CHAPTER II
LITERATURE REVIEW

2.1 Changes of Horizontal Distance from Condyle to Nasal Septum

Temporomandibular joint is one of the most complex joints in the body. It is a bilateral symmetric synovial joint between the temporal bone and mandible. The three main components in the temporomandibular joint position are the mandible condyle, glenoid fossa, and articular disc. The function of the disc is to separate, protect and stabilize the condyle in the glenoid fossa during functional movements (Okeson, 2008).

Temporomandibular joint has an important bond with the oral cavity and teeth. Oral structures and the associated muscles will affect the position and function of the mandibular condylar portion of the temporomandibular joint. Therefore, orthodontic treatment has a direct influence on the temporomandibular joint (Al-koshab et al., 2015)

Most of the functional appliances used in orthodontic treatment are indicated to displace the mandibular condylar downward and forward in the glenoid fossa. Then, adaptive remodelling on both articular surface of the temporomandibular joint surface occurred to compensate the position changed of mandible (Chavan et al., 2014). For example, Twin-block appliance increased condylar volume, mandibular length, and intercondylar distance by enhancing growth of condyle in upward and backward direction (Yildirim et al., 2014).
According to a histochemical study on rat’s condylar cartilage and glenoid fossa cartilage during mandibular advancement, the mandible protrusion is achieved through an endochondral ossification process in the mandibular condylar cartilage and intramembranous ossification process in the glenoid fossa (Owtad et al., 2011). Endochondral ossification is the replacement of cartilage by bone meanwhile intramembranous ossification is when the bone forms directly from the mesenchyme cells arranged in sheetlike layers that resemble membranes (Tortora and Derrickson, 2009). The condyles are able to respond to continuous stimuli throughout the remodeling process (Al-koshab et al., 2015).

![Figure 2.1 Condylar Cartilage of the Temporomandibular Joint (Rakosi et al., 1993)](image)

The condylar cartilage is a secondary type and can be categorized into four zones. The outer most layer of the condyle head consisted of fibrous connective tissue zone. Under the fibrous connective tissue zone, there are proliferation zone of undifferentiated connective tissue cells, which become differentiated to
chondroblast. Next, is the hyaline cartilage zone with chondroblast and hypertrophied cells followed by endochondral ossification zone in which the cartilage is broke down and replaced by bone.

Panoramic radiography collects the images using a rotating system to produce frontolateral panoramic image of the face. Panoramic radiograph allows wide view of the oral maxillofacial complex, including the nasal septum and condyle. Panoramic radiograph allows the comparison of proportions between skeletal and dental structures, individually and as a whole. Comparison of the structures between left and right region can be carry out using panoramic radiograph (Puricelli, 2009).

The anatomy of nasal septum act as a guidance for facial midline and median sagittal plane in the panoramic radiograph (Lemos et al., 2014). One of the research showed that in growth modification of Class II division 1 malocclusion with retrognathic mandible, Twin-block appliance created some significant effect on temporomandibular joint because condyle grow in upward and backward direction (Fareen et al., 2015). Therefore, panoramic radiograph as a frontolateral radiograph image of the face, it captures the growth of condyle in backward direction as the changes of horizontal distance from condyle to nasal septum.

2.2 Dentoskeletal Class II Malocclusion

Profit (2000) declared that malocclusion is a dental condition associated with malalignment of individual teeth in each arch, malrelationship of the dental arches relative to the normal occlusion, and combination of both. The two basic etiology of malocclusion is caused by hereditary factors and environmental effects.
Edward Angle (1899) defined Class II malocclusion as when mesiobuccal cusp of the maxillary first molar occluded mesially with the mesiobuccal groove of the mandible first molar. He further divided it into division 1 and division 2. Class II division 1 malocclusion are identified by narrowing of the maxillary arch, lengthened and protruding maxillary incisors, abnormal function of the lips, and some form of nasal obstruction and mouth breathing. Class II Division 2 malocclusion are determined by slight narrowing of the maxillary arch, crowding and retruding maxillary incisors, and normal nasal and lip function. However, Angle classification is not adequate to explain the Class II malocclusion arising from both dental and skeletal origin (Bishara, 2001).

Dental Class II malocclusion can be caused by maxillary dental protrusion and mesial drift of the maxillary first permanent molars. Maxillary dental protrusion may be confused with skeletal mid face protrusion but it is a dentoalveolar condition that caused by limited maxillary dental arch. Mesial drift of the maxillary first permanent molars particularly associated with premature loss of maxillary second primary molars. There are two type of treatment for dental Class II malocclusion
which are nonextraction approach involving distalization of the maxillary teeth and the extraction approach involving unilateral or bilateral dental extraction (Bishara, 2001).

Figure 2.3 Etiology of Skeletal Class II Malocclusion. (A) Maxillary Prognathism; (B) Mandibular Retrognathia; (C) Combination of Maxillary Prognathism and Mandibular Retrognathia (Proffit, 2000)

Skeletal Class II malocclusion can be caused by maxillary prognathism, mandibular retrognathia and combination of both condition (Rita and Sadat, 2014). Maxillary prognathism often resulted from overdevelopment of maxilla in vertical or anteroposterior dimension or both. Mandibular retrognathia is a term to describe a mandible that is small or the mandible is retruded compared to the normal maxilla. Combination of maxillary prognathism and mandibular retrognathia is common which would increase the severity of the skeletal Class II malocclusion (Bishara, 2001). Three types of skeletal Class II malocclusion treatment are growth modification, orthodontic camouflage, and orthonagtic surgery. The choice of treatment is determined by the severity of the problem and the age of the patient. (Mitchell, 2001).
2.3 Dentoskeletal Class II Division 1 Malocclusion

Class II malocclusion is a common malocclusion with a prevalence ranging from 5% to 29 and often caused esthetic problems. Therefore, the patients with Class II malocclusion are seeking orthodontic treatment more than other patients. Class II malocclusion is categorized into Class II division 1 and Class II division 2. In Class II division 1 patients, some reports indicated that the maxilla was more protrusive, and the mandible was normal in size and position. Another studies found that the maxilla was in a normal position but the mandible was retrusive. Other studies showed that in Class II division 1 patients there were both maxillary protrusion and mandibular retrusion (Molabashi et al., 2014).

![Figure 2.4 Class II Division 1 Malocclusion with Mandibular Retrognathia. (a) Intraoral Image; (b) Extraoral Image (Pachori et al., 2012)](image)

However, Class II division 1 malocclusion is often associated with mandibular retrognathia, proclined upper and lower incisors (Qamar et al., 2010). The facial profile for Class II division 1 malocclusion is always convex. Then, incomplete lip seal, excessive overbite and overjet can be observed too (Bishara, 2001). The etiology Class II division 1 malocclusion has a close relationship with mouth breathing, thumb sucking, or finger sucking (Kanao et al., 2009).
Class II division 1 malocclusion can be treated by several ways. In cases of Class II division 1 malocclusion, the treatment is different for growing patients and non-growing patients. Young growing patients with Class II division 1 malocclusion is suitable to use growth modification treatment because there is still potential growth in patients to prevent malocclusion in adolescents (Bishara, 2001). The growth modification treatment can be done by head gear, bionator, activator, twin-block, herbest appliance, or Frankel II regulator (Rita and Sadat, 2014). But, for non-growing patients do not benefit from growth modification and thus more likely to have orthodontic camouflage treatment or orthognathic surgery (Bishara, 2001).

2.4 Twin Block Functional Appliance

Functional appliance is an orthodontic appliance which forced the mandible into an eccentric or non-eccentric relation position when it is placed in the mouth. Most commonly, it is used to create mandible protrusion to treat the skeletal class II dental relationship. This correction has been long believed that displacement of condyle out of glenoid fossa are able to stimulate the growth of condyle (Bishara, 2001).

![Figure 2.5 Intraoral Images for Twin-block Appliance. (a)Frontal View; (b) Lateral View (Kharbanda1 and Chaurasia, 2015)
Among the functional appliances, Twin-block appliance is mostly used in the management of Class II malocclusion. Twin-block functional appliance is a two-piece removable bite blocks that are used to correct the skeletal Class II malocclusion. It modified the occlusal incline plane of acrylic bite blocks to construct a protrusive bite. Upper and lower bite blocks interlocked at a 70° angle and are indicated to be wear for 24 hours a day (Clark, 2015).

Twin-block appliance showed an immediate result of correcting mandibular retrognathia by transmission of favourable occlusal force to occlusal inclined plane that covered the posterior teeth. The occlusal forces transmitted to through the dentition to supply a constant proprioceptive stimulus to promote the maximum growth response of mandible (Clark, 2015).

The Twin-block appliance design is always started with upper appliance incorporates a midline screw to widen the maxillary arch. It is important to expand the maxillary arch to compensate with the mandibular arch in correcting mandibular retrognathia. Next, delta clasps are placed on upper molars, with additional ball ended clasps distal to the canines, or between the premolars or deciduous molars. For the lower appliance, delta clasps are placed on the first premolars and ball clasps mesial to the canines (Clark, 2015).

The stages of the treatment is carried out in 2 phase which are active phase and support phase. In the active phase, Twin-block appliance are used to correct the relationship with the maxilla by using occlusal inclined place of the bite block to correct the mandible position from skeletal retruded Class II to Class I occlusion. Once the active phase is accomplished, the Twin-block appliance are replaced with
an upper Hawley type of appliance with an anterior inclined plane, which is used to
enhance the corrected incisor relationship until the buccal segment occlusion is
fully interdigitated (Clark, 2015).

Then, the treatment is followed by retention using the upper anterior inclined
place appliance to maintain the full buccal segment occlusion. The appliance wear
is reduced to night time only after the occlusion is fully established. An average
period of treatment is 18 months, including retention (Clark, 2015).

Twin-block appliance has a lot advantages compare to other appliances. For
example, wearing for 24 hours per day is allowed and patients can eat while wearing
the appliance. Mandible can perform movement in anterior and lateral excursion
without restriction because it is a two-piece bite blocks. Patients are able to talk as
normal because the tongue movement is not affected, as well as the patients
appearance. The last advantage of Twin-block appliance is the face profile
improved immediately after wearing the appliance (Rita and Sadat, 2014).

2.5 Lemos Asymmetry Analysis

![Figure 2.6 Lemos Asymmetry Analysis (Lemos et al., 2014)](image-url)
Lemos asymmetry analysis is a new digital analysis for mandibular asymmetry measurements on digital panoramic radiograph. Both linear measurement and angular measurement can be calculated for both sides of each digital image (Lemos et al., 2014).

![Image of dental panoramic radiograph with anatomical points labeled](image)

**Figure 2.7** Anatomical Points on Dental Panoramic Radiograph Image. (1) Right Pterygomaxillary Fossa (RPF); (2) Anterior Nasal Spine (ANS); (3) Left Pterygomaxillary Fossa (LPF); (4) Most Cranial Point of Left Condyle (LHC); (5) Left Gonion (LGo); (6) Most Cranial Point of Right Condyle (RHC); (7) Right Gonion (RGo); (8) Pogonion (Pg); (9) Inter-incisive Point (IP) (Lemos et al., 2014)

The anatomical points are indicated directly on the digital dental panoramic radiograph image using the ImageJ software as follow (Lemos et al., 2014):

1. Right pterygomaxillary fossa (RPF)
2. Anterior nasal spine (ANS);
3. Left pterygomaxillary fossa (LPF)
4. Most cranial point of left condyle (LHC)
5. Left gonion (LGo)
6. Most cranial point of right condyle (RHC)
7. Right gonion (RGo)
8. Pogonion (Pg – present as a white spot on the midline of mandible)

9. Inter-incisive point (IP)

Various type of linear measurement can be measured which are ramus heigh (RH) is the distance between the most cranial point of the condyle (points 4 and 6) and the gonion (points 5 and 7), corpus length (CL) is the distance between gonion and pogonion (points 5, 7 and 8), the gonion, distance between pogonion and median sagittal plane (Pg-MSP) (points 2 and 8), distance between inter-incisive pint and median sagittal plane (IP-MSP) (points 2 and 9), and CHD is the difference between the heights of the right and left condyle (a horizontal line automatically drawn from the taller condyle). Meanwhile, in angular measurement, only gonial angle (GA) which formed between RH and CL for both region on images can be expressed in degrees (Lemos, et al., 2014).

The modification of Lemos asymmetry analysis is used as the method for the research methodology. A horizontal line was drawn from the point of taller condyle perpendicular to the median sagittal plane to detect the difference between the heights of the right and left condyle (Lemos et al., 2014). Hence, this horizontal line is used as the modification of Lemos asymmetry analysis to measure the horizontal distance from the median sagittal plane to the most cranial surface of condyle head.