7 Lateralization and Handedness

For long, hand preference in performing tasks was taken into account as an indicator of brain lateralization, but a person's preferred hand is not a clear indication of the location of brain function. (Ocklenburg, Beste and Güntürkün, 2013). Although 95% of right-handed people have left-hemisphere dominance for language, 18.8% of left-handed people have right-hemisphere dominance for language function. Additionally, 19.8% of the left-handed have bilateral language functions (Corballis, Hattie and Fletche, 2009).

The primary historical reason that the hand-brain link was considered important and became a generally-accepted methodology, was because for nearly
a century it was the only hint that a neurosurgeon had prior to surgery which hemisphere was specialized for language. Clinicians used handedness as a marker for brain lateralization until the Wada (sodium amytal) Test was introduced in the 1960s (Jones and Martin, 2009).

This association between hand and brain captured the imaginations of researchers because it would be so useful, easy, non-invasive, cheap, to study patterns of brain asymmetries by using a person's handedness as a marker for brain lateralization (Gutwinski, et al., 2011).

Clarifying the relationship between handedness and functional brain specializations, and learning more about the developmental and neurobiological mechanisms that underlie these relationships, may help us better understand a wide debating issues related to handedness and their relative’s psychomotor functions (Leask and crow, 2001).

### 2.8 Handedness related tooth brushing

Left handers were more successful to access the right side of the oral cavity than right handed subjects. However, in relation to the left side of the mouth, right handed individuals were more successful. So, during application of oral hygiene procedures, by encouraging for both hand usage, negative effects derived from only right or left hand use can be prevented (Ozden, 2011).