CHAPTER II
LITERATURE REVIEW

2.1 Overview of Tooth Impaction

Teeth that fails to erupt into the dental arch within the expected developmental window are called tooth impaction.

2.1.1 Definition of Tooth Impaction

Impacted teeth definition can be found in many literatures, although the word is vary, but the meaning is still the same. In essence, bones, teeth, and soft tissue forms the barriers in the path of eruption by the impacted teeth to prevent the permanent teeth to erupt into normal functional positions. Generally, tooth impaction is a failed teeth to erupt into dental arch during the growth because it has been blocked by nearby teeth, bones thick, dense and soft tissue is influenced by genetic factors. The teeth will be latent for a lifetime if extraction is not done (Peterson, et al., 2003). Besides that, tooth impaction can also be defined when it has passed through a complete crown formation time, complete root or later than 6 months after the contralateral tooth eruption (Bishara, 2001).
2.1.2 Etiology of Tooth Impaction

Tooth impaction are commonly cause by supernumerary teeth, dense overlying bone, prolonged deciduous tooth retention, malposed tooth germs, arch-length deficiency, odontogenic tumors, and cleft lip and palate. Systemic factors such as Cleidocranial dysplasia, Down syndrome, febrile diseases, and endocrine deficiencies can also cause tooth impaction but it is less common (Al-Asfour, 2013).

In a study showed that 85% of palatally impacted canines had adequate space for eruption, whereas only 17% of labially impacted canines had adequate space. Therefore, the primary etiologic factor for labially impacted canines is arch length discrepancy. There are localized, systemic and genetic factors that could lead to tooth impaction. The examples for localized factors are failure of the primary tooth to resorb, prolonged retention or early loss of the primary tooth, ankylosis of the permanent tooth, cyst or neoplasm, dilaceration of the root, absence of the maxillary lateral incisor, variation in root size of the lateral incisor, variation in timing of lateral incisor root formation, iatrogenic factors and idopathic factors. Whereas, endocrine deficiencies, febrile diseases and irradiation are included in the systemic factors of tooth impaction. Other than that, heredity, malposed tooth germ and presence of alveolar cleft are also contributes in the genetic factors of tooth impaction (Manne et al, 2012).

The cause of mandibular third molar impaction is said to be due to insufficient space between the anterior border of the ascending ramus of the mandible and the second mandibular molar distal part. The amount of space is determined primarily by facial growth. It was hypothesized that those with a predominantly vertical (dolichofacial) growth pattern would have higher incidence of mandibular third molar impaction compared with those with predominantly horizontal (brachyfacial) (Divya and Themozhi, 2014).

One of the most popular theory is inadequate development of the retromolar space. Anterior surface of mandibular ramus growth is related to resorption whereas, posterior surface of
mandibular ramus is related to deposition, but in case of imbalance of this process, the mandibular third molars could not erupt due to lack of space. Favourable path of eruption aslo affects the proper eruption of mandibular third molars. For example, during the initial stages of calcification and root development if the tooth bud is medially angulated, therefore the path of eruption will be unfavourable. However, impaction of mandibular third molars can also develop due to a decrease in the angulation of the mandible and an increase in the angulation of the mandibular plane (Juodzbalys and Daugela, 2013).

In a study, it is found that the relation between the root angulation and impaction where angulated roots were more common in impacted mandibular third molars as compared to erupted mandibular third molars. Some authors indicates other important third molar impaction causes including malposition of the tooth germ, hereditary factors, lack of sufficient eruption force for third molars, and the theory of phylogenetic regression of the jaw size is insufficient mesial movement of the dentition of modern human due to lack of interproximal attrition (Juodzbalys and Daugela, 2013).

2.1.3 Prevalence of Tooth Impaction

All teeth can be impacted, but the impaction cases are more common in both the third molar teeth of the upper jaw and lower jaw, followed by second-most by maxillary canine, mandibular canine and the third-most maxillary premolars and mandibular premolars (Hupp, et al., 1998). Myberg conducted a research with a population of 6000 school children in Sweden obtain the results of the prevalence of impacted teeth which is other than third molar teeth is 5.4% (Miloro, 2004). In a study, from the total of 3853 impacted teeth, mandibular third molars were most commonly encountered (82.5%), followed by maxillary third molars (15.6%), and maxillary canines (0.8%) (Chu et al., 2003).
According a research by Elsey and Rock, the third molar impaction is occurring in up to 73% of young adults in Europe. In general, third molars have been found to erupt between the ages of 17 and 21 years. Furthermore, it is reported that different races have different third molar eruption time. For example, mandibular third molars may erupt as early as 14 years of age in Nigerians, whereas, in Europeans up to the age of 26 years. The average age for the mandibular third molars eruption in male is approximately 3 to 6 months ahead of females. However, most authors claim that the incidence of mandibular third molar impaction is higher in females (Juodzbalys and Daugela, 2013).

Dachi and Howell performed evaluations at the dental radiographs and they found from 3874 of the impacted teeth, the numbers of impacted permanent maxillary canines reached 0.92% whereas, other teeth than third molar reached 0.38% (Miloro, 2004). Maxillary canine impaction occurs in approximately 2% of the population and is more common twice in females as it is in males. Furthermore, the occurrence of canine impaction in the maxilla is more than twice that in the mandible. Of all patients who have impacted maxillary canines, 8% have bilateral impactions. Approximately one-third of impacted maxillary canines are located labially and two-thirds are located palatally (Manne et al, 2012).

The prevalence of impacted premolars has been found to vary according to age. The overall prevalence in adults has been reported to be 0.5% whereas, 0.2 to 0.3% for mandibular premolars. Maxillary premolars and canines impactions are seen more often palatally compared with buccally, while the incidence of mandibular premolars is predominantly lingual. Literature specific to impacted premolars is not extensive, despite the fact that mandibular second premolars alone account for approximately 24% of all dental impactions. (Kale et al, 2012)

The prevalence of supernumerary teeth in primary dentition is 0.3-0.8%, and in permanent dentition 1.5-3.5%. A meta-analytic study has shown that the value obtained for prevalence depends directly on the diagnostic tools used, panoramic radiography being the most effective
diagnostic method. Differs from tooth impaction, supernumerary teeth are more prevalent among men than women in a proportion of 2:1.

While the upper maxilla presents supernumerary teeth more frequently than the mandible. A study by Liu et al. of 487 patients and 626 supernumerary teeth, it is found that they were located in the upper maxilla in 92% of the patients. In another study of 283 supernumerary teeth, they were situated in the upper maxilla in 95% of cases, while Mahabob et al. analyzed 2,216 patients with 27 supernumerary teeth, 67% of which were situated in the upper maxilla. Minguez-Martínez et al. studied 303 supernumerary teeth in 200 patients observing that 88% were situated in the upper maxilla. However, there is one study of 393 supernumerary teeth found almost the same frequency in the two jaws (Ata-Ali et al, 2014).

According to a research, total of 7468 panoramic radiographs of Chinese patients aged 17 to 89 years were examined. A total of 2115 patients presented with at least one impacted tooth, and impacted third molars were found in 2081 patients. The 20 to 29 years age group had the highest prevalence of tooth impaction (55.1%), but this decreased with increasing age (Chu et al., 2003).

2.1.4 Classification of Molar Impaction

Permanent molar impaction can be categorized into classification. The form of molar impaction classification according to the experts as follows. There are 2 popular classification for molar impaction which are known as Pell’s and Gregory’s classification and Archer’s classification (Divya and Themozhi, 2014).

1. Pell and Gregory Classification
For determining the level of impaction based on Pell and Gregory classification, third molar were categorized into 2 groups.

1) In class A, the highest part of the mandibular third molar is on the same level or below the occlusal plane of the adjacent second molar. (Figure 2.1)

2. In class B, the highest part of the mandibular third molar is below the occlusal plane but above the cervical line of the second molar. (Figure 2.1)

3. In class C, the highest part of the mandibular third molar is beneath the cervical line of the second molar. (Figure 2.2)

**Figure 2.1**: Pell and Gregory Classification
(A) : Class A  
(B) : Class B  
(Divya and Themozhi, 2014)
**Figure 2.2** Pell and Gregory Classification

Class C (Divya and Themozhi, 2014)

Also, the relationship of the impacted third molar to the ramus of the mandible and the second molar is classified as follows.

1. In class I, sufficient space available between the anterior border of the ascending ramus and distal side of second molar for eruption of the third molar. (Figure 2.3)

2. In class II, the space available between the anterior border of the ramus and the distal side of the second molar is less than 1/2 mesiodistal width of the crown of the third molar. (Figure 2.3)

3. In class III, the third molar is totally embedded in bone from the ascending ramus because of absolute lack of space. (Figure 2.4)

**Figure 2.3**: Pell and Gregory Classification

(A) : Class I
(B) : Class II

( Divya and Themozhi, 2014)
2. Archer’s Classification

1) Mesioangular is when the impacted tooth is positioned with the Crown pointing in the mesial direction towards the second molar and the roots pointed distally.

2) Distoangular is when the impacted tooth is positioned with the Crown pointing in the distal direction towards the second molar and the roots pointed mesially.

3) Vertical is when the tooth has not erupted completely and the crown of the third molar lies near the root of the second molar.

4) Horizontal is when the impacted third molar lies horizontally in the alveolar bone, with the crown towards the second molar and the root tips towards the distal side.

5) Buccoangular is when the impacted tooth is positioned in such a way in the alveolar bone that the occlusal surface of the crown is towards the buccal aspect.

6) Linguoangular is when the impacted tooth is positioned in such a way in the alveolar bone that the occlusal surface of the crown is towards the lingual aspect.

7) Inverted is when the impacted tooth is completely inverted with the root tips towards the occlusal surface and the crown of the tooth towards the root of the second molar. This is a very rare scenario but has been documented in the past (Fragiskos, 2007).
2.1.5 Classification of Canine Impaction

Permanent canine impaction can be categorized into classification. The form of canine impaction classification according to the experts as follows. There are 3 popular classification for molar impaction which are known as Yavuz’s and Buyukkurt’s classification, Archer’s classification and Stivaros’ and Mandall’s classification. (Yavuz et al, 2007) (Counihan et al, 2013) (Gan, 2010)

1. Archer’s Classification

The classification method of the maxillary canine impaction is very varied. One of the commonly used classification is the classification theories is Archer. Archer canine impaction divide into 5 classes in general. (Gan, 2010)

1) In class 1, the canine is in the palate with horizontal, vertical, or semivertikal position.
2) In class 2, the canine is in the buccal area with horizontal, vertical, and semivertikal position.

3) In class 3, the canine is between two teeth with the dental crown is at the palatal side and the root is at the buccal side or otherwise the crown is on the buccal side and root is in the palatal side until it is called intermediate position.

4) In class 4, the canine is in the alveolar process with a vertical position between the lateral incisor and premolar teeth.

5) In class 5, the canine is in a toothless bone jaw or edentulous. (Gan, 2010)

2. Stivaros’ and Mandall’s Classification

Stivaros and Mandall classified the position of maxillary permanent canine impaction into 4 category.

1) Based on the position of canine angulation to midline.

![Figure 2.6 Canine Angulation to Midline](Counihan et al, 2013)

(1) In grade 1, the canine is at an angle of 0°-15°
(2) In grade 2, the canine is at an angle of 16°-30°

(3) In grade 3, the canine is at an angle of >30°

2) Based on the position of canine root apex horizontally.

![Figure 2.7 Canine Root Apex Horizontally (Counihan et al., 2013)](image)

(1) In grade 1, the canine root apex is above the canine region.

(2) In grade 2, the canine root apex is above the first premolar region.

(3) In grade 3, the canine root apex is above the second premolar region.

3) Based on the vertical height of canine crown.

![Figure 2.8 Vertical Height of Canine Crown (Counihan et al., 2013)](image)

(1) In grade 1, the canine is at below of the Cemento Enamel Junction (CEJ) of the lateral incisor.
(2) In grade 2, the canine is at above the CEJ, but less than half of the lateral incisor root.

(3) In grade 3, the canine is more than half, but less than full root length.

(4) In grade 4, the canine is at full root length of lateral incisor.

4) Based on the canine crown horizontal overlap.

![Figure 2.9 Canine Crown Horizontal Overlap (Counihan et al, 2013)](image)

(1) In grade 1, there are no horizontal overlap.

(2) In grade 2, the canine crown overlap less than half of the lateral incisor root width.

(3) In grade 3, the canine crown overlap more than half but less than full root width.

(4) In grade 4, the canine crown overlap the full root width of the lateral incisor root or wider.

3. **Yavuz’s and Buyukkurt’s Classification**

Yavuz and Buyukkurt classify canine impaction based on the level of depth of the teeth. This classification is common and is often used to classify impacted permanent mandibular canine. Yavuz and Buyukkurt classification divide canine impaction into three levels.
1) In level A, the crown of the impacted canine tooth is at the cervical line of the adjacent teeth.
2) In level B, the crown of the impacted canine tooth is between the cervical line and root apices of the adjacent teeth.
3) In level C, the crown of the impacted canines is beneath the root apices of the adjacent teeth.

**2.2 Overview of Mandibular Premolar Tooth**

The premolar term is used to appoint the teeth in the secondary dentition of mammals that are positioned just in front of molars and behind of canines. There are total of eight premolars in our permanent dentition, four in the upper jaw and four in the lower jaw. They are the fourth and the fifth teeth from midline in each region (Scheid and Weiss, 2012).

**2.2.1 Morphology of Premolars**

The premolars are those teeth that succeed the deciduous molars regardless of the number to be succeeded. The term bicuspid, which is widely used to describe human teeth, presupposes two cusps, a supposition that makes the term misleading, because mandibular premolars in the human subject may show a variation in the number of cusps from one to three. (Nelson and Ash, 2010)
According to Universal Numbering System, the maxillary right and left first premolars can be identified as teeth Numbers 5 and 12, respectively, whereas Numbers 4 and 13 for the maxillary second premolars right and left, respectively. The mandibular right and left first premolars identified as Numbers 28 and 21, respectively, and the mandibular right and left second premolars are in Numbers 29 and 20, respectively (Scheid and Weiss, 2012).

The distal surfaces of first premolars contact the mesial surfaces of second premolar, whereas the mesial surfaces contact the distal surfaces of adjacent canines. The distal surfaces of second premolars are in contact with the mesial surfaces of adjacent first molars (Scheid and Weiss, 2012). The maxillary premolars are developed from four lobes which is the same number as anterior teeth. The primary difference in development is the well-formed lingual cusp, developed from the lingual lobe, which is represented by the cingulum development on incisors and canines. The middle buccal lobe on the premolars, corresponding to the middle labial lobe of the canines, remains highly developed, with the maxillary premolars resembling the canines when viewed from the buccal aspect. (Nelson and Ash, 2010)

The maxillary premolar crowns are shorter than those of the maxillary canines, and the roots are also shorter. The root lengths equal those of the molars. The crowns are a little longer than those of the molars. Because of the cusp development buccally and lingually, the marginal ridges are in a more horizontal plane and are considered part of the occlusal surface of the crown rather than part of the lingual surface, as in the case of incisors and canines. When premolars have two roots, one is placed buccally and one lingually (Nelson and Ash, 2010).

The internal anatomy of the maxillary first premolars is particularly complex due to their variation in number of roots and canal configuration. Several researchers have reported a low incidence of maxillary first premolars with a single canal. It is observed an incidence of a single canal above 10% (Pécora et al, 1992).
The maxillary first premolars are described as having two roots and two root canals with 56% and one root and two root canals with 40%. Although rarely, these teeth can also have three roots and three root canals and are identified in the literature as small molars, as the tooth structure and the positioning of the roots in these cases resemble those in molar teeth. Maxillary first premolars were first studied by Vertucci in 1979. According to this study, 5% of 400 maxillary first premolars have three canals, 0.5% of them are teeth with three canals in a single root, 0.5% have three canals in two roots and 4% have three canals in three roots. However, Carns discovered three separate canals in 6% of the upper fourth teeth (Kirilova et al., 2014).

### 2.2.2 Function of Premolars

There are few reasons why premolars are important for us, for example premolars work with molars for food mastication. Premolars also helps to maintain the vertical dimension of the face between the nose and chin. Other than that, these premolars support the corners of the mouth and cheeks to keep them from bulging downward. This is more visible in older people and the first premolars help the canines in cutting and shearing food particles. Fortunately, patients who have four to eight occluding premolars can still chew or masticate adequately even if they have lost all of their molars. However, it is very discernible if a person lost one or more maxillary premolars when he smiles (Scheid and Weiss, 2012).

The buccal cusp of the maxillary first premolar, especially, is long and sharp, assisting the canine as a prehensile or tearing tooth. The second premolars, both maxillary and mandibular, have cusps less sharp than the others, and their cusps articulate with opposing teeth when the jaws are brought together; this makes them more efficient as grinding teeth, and they function much like the molars, but to a lesser degree. (Nelson and Ash, 2010)

### 2.2.3 Permanent Premolars Eruption Process
The permanent dentition consisting of 32 teeth is completed from 18 to 25 years of age if the third molar is included. Apparently there are four or more centers of formation (developmental lobes) for each tooth. The formation of each center proceeds until a coalescence of all of them takes place. During this period of odontogenesis, injury to the developing tooth can lead to anomalous morphological features (Nelson and Ash, 2010). During the eruption, there are many stages in the teeth that run simultaneously, such as elongation of roots, the exaltation of the alveolar process, the movement of the teeth in the jawbone towards the occlusal plane, and the process of root resorption of primary teeth (Litsas and Acar, 2011).

Although no lines of demarcation are found in the dentin to show this development, signs are found on the surfaces of the crowns and roots; these are called developmental grooves. Fractures of the teeth occur most commonly along these grooves. The developing premolars, which eventually take the place of deciduous molars, are within the bifurcation of primary molar roots (Nelson and Ash, 2010).

The calcification process of permanent first premolar starting at age 18-24 months and the formation of the crown complete at the age of 5-6 years whereas for the second premolar is at the age of 24-30 months and the formation of the crown complete at the age of 6-7 years (Logan and Kronfeld, 2003). The first premolars erupt after the maxillary lateral incisors when the child is about 10 years old. However, the second premolars usually emerge during the next year (Nelson and Ash, 2010). Then at the age of 11-12 years only mandibular second premolar will be erupted. Root formation of first premolars occurs at age 12-13 years, and the second premolar at the age of 12-14 years (Logan and Kronfeld, 2003).

2.2.4 Premolar Impaction
Premolar impaction is when the premolar tooth prevented to erupt because it is embedded in the alveolus or the premolar is hold in a position by the adjacent teeth or bone. For example, the early loss of deciduous predecessor cause mandibular second premolar to be impacted (McNamara & McNamara, 2006).

1. Etiology of Premolar Impaction

Premolar impactions may be due to local factors such as mesial drift of teeth arising from premature loss of primary molars; ectopic positioning of the developing premolar tooth buds; or pathology such as inflammatory or dentigerous cyst. They may also be associated with over retained or infraocclusal ankylosed primary molars or with syndromes such as cleidocranial dysostosis. In the anterior mandible, the mandibular premolars erupt after the mandibular first molar and mandibular canine. Thus if the room for eruption is inadequate, one of the premolars usually the second premolar remains unerupted and becomes impacted. Genetic and environmental factors are included in the multifactorial nature of tooth eruption, which may be disturbed at any stage of tooth development. Genetic and environmental factors are included in the multifactorial nature of tooth eruption, which may be disturbed at any stage of tooth development (Kalia and Aneja, 2009).

The most common cause of mandibular second premolar impaction is premature loss of deciduous predecessor. Impaction of the mandibular second premolar has also been related to the initial angulation of the tooth and the early loss of the first permanent molar. The other causes leading to this problem include, over-retained or infraocclusal and ankylosed primary molars. Ectopic positioning of the developing premolar tooth buds or pathology such as inflammatory or dentigerous cysts also can cause premolar impaction. Other than that, extrinsic obstructions, such as supernumerary teeth and odontomas can also affect the impaction. They
may also be associated with, thick and fibrous gingival tissue or with syndromes such as cleidocranial dysostosis (Kalia and Aneja, 2009).

2. Prevalence of Premolar Impaction

All teeth can be impacted, but cases of impaction are more common in both the third molar teeth of the upper jaw and lower jaw, followed by second-most by maxillary canine, canine mandibular and maxillary premolars and mandibular premolars (Hupp et al, 1998). A research conducted by Myberg with a population of 6000 school children in Sweden obtain the results of the prevalence of impacted teeth aside from third molar teeth is 5.4%. Evaluations were performed at the dental radiographs 3874 by Dachi and Howell found the numbers of impacted permanent maxillary canines reached 0.92% and amounted 0.38% occur in other than third molar teeth (Miloro, 2004). The prevalence of impacted premolars has been found to vary according to age. The overall prevalence in adults has been reported to be 0.5% - the range being 0.2 to 0.3% for mandibular premolars. Impaction of maxillary premolars and canines is seen more often palatally compared with buccally, while the incidence of mandibular premolars is predominantly lingual. Literature specific to impacted premolars is not extensive, despite the fact that mandibular second premolars alone account for approximately 24% of all dental impactions. (Kale et al, 2012).

3. Effect of Premolar Impaction if its not treated

Impaction of second mandibular premolar may lead to several problems in occlusion such as loss of space due to mesial drift of molar and distal movement of mandibular first premolar, lower midline shift towards the impacted side, spacing in the mandibular arch and deep overbite (Jain and Kallury, 2011). These impacted premolars and canines, if left unattended may
develop dentigerous cysts around them. Adenomatoid Odontogenic Tumors have also been described to develop in relation to impacted teeth. This might require extensive surgical intervention under general anesthesia for its enucleation (Kale et al., 2012).

Impaction of second mandibular premolar may lead to several problems in occlusion such as loss of space due to mesial drift of molar and distal movement of mandibular first premolar. Impacted premolars may lead to aesthetic concerns, masticatory inefficiency and oral hygiene difficulties as well as follicle pathology and destruction of adjacent structures, including neighboring teeth (Al-ghurabi, 2014). Impaction of the premolars may also be associated with, thick and fibrous gingival tissue or with syndromes such as Cleidocranial dysostosis. Unerupted teeth if left untreated with a thick oral mucosa may undergo pathologic changes, hinder in chewing process, lead to food impaction or may result in a carious lesion of the teeth (Peeran et al, 2012).

4. Management of Premolar Impaction

There are several treatment options available to manage this problem. First, the impacted tooth can be extracted and the resulting space can be closed by orthodontic mechanotherapy. From periodontal point of view, extraction of unerupted mandibular second premolar may leave a marked bony defect in the area, even after the adjacent teeth have been fully uprighted. Prosthetic rehabilitation can be considered in non-extraction cases, after second premolar space has been reopened by orthodontic mechanotherapy. (Jain and Kallury, 2011)

Another alternative will be to uncover the tooth surgically and move it into the arch by orthodontic treatment. The time span required for this treatment may be long and depends upon several factors, such as the initial distance between the tooth and the occlusal plane, angulation of the impacted tooth, age of the patient, the stage of the development of the particular tooth
and the manner in which hard and soft tissue healing occurs after the surgical procedure (Jain and Kallury, 2011).

Conservative management with exposure of the crown has been advocated. The majority of reported cases involved distally impacted premolars in which the long axis was inclined to favour eruption if exposed. Surgical exposure is unpredictable and best limited to cases with no more than 45° tilting of the long axis from its normal position. In some cases, orthodontic traction and repositioning may be indicated. Exposure and bonding can be technically demanding and extreme cases are best not exposed but, instead, managed with a wait and see approach. Recently Becker discussed two cases of surgical exposure followed by bonding of an attachment for traction. One of these cases was a failed attempt at bonding and traction, underscoring the difficulty of access for bonding. If the primary molar and premolar are in close association, extraction of the molar may be all that is required to allow for eruption. As long as tilting of the premolar is slight and it is not too deep in the alveolus, removal of the deciduous molar will usually result in premolar eruption (Nazir and Akram, 2013).

In selecting an appropriate treatment option, underlying etiological factors, space requirements, need for extractions of primary molars, degree of impaction and root formation of the impacted premolar should be considered. Factors such as patient’s age, medical and dental status, oral hygiene, functional and occlusal relationship and attitude towards and compliance with treatment will also influence choice of treatment options (Nazir and Akram, 2013).

Transplantation of teeth has been advocated as an alternative to other methods of treatment of impacted teeth. It may be a good alternative for the adult patient who cannot undergo conventional orthodontic movement of an impacted tooth. The advocated technique is a careful wide exposure of the impacted tooth. The tooth is then moved into its position within the dental arch and is stabilized with a segmental orthodontic appliance. Endodontic treatment, if
necessary, is rendered 6 to 8 weeks after the surgical procedure initially using calcium hydroxide paste. Then a conventional root canal filling is performed 1 year later. Teeth may be transplanted from one position to another in the dental arch. This may be particularly useful in situations in which patients are asymmetrically missing several teeth. Conventional orthodontic treatment for impacted teeth in children and young individuals is usually the treatment of choice. However, when extraction may be necessary or with congenitally missing teeth, transalveolar transplantation may be a sound alternative (Bishara, 2001).

2.3 Radiographic Examination

In addition to clinical assessment, the protocol begins with a dental panoramic X-ray around which the complementary techniques revolve. Emphasis should be placed on simple conventional sophisticated methods and keep modern imagery to circumstances where simple tests are insufficient (Bourzgui et al, 2003). Radiography of the mouth and associated structures can initially be very frustrating. However, once the techniques are mastered, it is possible to produce high quality diagnostic radiographs consistently (Deforge and Colmery, 2002).

2.3.1 Clinical Examination

According to Bourzgui, the clinical examination often allows establishing a presumption of inclusion. Two methods are used.

1. Inspection

1) The persistence of a deciduous tooth in the arch beyond its normal replacement date;
2) The absence of a permanent tooth when its normal time of eruption is exceeded;
3) Reduction of the space of tooth eruption by underlying mesialization adjacent teeth;
4) The malposition or malformation of the teeth adjacent to the missing tooth (versions and rotations);
5) Lack of synchronization between left and right exfoliation and eruption of teeth two counterparts, are all elements for a strong presumption of inclusion or retention tooth (Bourzgui et al., 2003).

2. Palpation

Palpation of the buccal and lingual mucosa simultaneously using the indexes of the two hands is recommended to estimate the position of the teeth changing (Bourzgui et al., 2003).

2.3.2 Dental Radiographs

There are two main types of dental radiographs which are intraoral radiograph and extraoral radiograph. Under intraoral radiograph, there are periapical imaging and occlusal imaging. Whereas, for the extraoral radiograph, there are frontal and lateral cephalometric and panoramic radiograph (White and Pharoah, 2104).

The periapical examination can obtain a view of the entire tooth and its surrounding structures. Bitewing examinations were introduced by Dr. Raper in 1925. Bitewing images focus on the clinical crowns of both the maxillary and mandibular teeth. Bitewings do not show the apices of the tooth and cannot be used to diagnose in this area. The greatest value of bitewing radiographic images is the detection of interproximal caries in the early stages of development, before it is clinically apparent. Bitewing images also reveal the size of the pulp chamber and the relative extent to which proximal caries have penetrated. Occlusal radiography is a supplementary radiographic examination designed to provide a more extensive view of the maxilla and mandible (Farman and Kolsom, 2014).
1. Intraoral Radiographs

Intraoral radiographic imaging examinations are the backbone of imaging for the general dentist. Intraoral images can be divided into three categories, periapical projections, bitewing projections, and occlusal projections. Periapical radiographs should show all of a tooth, including the surrounding bone. Bitewing images show only the crowns of teeth and the adjacent alveolar crests. Occlusal images show an area of teeth and bone larger than periapical images. A full-mouth set of radiographs consists of periapical and bitewing projections. These projections, when well exposed and properly processed, can provide considerable diagnostic information to complement the clinical examination (White and Pharoah, 2014).

Bitewing radiographic images are of particular value in detecting interproximal caries in the early stages of development, before it is clinically visible. Bitewing radiographic images are also useful in evaluation of the alveolar crests for detection of early periodontal disease. Bitewings also provide a useful adjunct to evaluating periodontal conditions. They offer a good view of the septal alveolar crest, and in addition, permit changes in bone height to be accurately assessed by comparison with adjacent teeth (Farman and Kolsom, 2014).

Figure 2.11 Premolar Bitewing Radiograph (White and Pharoah, 2014).
The occlusal image is very useful in determining the buccolingual extension of pathologic conditions, and provides additional information as to the extent and displacement of fractures of the mandible and maxilla. Occlusal radiographic images also aid in localizing unerupted teeth, retained roots, foreign bodies, and calculi in the submandibular and sublingual salivary glands and ducts. It should be noted that when imaging soft tissues exposure time needs to be appropriately reduced (Farman and Kolsom, 2014).

The very common intraoral projection techniques that are used for periapical imaging are the paralleling technique and the bisectingangle technique. Most clinicians prefer the paralleling technique because it provides a less distorted view of the dentition. The paralleling technique is the most appropriate technique for digital imaging (White and Pharoah, 2014).

The main clinical indications for periapical radiography are to detect apical infection or inflammation, to assess the periodontal status, after trauma to the teeth and associated alveolar bone, to assess the presence and position of unerupted teeth, to assess the root morphology
before extractions, during endodontic treatments, apical surgery preoperative assessment and postoperative appraisal, the detailed evaluation of apical cysts and other lesions within the alveolar bone and to evaluates the implants postoperatively (Whaites, 2013).

Paralleling technique have many benefits for example it can produce accurate image with little magnification, the zygomatic buttress shadow appears above the apices of the molar teeth, well represents the periodontal bone levels. Other than that, the periapical tissues are accurately shown with minimal foreshortening or elongation. The crowns of the teeth are also well shown thus enabling the detection of approximal caries. The horizontal and vertical angulations of the X-ray tubehead are automatically determined by the positioning devices if placed correctly. The X-ray beam is aimed accurately at the centre of the film therefore all areas of the film are irradiated and there is no coning off or cone cutting. Reproducible radiographs are possible at different visits and with different operators. The relative positions of the film packet, teeth and X-ray beam are always maintained, irrespective of the position of the patient’s head. This is useful for some patients with disabilities (Whaites, 2013).

![Figure 2.13 Premolar Parellel Radiograph](White and Pharoah, 2014).

However, the paralleling technique also have some disadvantages including Positioning of the film packet can be very uncomfortable for the patient, particularly for posterior teeth, often
causing gagging, positioning the holders within the mouth can be difficult for inexperienced operators. Sometimes, the anatomy of the mouth makes the technique impossible. The apices of the teeth can sometimes appear very near the edge of the film. It can be very difficult to position the holders in the lower third molar regions can be very. Other than that, by using a short spacer cone, the technique cannot be performed satisfactorily because of the resultant magnification. The holders have to be autoclavable or disposable (Whaites, 2013).

As for the bisected angle technique, the advantages are film positioning packet is comfortable for the patient in any area of the mouth. The positioning is also very simple and quick. The image of the tooth will be the same length as the tooth itself and should be adequate for most diagnostic purposes, if all angulations are assessed correctly (Whaites, 2013).

The disadvantages of bisected angle technique includes the image is often badly distorted when many variables involved in the technique, wrong vertical angulation will result in foreshortening or elongation of the image, the periodontal bone levels cannot be seen clearly, the shadow of the zygomatic buttress frequently overlies the roots of the upper molars. Other than that, the horizontal and vertical angles have to be assessed for each patient and considerable skill is required, reproducible views is impossible to be obtained, if the central ray is not pointed at the centre of the film, coning off or cone cutting may be formed, especially using rectangular collimation. Overlapping of the crowns and roots can be easily formed if the angulation of horizontal is wrong. The approximal caries is very hard to be detected because of the distortion of the teeth crowns. Lastly, the buccal roots of the maxillary premolars and molars are foreshortened (Whaites, 2013).

2. Extraoral Radiographs

Extraoral radiographs are used to examine areas that are not fully covered by intraoral films or to evaluate the cranium, face including the maxilla and mandible, or cervical spine for
diseases, trauma, or abnormalities. Standardized extraoral cephalometric radiographs also help in evaluating the relationship between various orofacial and dental structures, growth and development of the face, and treatment progression (White and Pharoah, 2014).

### 2.3.3 Panoramic Radiographs

Panoramic imaging which is also called pantomography is a technique for producing a single image of the facial structures that includes both the maxillary and the mandibular dental arches and their supporting structures. This technique produces a tomographic image in that it selectively images a specific body layer. In panoramic radiography, an x-ray source and an image receptor rotate around the patient’s head and create a curved focal trough, a zone in which the included objects are displayed clearly. Objects in front of or behind this focal trough are blurred and largely not seen. Thus, the panoramic machine creates a focal trough through the dentition and nearby structures (White and Pharoah, 2014).

![Figure 2.14 Panoramic Radiograph](image)

Figure 2.14 Panoramic Radiograph (White and Pharoah, 2014).
1. Indication of Panoramic Radiograph

The indication of panoramic radiograph includes the overall evaluation of dentition, to examine for intraosseous pathology, such as cysts, tumors, or infections, temporomandibular joints gross evaluation, to evaluate the position of impacted teeth, to evaluate permanent dentition eruption, for dentomaxillofacial trauma and the developmental disturbances of maxillofacial skeleton (White and Pharoah, 2014).

2. Advantages of Panoramic Radiograph

The advantages of panoramic radiograph compared to a full-mouth examination are the coverage is very broad including facial bones and teeth, the radiation dose is lower, the panoramic radiographic technique is friendly and very easy, it can also be used in patients with trismus or in patients who cannot tolerate intraoral radiography, the radiographic technique is very quick and convenient for patient and very useful visual aid in patient education and case presentation (White and Pharoah, 2014).

Based on the textbook by Whaites, panoramic radiograph can image a large area and all the tissues within the focal trough, including the anterior teeth. It is also convenient to be used with patient who have difficulties in opening their mouth. The image produced is easy to understand, and therefore can be a useful teaching aid to patients. Patient movement in the vertical plane distorts only that part of the image being produced at that instant. The positioning of patient is very simple and does not need any expertise. The overall view of the jaws allows detection of any unsuspected disease, fractures and in addition it is convenient for the injured patient. It is
useful for evaluation of periodontal status and in orthodontic assessments. Other than that, the antral floor, medial and posterior walls can be seen clearly. The condylar heads of both sides are shown on one film, thus its very easy to compare them. This radiograph also contributes in the development of field limitation techniques with resultant dose reduction (Whaites, 2013).

3. Disadvantages of Panoramic Radiograph

However, there are few numbers of disadvantages which includes it has only lower resolution images and the details is less fine compared to intraoral radiographs. The linear measurements are unreliable due to unequal magnification across image. The image formed is superimposition of real images and requires careful visualization to convert anatomic and pathologic details. To avoid positioning errors, it requires accurate positioning of patient. Patient with severe maxillomandibular discrepancy is not suitable with this radiograph. (White and Pharoah, 2014).

Whaites said that the tomographic image represents only a section of the patient. The structures or abnormalities not in the focal trough may not be evident. The distortion and magnification of the final image is produced by tomographic movement and the distance between the focal trough and film. The image quality can be loss due to using of indirect-action film and intensifying screens. The technique is not suitable for children under 5 years or on some disabled patients because of the length of the exposure cycle. Lastly, the film will be out of focus if the patients do not conform to the shape of the focal trough (Whaites, 2013).