Hard tissue features associated with the presence of impacted mandibular third molars

A mini-thesis submitted in partial fulfilment of the requirements for the degree of MSc in the department of Oral and Maxillo-Facial Radiology, Faculty of Dentistry, University of the Western Cape.

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DECLARATION

I, Sahar Malik Babiker, hereby declare that **"Hard tissue features associated with the presence of impacted mandibular third molars"** is my original work and has not been partially or in whole submitted to any university for the award of a degree. I further declare that all the work cited have been adequately indicated and acknowledged as complete references.

Sahar Malik Babiker

November 2016

Signature……..

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DEDICATION

This thesis is dedicated to

My beloved parents, my amazing mother 'Igbal' and my angelic father 'Malik'

My three adorable brothers Ahmed, Ammar &Yasir

My dear friends Salma and Nabila

My Dear Husband Mohamed.

ABSTRACT

Different pathology associated with impacted wisdom teeth in the oral cavity showed that it is prevalent and may lead to varied dental complications. This study adopted a descriptive cross-sectional retrospective analytical design in order to examine hard tissue features associated with the presence of impacted third molars in a random sample of 2998 digital panoramic radiographs (DPRs) of patients' records in Tygerberg Oral Health Centre, Faculty of Dentistry, University of Western Cape.

The specific objectives of the study were to categorize the type of impactions in the DPRs of patients and to determine the prevalence of distal cervical caries (DCC) in second molars, any radiolucent (RL) /radiopaque (RO) lesions or external root resorption (ERR) complications associated with impacted wisdom teeth.

Results of the pantomographs and clinical records of patients indicated that the most prevalent type of impaction (TOI) is Mesioangular (MA) Impaction (65%) followed by Horizontal (H) Impaction (17%), Vertical (V) Impaction (15%), Transverse (TVS) Impaction (2 %) and Distoangular (DA) Impaction (1.2 %), respectively. The least prevalent type was Inverted (INV) Impaction with a frequency count of 0.5%.

The results further indicated varied dental complications resulting from impaction, ranging from ERR with a frequency of 3% of which 66.70% was associated with MA type of impaction, followed by H with a frequency of 26.7%. The association of Gender and RL/ RO lesions was significant (***p*-value=0.04)** while association between DCC and types of impaction was also significant **(*p*-value =0.0017)**.

The study concluded that the high prevalence of MA among all populations and genders over the years may be related to the anatomical normal inclination of the third molars to the mesial surface. The low prevalence of DA observed in the study sample on the other hand might be attributable to gender and demographic factors.

Lastly, this study has only one radiopaque lesion and the high prevalence of RL lesions in males and in the older age group suggests that these complications take a while to develop.
Future research is needed to raise more awareness and encourage patients to seek treatment of symptomatic and asymptomatic third molars before complications arise.

KEYWORDS

Digital Panoramic Radiographs

External Root Resorption

Distal Cervical Caries

Types of impaction

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LIST OF ABBREVIATIONS

DPRs	Digital Panoramic Radiographs
TOI	Type of Impaction
ERR	External Root Resorption
DCC	Distal Cervical Caries
RL	Radiolucent
RO	Radiopaque
DC	Dentigerous Cyst
KCOT	Keratocystic Odontogenic Tumour
MA	Mesioangular
DA	Distoangular
TVS	Transverse
H	Horizontal
INV	Inverted
V	Vertical

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CHAPTER ONE: INTRODUCTION

Back then humans ate hard food such as nuts, tubers and tough grasses with their wide and powerful jaws. Jaws had enough space to accommodate third molars ("wisdom tooth") that usually erupt between the age of 16 and 24. Culture and industrial development of food changed eating habits allowing gene shifts that led to smaller jaw size. Eventually this change led to a dental condition called the impaction, where the tooth is prevented from erupting due to numerous factors (Al- Khateeb and Bataineh, 2006).

Impaction is the failure or delay of eruption of certain teeth that are lying in the jaw. It can occur in any permanent tooth and it is a very common phenomenon (Gisakis *et al.,* 2011; Brkic, 2012). Impaction prevalence is attributed to several factors such as; timing of dental eruption, inhibition of growth by adjacent tooth, high thickness of mucosa over growing tooth and genetic factors that inhibit the normal growing process (Al-Khateeb *et al.,* 2006; Mehdizadeh*et al.,*2014). Another reason for impaction is the incomplete up righting of a tooth from mesioangular to a vertical position (Sheikh *et al.,* 2012). Third molars or wisdom teeth are considered to be the most frequently impacted teeth in the oral cavity followed by the maxillary canines and second premolars. Impacted third molars have been a source of concern for surgeons for a long time (Fu *et al.,* 2012).

Tygerberg Oral Health Centre is a governmental hospital in Cape Town, Western Cape, which serves mostly the middle to low income population. The dental hospital provides treatment to approximately 120000 patients per annum. Some patients are referred to the radiology department for a panoramic radiograph as part of the diagnosis and treatment planning.

1.1 Problem Statement

Although many third molar impactions have been reported in research globally, there appeared to be a lack of studies related to the prevalence of impacted lower third molar teeth in South Africa. The need for studies to determine the prevalence of impacted mandibular third molars and the complications associated with them was identified.

1.2 Limitations of this study

- No histology was considered for the 563 cases in the study, therefore no opinion can be be given regarding the diagnosis of the RL and RO lesions.

- The Faculty of Dentistry, UWC is a referral centre for many patients. Selection of their radiographs therefore has a component of bias and does not represent the situation in the broader population in the Western Cape.

CHAPTER TWO: LITERATURE REVIEW

The advent of dental radiography and the ability to diagnose the oral hard tissues allowed practitioners to see beyond the visible scope and diagnose teeth that were not visible and possibly impacted. Impaction is nine times more prevalent in the mandible than in the maxilla (Mehdizadeh *et al.,* 2014; Khawaja *et al.,* 2015; Chang *et al*, 2009). In other words, it occurs more in the lower jaw than in the upper jaw.

Retained impacted teeth are associated with food ruminants, soft tissue inflammation and pain. The pathologic conditions may be either crowding of teeth, cyst development, tumor development, periodontal problems, root resorption, pericoronitis, pathological fractures, pain or dental caries (Mehdizadeh *et al*, 2014; Khawaja *et al*., 2015; Chang *et al* , 2009; Sheikh *et al*., 2012; Sandhya and Dharman, 2016).

2.1 Prevalence of impactions:

Looking at the literature, we found that third molar impaction prevalence was variable. Several studies showed a relationship between the prevalence of impacted third molars and some demographic factors such as: race, age and gender (Kruger *et al*., 2001; Khan *et al.,* 2006; Haghanifar and Emamverdizadeh, 2006; Mehdizadeh*et al.,* 2014).

Hashemipour *et al.,* (2013) performed a review of the literature and reported that the incidence of third molar impaction is 69 % (Hashemipour *et al.,* 2013; Quek *et al*, 2003)

2.2 Third molar impaction and gender

Gender plays a role in all aspects of research. The assumption was investigated and initial studies showed high frequencies for the occurrence of impactions in females (Hashemipour *et al.,* 2013). A study by Mehdizadeh *et al.,* (2014) showed that the prevalence of impacted third molar

teeth in women was higher than that of men in Iran. This finding is comparable with a number of previous studies where gender and impaction were examined (Kruger *et al.,* 2001; Quek *et al.,* 2003; Yuasa and Sugiura, 2004; Haghanifar and Emamverdizadeh, 2006). This can be attributed to the space deficiency and smaller jaw size in women or to racial differences (Mehdizadeh*et al.,* 2014).

The smaller jaw size in women can be due to the fact that skeletal growth reduces by the time the third molars erupt, while in men the jaws tend to grow for a longer period (Hashemipour *et al.,* 2013; Mehdizadeh *et al.,* 2014).

2.3 Third molar impaction and age

In general, third molars erupt between 16 to 24 years of age (Khan *et al.,* 2006). In Europe third molar impaction incidence was estimated at 70 % in young adults (Elsey and Rock, 2000) and has been found to vary within races (Kruger *et al*., 2001). Kruger *et al.,* (2001) reported that mandibular third molars erupt at the age of 26 in Europe while in Nigeria a study by Spiotto *et al.,* (2013) showed that the mean age for mandibular third molar eruption was 14 years.

The relation between age and third molar impaction appears to be variable between different races.

2.4 Third molar impaction and Type of Impaction

The most common type of impaction is the Mesioangular (MA) followed by the Vertical (V) Impaction (Khan *et al.,* 2010; Jung and Cho, 2013). A study in a Jordanian population showed that V impaction occurred most frequently, followed by the MA type. A Spanish study in Barcelona also showed that V was the most common type followed by MA (Khan *et al.,* 2010).

Qirreish's (2005) study at the University of the Western Cape Oral Health Centre found that V impaction was the most common type of impaction that counted for 33.6%, followed by MA, and Horizontal (H) type. The least common type was the Distoangular (DA) Impaction that was as low as 1.2 %. Transverse (TVS) Impaction was about 4.6 % of all cases studied. The variable prevalence of TOI reported in the previous studies may be due to different factors such

as the age group studied, the study design, the sample size, ethnic and geographical differences between study countries and the types of classification used.

2.5 Classification of impaction:

In the past, the classification of third molar impaction used by many authors was varied. The purpose of a classification is to try and standardize each type; to facilitate the assessment of the impacted tooth and the possible complications that may occur on the adjacent teeth. Moreover, it helps to determine the treatment plan and surgical removal if needed.

Clinical and radiographic examinations not only facilitate the classification of these teeth but also help in diagnosing and differentiating the different pathologies associated with them.

Different types of classifications of impacted third molars are:

- Winter's classification
- Pell-Gregory classification
- Leone classification
- Shiller classification

The majority of studies in the literature have used Winter's and Pell –Gregory classification. We followed Winter's type of classification due to its simplicity and to standardize our study with the literature.

Winter's classification (1926):

Winter's classification is based on the long axis of the impacted tooth in relation to the long axis of the second molar (Winter, 1926). They are subdivided into 6 types.

- **Mesioangular:**

The wisdom tooth is angled forward, toward the front of the mouth, more towards the adjacent second molar and generally in contact with the distal surface of the second permanent molar (Winter, 1926).

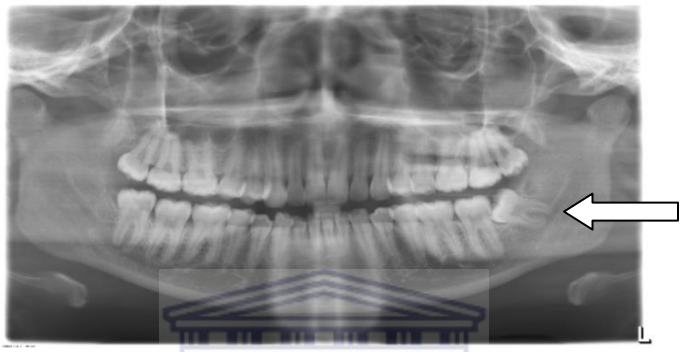

Figure 1: Panoramic radiograph showing mesioangular impaction of tooth 38

- **Distoangular:**

The distal or distoangular impaction has its long axis angled away from the second molar and the crown facing towards the ramus of the mandible (Winter, 1926).

Figure 2: Panoramic radiograph showing distoangular impaction of 38

- **Vertical:**

The long axis of the tooth runs parallel to the long axis to the second molar. The vertical type is directed towards the occlusal plane (Winter, 1926).

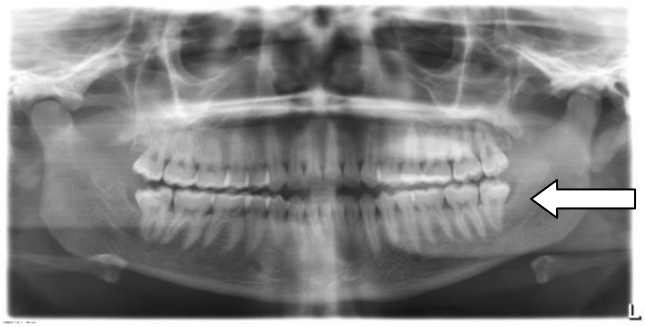

Figure 3: Panoramic radiograph showing vertical impaction in 38

- **Horizontal:**

The long axis is lying perpendicular to the second molar within the mandible and has the crown facing the roots of the adjacent second molar (Winter, 1926).

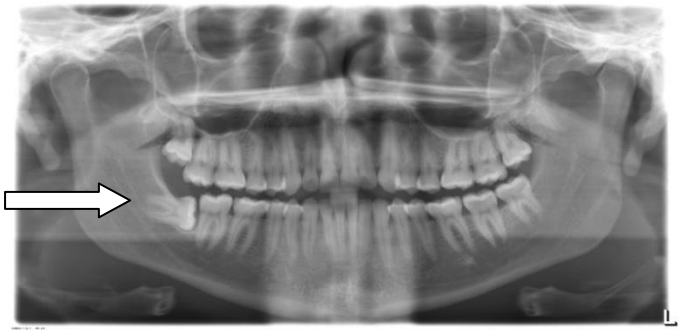

Figure 4: Panoramic radiograph showing horizontal impaction in 48

- **Inverted:**

Takes a vertical position with the crown directed towards the inferior alveolar canal (Winter, 1926).

Figure 5: Panoramic radiograph showing inverted impaction in 48

- **Transverse: (buccoangular)**:

The crown is directed mainly towards the buccal or lingual side of the jaw (Winter, 1926).

Figure 6: Panoramic radiograph showing transverse impaction in 48

2.6 Pathology associated with impacted third molars

2.6.1 Distal cervical caries

Distal cervical caries (DCC) is due to the formation of plaque in the distal region of the second molar at the point of contact with the impacted tooth. It is found in the cervical region between the crown and root and may extend toward the root, hence, the name distal cervical caries.

The pattern of eruption of the tooth and the position of the third molar may be a major factor in the occurrence of caries. Partially erupted H and MA molars predispose to food impaction and plaque accumulation on the distal surface of the second molars and the possible development of root caries. In some cases, caries is not evident clinically, but may be present in the form of hidden caries which can be visualized radiographically (Sheikh *et al.,* 2012). It has been found that even when the second molar is restored by means of dental restorations, recurrent caries may still develop eventually which can lead to the loss of both the second and the third molar (Sheikh *et al.,* 2012). The loss of 2 molar teeth may result in the opposing teeth over-erupting and thereby exacerbating the process and aiding in possible loss of more teeth.

In a study conducted to evaluate patients who were referred for third molar extraction and incidence of DCC in the second molar, MA was found to be the only cause of DCC in second molars (Khan *et al.,* 2010). They were optimistic in finding a means of reducing the incidence of DCC. Sheikh *et al.,* (2012) indicated that DCC associated with a MA could occur at various angles but the highest occurrence was found between 40-80 degrees. Dental caries can also occur if there is no contact between the impacted tooth and the second molar. Partially impacted teeth and the adjacent tooth may develop cavitation due to the fact that maintenance of adequate oral hygiene is difficult (Sheikh *et al.,* 2012).

A study carried out in a Turkish population correlating the presence of DCC in second molars, considering the TOI and the age of the patient, concluded that the prevalence of second molar distal caries averaged about 20% and the mean age of patients was 25 years (Özeç *et al*., 2009).

The mean age of patients with DCC on the mandibular second molars was more than the mean age of patients with impactions. This may be due to the fact that delayed extraction of the mandibular third molars raises the risk of caries on the mandibular second molars and thus were found in older patients. Chang *et al.,* (2009) also suggested that the occurrence of DCC is an indication for removal of third molars and this increases noticeably with age. Knutsson *et al.,* (1996) reported that the chance of caries development in the adjacent second molar is up to 43% higher with a partial impaction than it is with a full bony impaction.

Partially impacted third molars do not play a role in mastication thus lead to the accumulation of bacteria that cannot be easily cleansed by flossing or brushing, hence caries starts to develop Fejerskov and Kidd, (2008). Al-Khateeb and Bataineh, 2006 (cited in sheikh *et al.,* 2012) found that one-third partially impacted mandibular third molars had the highest propensity for developing DCC.

Sandhu and Kaur, (2008) reported that the incidence of DCC was 8% and similarly a study conducted in 2006 found that DCC accounts for 5% (Al-Khateeb and Bataineh, 2006). This was contradictory to the higher incidence reported by other authors (Yamaoka Tambo and Furusawa, 1997). The occurrence of DCC was reported as high as 32% by Van der Linden *et al* (1995) in South Africa.

While the majority of impacted molars present with symptoms and complications, there is a proportion of impacted third molars that may remain asymptomatic (Elter *et al.,* 2005). Adeyemo, (2006) compared the incidence of DCC in second molars associated with impacted third molar with that of fully erupted third molars. The study concluded that DCC in second molars occurs only in association with impactions.

Dental caries was found to be the most common radiographic lesion. A study done in Jordan (2006) demonstrated that dental caries accounted for 21.5% of teeth studied. Caries was more frequently seen in the third molar itself other than in the adjacent molar teeth. However, the figures obtained in this study are probably an underestimate of the true rate of dental caries because the diagnosis was based on orthopantomograms (Al-Khateeb and Bataineh, 2006).

One third of young adults with third molars erupted to the level of the occlusal plane could be affected by occlusal caries in the third molar itself (Shugars *et al.,* 2004). Third molars are the last teeth to erupt and usually do not erupt to the occlusal plane until jaw growth is almost complete. Once the third molars erupt, caries takes time to develop in susceptible patients. With the use of fluoridated water, progression of caries through enamel may take more than 5 years. Caries formation isolated to a third molar without occurring in the first or second molars was very rare (Shugars *et al.,* 2004).

2.6.2 Cyst and Tumours:

Some cysts and tumours are considered to be associated with impactions. According to Montevecchi *et al.,* (2012) the longer the impaction exists, the higher the chances of developing cysts or tumours, due to the fact that it takes more than ten years for the cyst or tumor to form around impacted wisdom teeth.

Research findings suggest that cyst and tumour development in association with impacted wisdom teeth vary slightly (Shin *et al*, 2016). This variation recorded might be due to the fact that most dentists extract the impacted teeth without sending the tissues attached to it for histopathological examination (Glosser and Campbell, 1999; Vigneswaran and Shilpa, 2015; Shin *et al.,* 2016). Cyst and tumour development in association with impacted wisdom teeth are reported to range from 2% to 6.2 % (Stathopoulos *et al*. 2011; Lyons *et al*. 1980; Güven *et al*. 2000; Shin *et al.,* 2016).

A higher incidence of about 13.3% of cyst or tumour formation was reported in the oldest age group (46 years and above) compared to the youngest age (below 46 years) with a 1.5 % incidence (Shin *et al.,* 2016). There was a definite correlation between the age and cyst formation (Adelsperger *et al.,* 2000). Baykul, *et al.,* (2005) studied the effect of age and cyst formation and concluded that the patients older than 20 years were found to have a higher tendency for pathological changes around impacted molars.

Odontogenic Cyst development such as Dentigerous cysts (DCs) and Keratocystic Odontogenic tumours (KCOT) have been explained by many theories. One theory suggests that chronic inflammation leads to cystic lesions (Lin *et al.,* 2012). Another theory suggests that genes and mutation play a role in cystic formation (Cabay, 2014). In accordance to the above mentioned theories, the higher incidence of cyst or tumor formation in the older group is a consequence of continued chronic inflammation or the less likely genetic mutations (Shin *et al.,* 2016).

Stathopoulos *et al.,* (2011) conducted a study in Greece where they examined more than 6000 impacted wisdom teeth in order to determine their association with cysts and tumours. The study showed that the rate of cyst and tumour development was almost 3% and patients older thano70 were more likely to show pathologies. The study concluded that such lesions may have been symptomless for years or those pathologies may start to develop at a much later age.

A Korean study reported a male predominance in cystic formation, more particularly DC, in an Asian population (Lin *et al.,* 2012; Selvamani *et al.,* 2012). It was presumed that the higher consumption of alcohol or tobacco amongst males, affect the genetic mutations that potentiates cyst and tumor development (Shin *et al.,* 2016). This presumption of a higher male predominance was also noted in other studies without proper justification (Adelsperger *et al.,* 2000; Rakprasitkul, 2001; Shin *et al.,* 2016).

Baykul, *et al.,* (2005) performed a study to assess the prevalence of cystic formation within the normal follicle space associated with the impacted third molars. They evaluated the angulations of the impacted third molars and the contact with the second molars. The results showed that half of the study samples had developed odontogenic cysts. They concluded that the V impaction was the most predominant type that leads to cystic formation followed by the H and MA impactions. This is controversial because the criteria used namely ‘’soft tissue with a dense fibrous connective tissue wall’’ lined by a few layers of stratified squamous epithelium are not adequate to diagnose cysts

Narang *et al.,* (2012) stated that it is controversial to differentiate between a slightly enlarged dental follicle and a DC in terms of radiological criteria only.

The interpretation of DC in these studies was considered with a pericoronal width of 3-4 mm and a symmetrical RL (Adelsperger *et al*, 2000; Güven *et al*, 2000; Kotrashetti *et al.*, 2010).

A study of the hard tissue features of impacted molars by Curran *et al.*, (2002) showed that odontogenic tissues around impacted teeth have the tendency to differentiate into variable tissue types as well as cystic and neoplastic tissues. The study further specified that dental follicles may show considerable thickening of their walls seen radiographically as pericoronal radiolucencies although there was no cystic formation. On the other hand, considerable pericoronal pathology has been found on histopathology examination of follicles that showed no enlargement in radiographic images. Hence, presence or absence of cystic lesions and tumours is not only confirmed by radiological images (Curran *et al.,* 2002; Kotrashetti *et al.,* 2010).

Kotrashetti*et al.,* (2010) mentioned that enlarged dental follicles and DC may be difficult to distinguish radiographically. DC goes through greater cell proliferation at their developing stage compared to healthy follicular tissues. Excision of the tissues surgically and histological identification can only provide a final diagnosis (Kotrashetti*et al.,* 2010). DC developing around impacted third molars may have the tendency to progress into a unicystic Ameloblastoma or KCOT which is a more serious condition (Zhang *et al.,* 2010).

Khan *et al.,* (2010) have stated that third molar impaction may lead to development of tumours such as Ameloblastoma and epidermoid carcinoma. The occurrence of Ameloblastoma was also reported by Al-Khateeb and Bataineh, (2006) as the most common occurring tumour, followed by Giant cell Granuloma in association with impacted third molars. Vigneswaran and Shilpa, (2015) in Chennai reported that out of 2778 cases 70 showed pathology. Of the 70 cases, 24% were DC and 16% Ameloblastoma and 2 cases of squamous cell carcinoma.

Although development of malignant tumours around an impacted third molar is exceedingly rare, Stathopoulos *et al.,* (2011) suggested that dentists should at least be aware of the potential for malignant transformation. Güven *et al.,* (2000) also reported 2 cases of malignancies around an

impacted third molar that accounted for 0.02 % of their study sample based on panoramic radiography.

2.6.3 External Root Resorption ERRS:

External root resorption (ERR) is a pathological process that occurs on the outer surface of the permanent tooth which is commonly believed to be induced by local inflammation or mechanical stress (Fuss *et al.,* 2003; Wang *et al.,* 2016). Considerable evidence indicates that ERR can occur as a result of a periodontitis, trauma, orthodontic treatment and due to the mechanical pressure from the impacted tooth (Pandis *et al.,* 2008; Larson, 2009). ERR of the adjacent second molars was noted to range from 0.3 up to 24.2 % (Nemcovsky *et al.,* 1996; Wang *et al.,* 2016).

Research shows that impacted wisdom teeth may lead to ERR on second molars in the distal cervical region. This is not easily detected and has little or no symptoms until it develops into an acute pulpitis or periapical inflammation (Oenning *et al.,* 2014). Furthermore, the effect of root resorption on the second molar is severe; it makes it susceptible to many complications that eventually have to be treated with a root canal treatment (Fuss *et al.,* 2003).

ERR may result due to pressure from the eruptive force of the third molar and chemical mediators secreted by reduced enamel epithelium of the third molar. The impacted third molars also decrease the amount of bone on the distal aspect of second molars which leads to periodontal defects which are difficult to manage (Nazir *et al.,* 2014).

Wang *et al.,* (2016) suggest that it is better to identify the complications of ERR that results from third molar impaction and prevent them rather than treating them in order to keep the second molars in good condition and maintaining their function.

Taking into cognizance the vast amount of impacted third molars (n =362) observed by Wang *et al*., (2016), they used CBCT to evaluate ERR and reported the number of ERR to be 20.1%. ERR is not easily detected because the progress remains symptomless until clinical symptoms present (Wang *et al.,* 2016). Current research revealed that the accurate detection of ERR largely depends on the type of radiographic examinations, as the difficulty of ERR detection by

means of histology or clinical examination is high (Nakata *et al*, 2009; Oenning *et al.*, 2014; Fuss *et al.*, 2003).

Intraoral periapical and panoramic images have been used for ERR detection. Studies involving only extra oral radiographs reported a low incidence (Nemcovsky *et al*., 1996). This could be attributed to the two-dimensional nature and unequal magnification as well as possible image distortions associated with extra oral panoramic radiography, thus providing a relatively low diagnostic value (Oenning *et al.*, 2014; Oenning *et al.*, 2015).

The introduction of Cone Beam Imaging has allowed the dental surgeons and clinicians to observe and diagnose the entire head from three dimensional perspectives, hence ERR and other pathology in the maxillofacial region is precisely detected with this imaging modality (Özen *et al*., 2009; Oenning *et al.*, 2015; Wang *et al.*, 2016).

CHAPTER THREE: RESEARCH DESIGN & METHODOLOGY

3.1. Aim

To study the hard tissues features associated with presence of impacted third molars.

3.2. Objectives

- Classify the type of impaction and describe the position of the adjacent second molar.
- To determine the prevalence of distal cervical caries in second molars, radiolucency, radiopacity, and root resorption as complications associated with impacted third molars.
- To determine the association of demographics and clinical variables.

3.3. Study design:

A descriptive cross-sectional retrospective analytical study design involving all digital panoramic radiographs performed between January and December 2015.

3.4. Study area:

The study was conducted at the Tygerberg Oral Health Centre, Faculty of Dentistry, University of Western Cape.

3.5. Study duration:

The study was carried out during the period July 2015 to September 2016.

3.6. Sample:

3.6.1. Sampling selection process:

A census of cases from January to December, 2015 was conducted constituting 2998 digital panoramic radiographs as a sample from the patient records in in the Tygerberg Oral Health Centre, Faculty of Dentistry, University of the Western Cape.

Either right or left affected sites were selected; if a radiograph sample contains bilateral impaction, tossing the coin random method was applied.

For convenience the samples were divided into two groups based on age:

Group A: samples of age category 16-27 years

Group B: samples of age 28 years and above

3.6.2. Target Population:

All patients who presented at Tygerberg Oral Health Centre, Faculty of Dentistry, University of the Western Cape for panoramic radiographs between Jan 2015 and Dec 2015.

3.6.3. Study Population:

The study sample was selected based on the following inclusion and exclusion criteria.

3.6.4. Inclusion criteria:

Digital panoramic radiographs of patients 16 years and older.

- Panoramic radiographs showing third molar impaction on one side of the mandible or both.
- Only radiographs which were taken at the Tygerberg Oral Health Centre with full demographic information of the patients.

- Good quality panoramic radiographs that show the impacted third molar teeth and the surrounding bone for diagnosis.

3.6.5. Exclusion Criteria:

- Patients under 16 years of age.
- Poor quality radiographs were discarded (poor exposure, artefact, movement).
- Radiographs that show no impaction in the mandible (maxillary impacted third molars were excluded because the mandible has a higher incidence of impaction and the study was about the most common type of impaction and the complications associated in the mandible).
- Panoramic Radiographs that were taken before or after 2015.

3.7. Data Collection:

Data was collected using a specifically designed data collection sheet (appendix 01).
Positive findings were recorded as "YES "and the negative were recorded as “No”. The results were transferred into a Microsoft Excel 2011® spread sheet (appendix 02) for further analysis.
Both the data collection sheet and the Microsoft Excel 2011® spread sheet were designed based on study objectives.

3.7.1. Data Processing and Analysis:

All the radiographs that met the inclusion criteria were assessed.
All the radiographs were assessed by two investigators from the radiology department.
The radiographs were examined for the presence of impaction, the type of impaction and its complications.
The complications that were addressed are: DCC, radiolucency, radiopacity and ERR.
The types of impaction that were assessed are MA, DA, V, H, TVS and INV. The examiners were standardized by making them familiar with Winter’s classification of impacted wisdom teeth.

Fifty panoramic radiographs were examined at a time to minimize examiner fatigue.

Moreover, the determined type of impaction was assessed in relation to the complications in terms of occurrence, frequency and distribution.

Two groups of 50 panoramic radiographs were re-examined separately by two (inter and intra) examiners to examine the diagnosis reliability. RL and RO were determined based on the normal and abnormal appearance of each radiograph and the lesions identified were re-examined by the co-supervisor. The rest of the 2998 were evaluated by the student.

Statistical analysis of the data was performed using the computer program SPSS for Microsoft Windows7 and the frequency distribution for complications was calculated.

A Chi-square test was used to compare the prevalence of each complication between males and females, and correlations regarding the type of impacted teeth.

Once the frequency of each complication had been calculated, the association between variables was determined.

3.8. Ethical Consideration:

The protocol was submitted to the Senate Research Ethics Committee of the University of the Western Cape for approval and permission to carry out the study. Study number: 15/7/35

Permission was requested from the Dean of the Faculty of Dentistry of the University of the Western Cape in order for the researcher to access the patients' files.

All the information obtained during this study will be confidential and no information about the patients will be disclosed.

All the radiographs were documented as allocated numbers.

CHAPTER FOUR: RESULTS

Out of the 2998 panoramic radiographs examined, a total of 563 radiographs satisfied the inclusion criteria.

4.1. Type of impaction

The distribution of the various types of impaction is depicted in (figure 7 and figure 8), 366 of the impactions were MA type representing (65%) of the impactions. H was found in 94 radiographs representing (17%) of the impaction types. V was found in 82 radiographs representing (15%) of the sample. 11 of the impactions were TVS representing (2%). DA type was found in 7 radiographs representing (1. 2%). 3 impactions (0.5%) were INV.

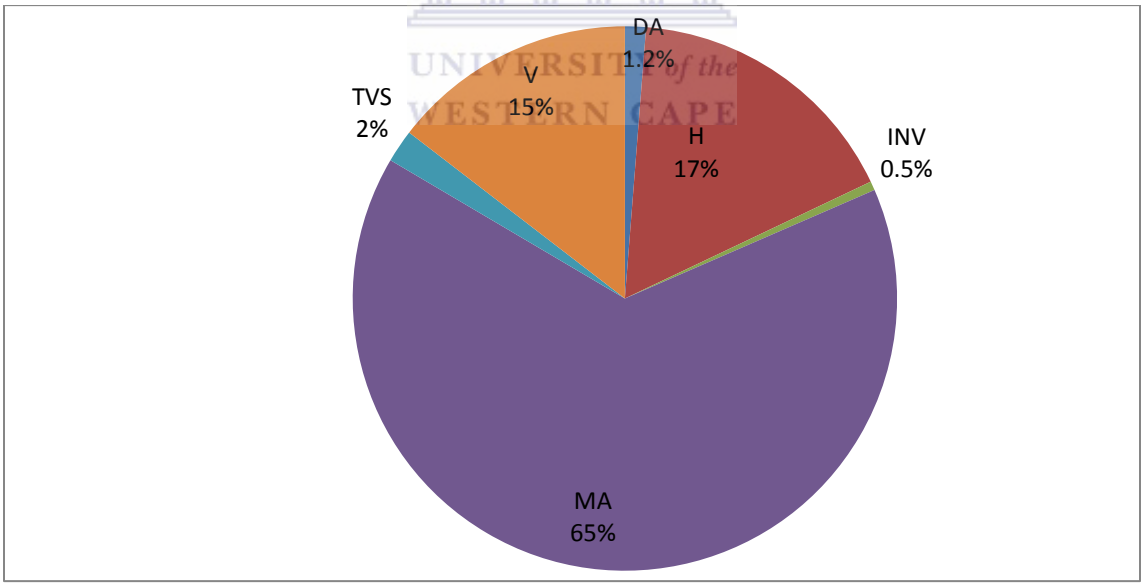

Figure 7: The percentages of the various types of impaction

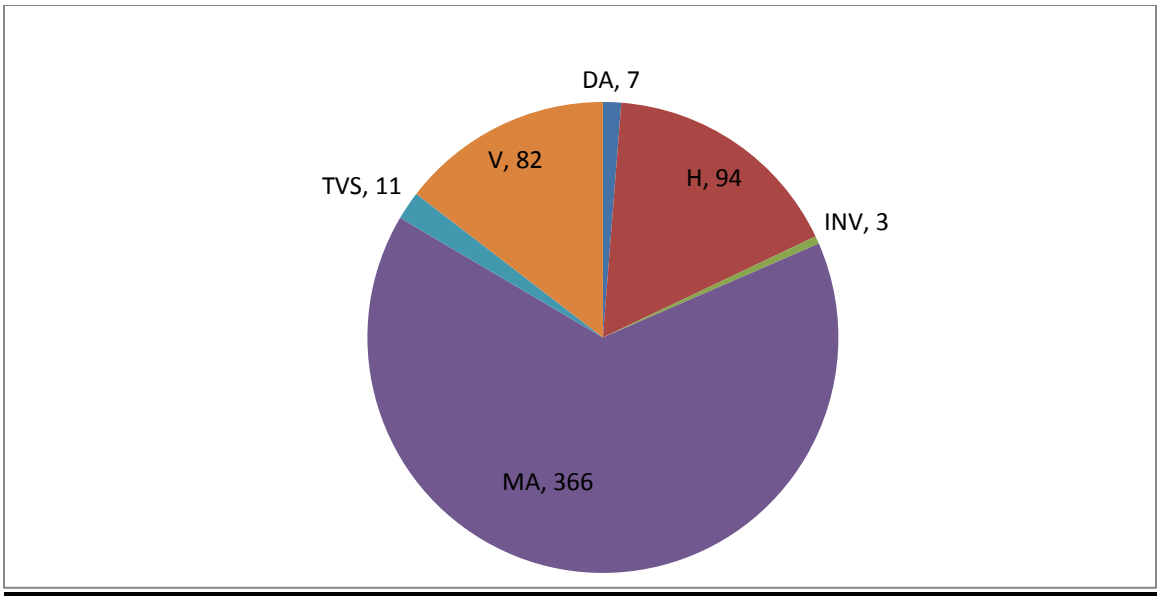

Figure 8: The prevalence of types of impaction

4.2. Demographic characteristic

Females constituted 54% of the 563 cases and males 46% as shown in (figure 9).

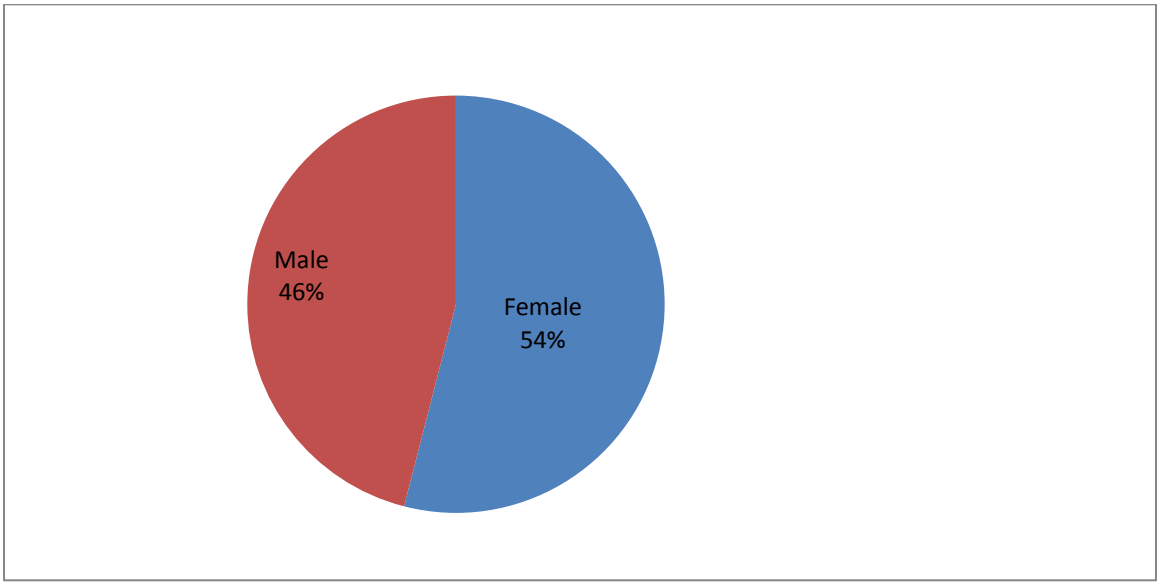

Figure 9: Gender ratio

As seen in (figure 10) the age range of patients was from 16 to 73 years. The mean age was 27 years. Females' mean age was 27.35 and males' mean age was 27.39.

Females constituted 32.3 % and males 27.9% in age group (16-27). Females constituted 21.7% and males 18.1% in the age group (28-73)

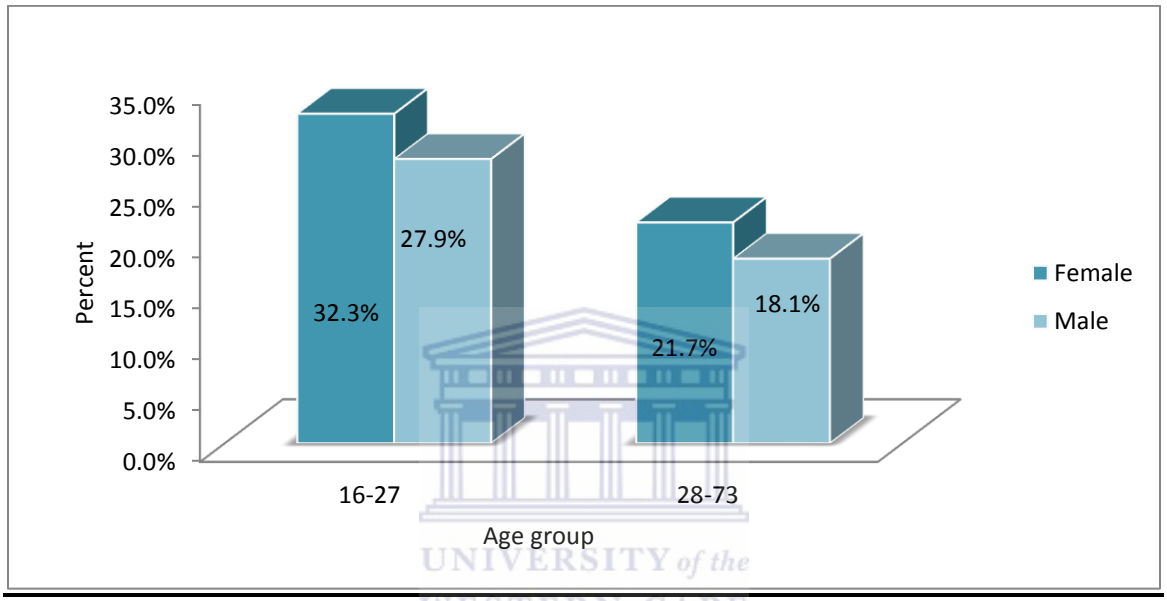

Figure 10: Gender distribution and age groups

4.3. Type of impaction and age group

As shown in (Figure 11): MA was the most common type of impaction in both age groups while INV type of impaction was the lowest in both age groups. DA, H type of impaction was more common in the age group (28-73) while TVS and V type were more common in the age group (17-27).

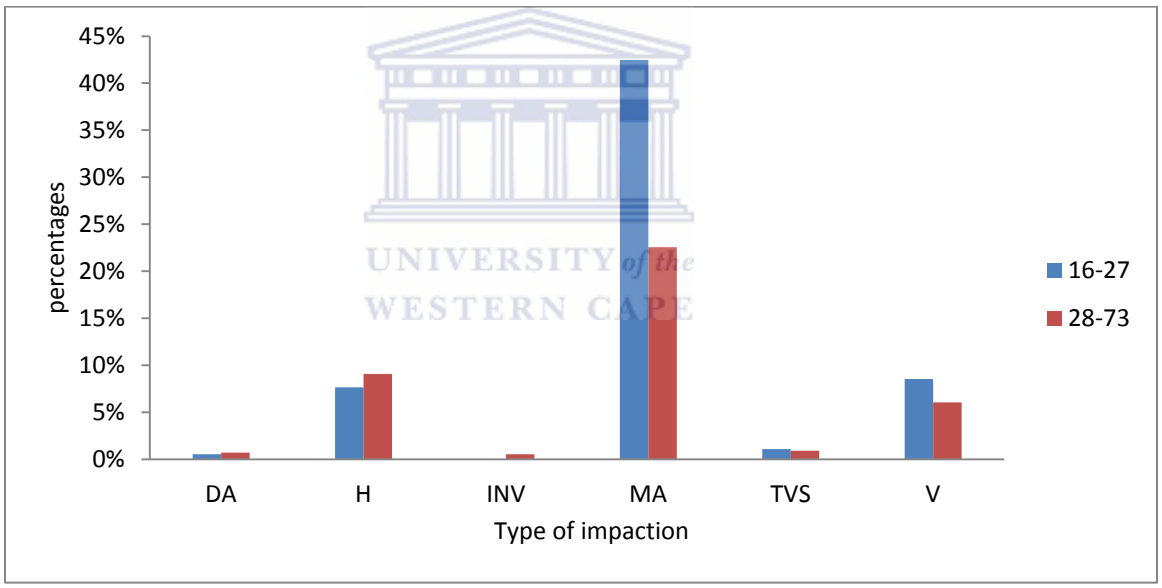

Figure 11: Prevalence of impaction among patients from different age groups

4.4. Hard tissue complication in association with impaction

DCC was the most common complication, found in 155 radiographs which constituted (28 %) of the study sample.

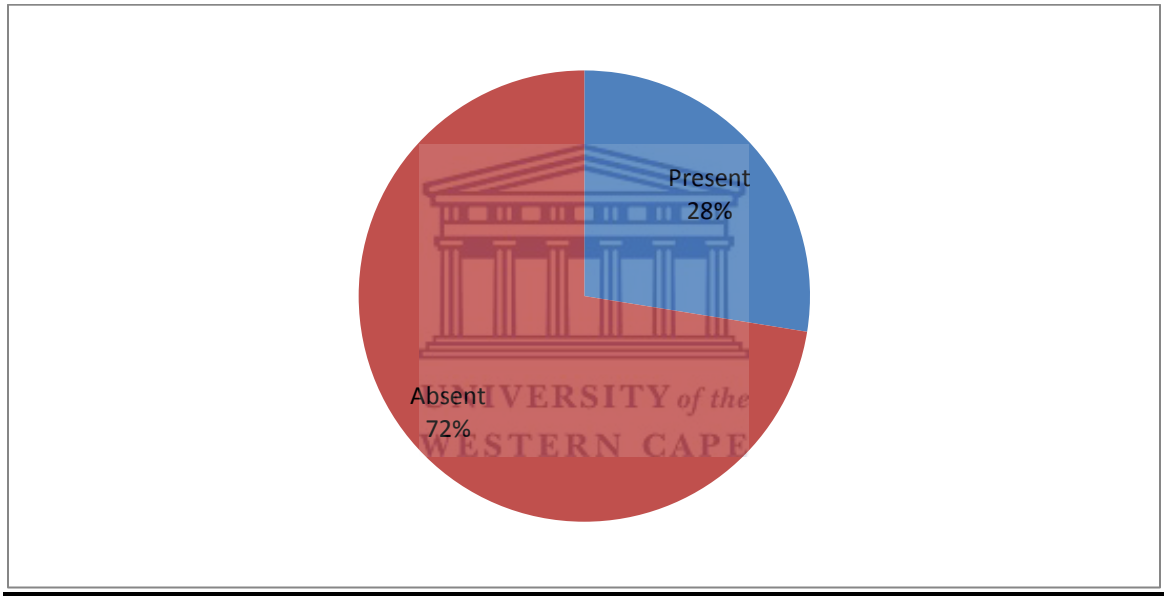

Figure 12: The prevalence of distal cervical caries in the study

Prevalence of RL/ RO and ERR in the study: RL lesions present in 16 panoramic radiographic images constituted for (3%), similar ERR found in 15 panoramic radiographs constituted for (3%).

Only one case of RO was observed in the study and it was found in a male which represents a ratio of 100 % in males.

As shown in (figure 13): DCC was found to be higher in males than females

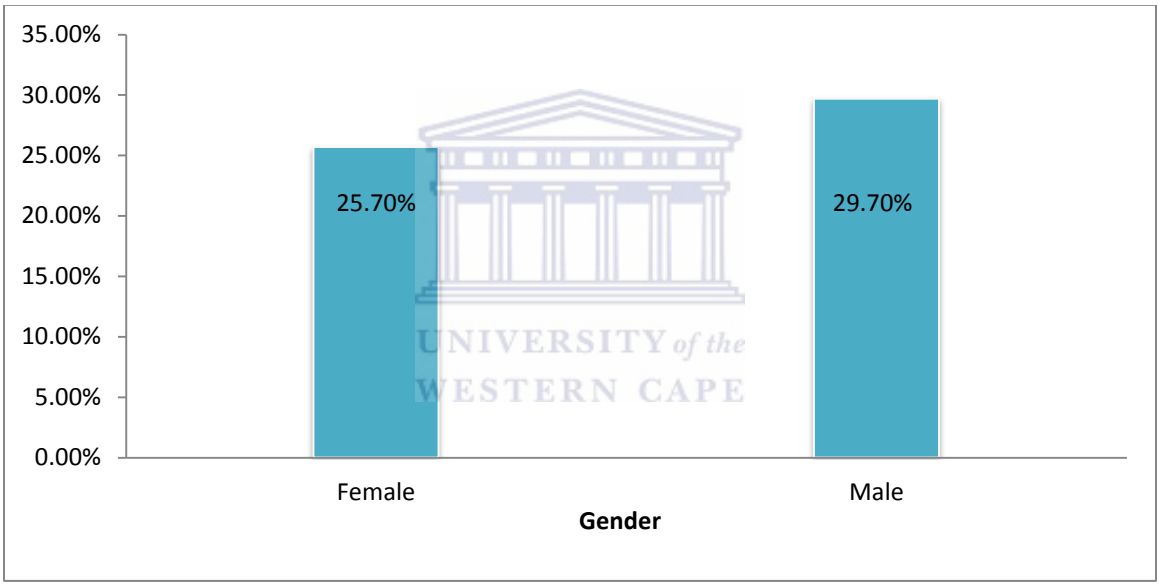

Figure 13: Average percentage of males and females with distal cervical caries associated with impacted third molars

As seen in (Figure 14) : RL lesions observed in the study were found more in males representing (68.80 %) compared to (31.30 %) in females. RL ratio was almost double in males.

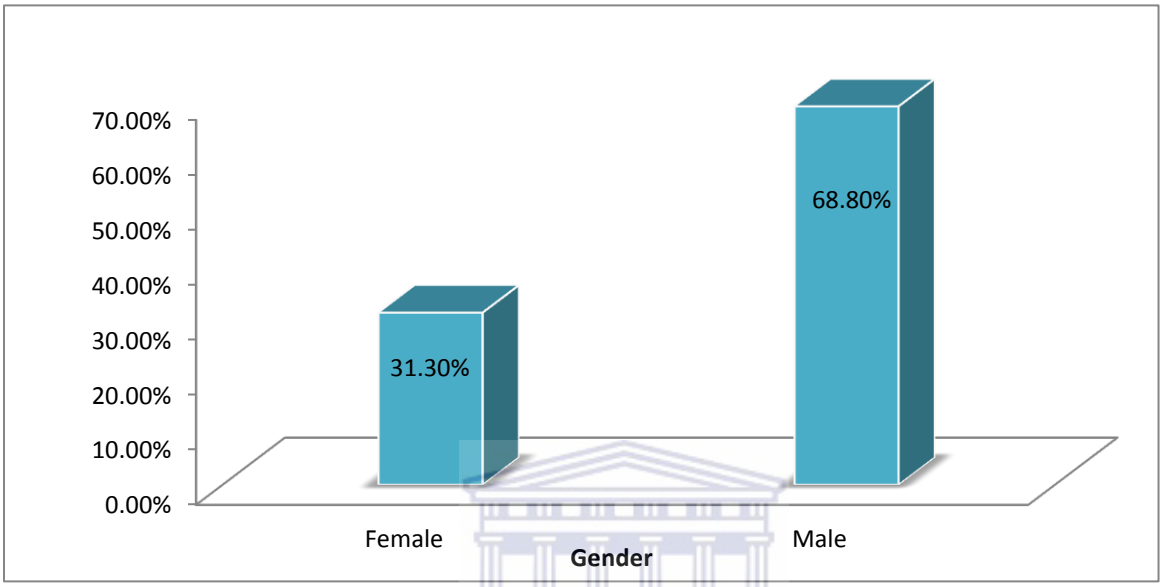

Figure 14: Depicting the prevalence of gender and radiolucency

Gender prevalence of ERR is shown in (figure 15). Females who presented with ERR count for (53.3 %) which is higher than ERR in males (46.7%).

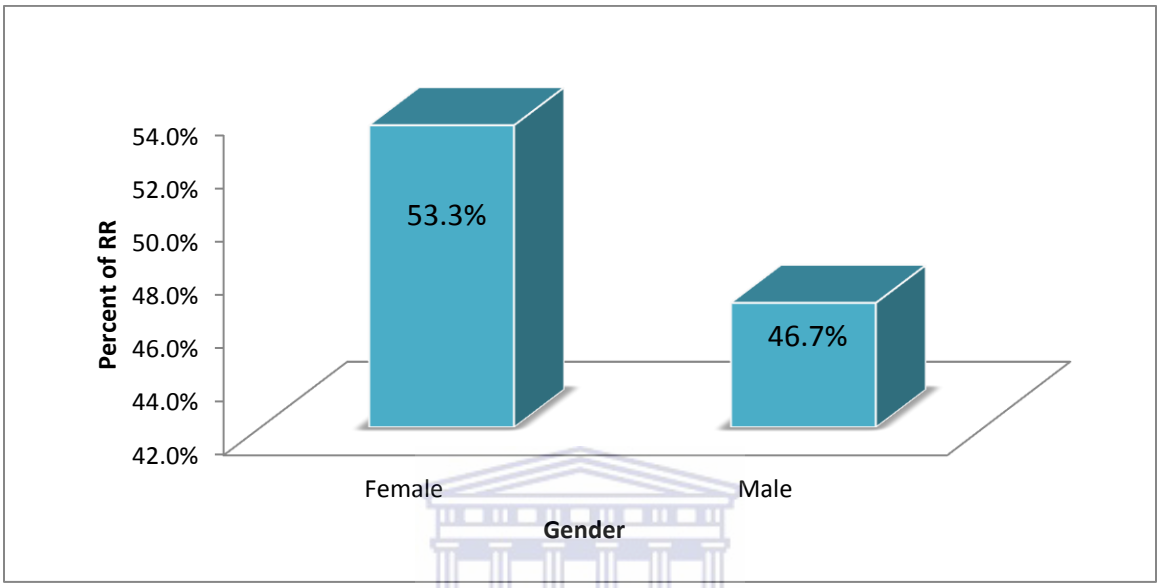

Figure 15: Representing the prevalence of external root resorption among gender

The most prevalent type of impaction in association with DCC is illustrated in (figure 16). MA type represented (73%) of all impactions while DA type of impaction was not associated with DCC (0%).

Horizontal type of impaction was associated with (20%) of DCC, followed by the V type of impaction that was associated with (6%) of DCC. While INV and TVS types of impaction were both associated with just (0.50%) of DCC.

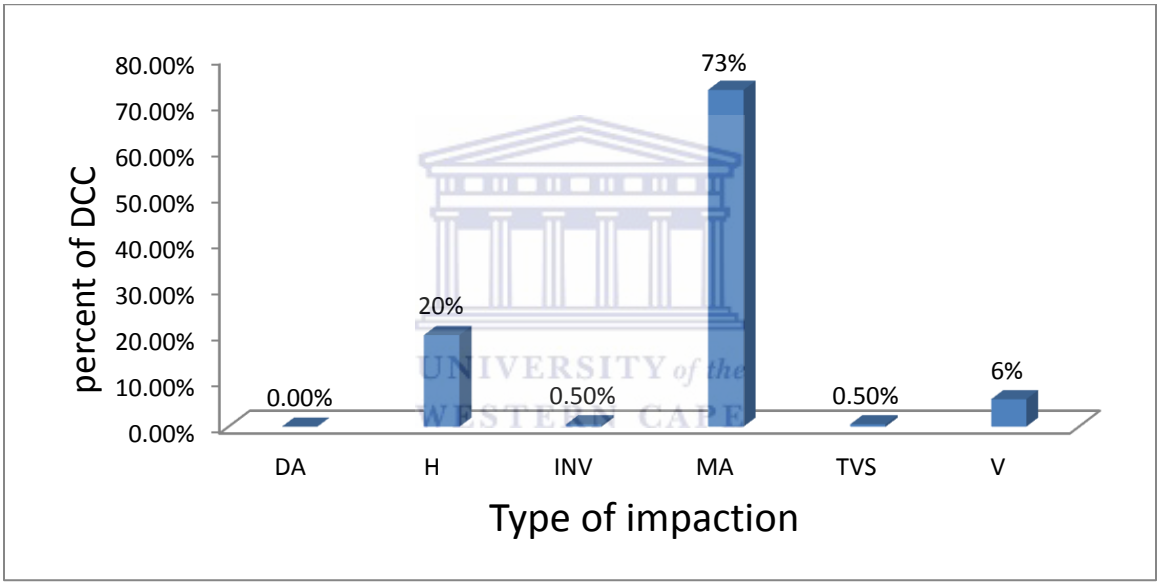

Figure 16: Prevalence of distal cervical caries associated with different types of impaction

ERR was highly associated with MA type of impaction accounting for (66.70%) of the cases; H impaction followed which was associated with (26.7%) of ERR. TVS type of impaction was in the third ranked associated with (6.70 %) of ERR cases. Other types like DA, V and INV impaction had no association with ERR (figure 17).

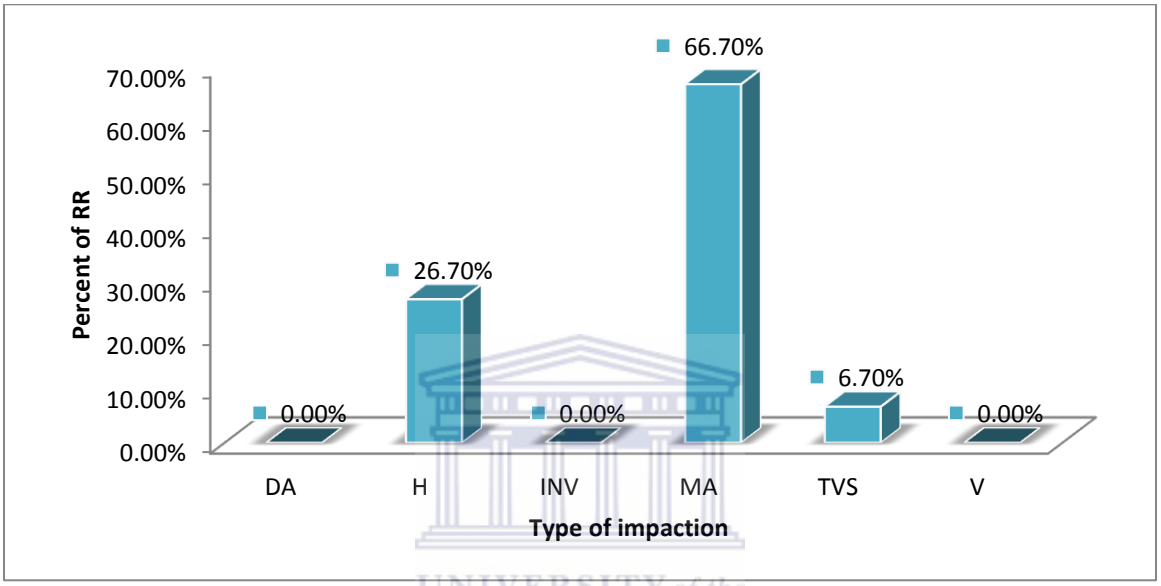

Figure 17: Showing the relationship between the type of impaction and external root resorption

55% of DCC associated with impaction occurred in the older age group while (45%) occurred in the younger age group (figure 18).

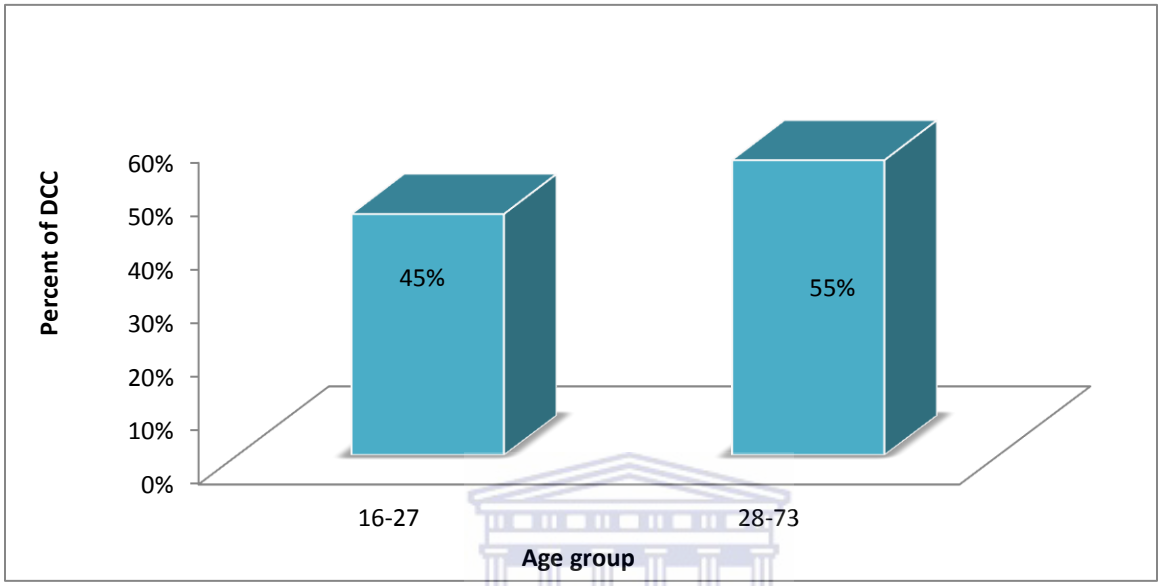

Figure 18: Prevalence of distal cervical caries in patients from different age group.

As shown in (figure 19): ERR associated with impaction was more common in the (28-73) age group (67%), while 33% occurred in the (16-27) age group .

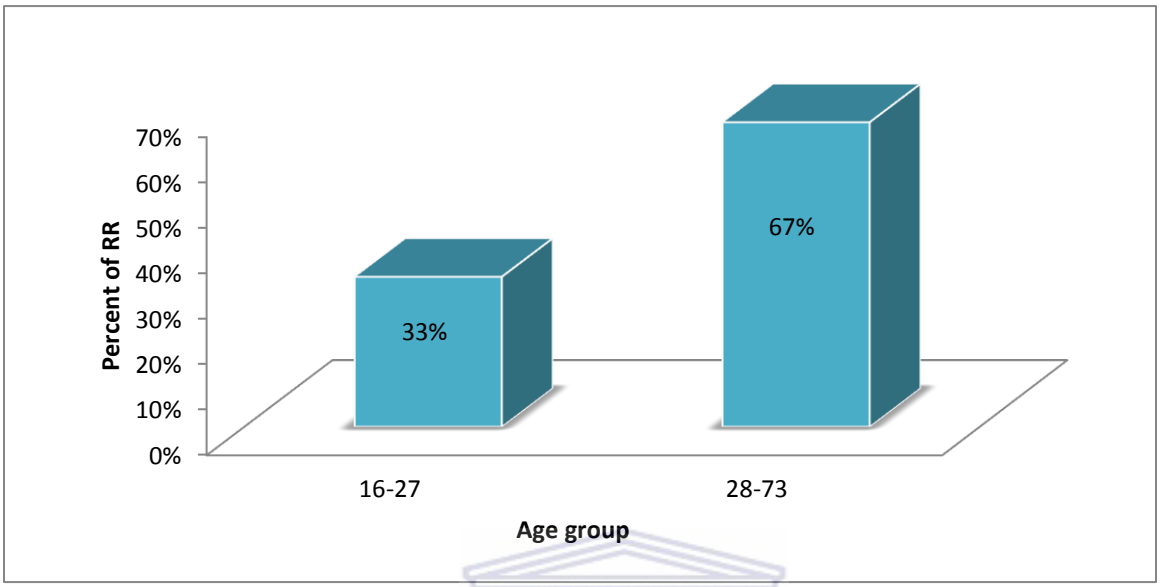

Figure 19: prevalence of external root resorption in patients from different age groups

As seen in (figure 20): RL lesions were more common in the older (28-73) age group representing (69%) compared to (31%) in the (16-27) age group. RL and age group showed significance with P value: 0.015892403.

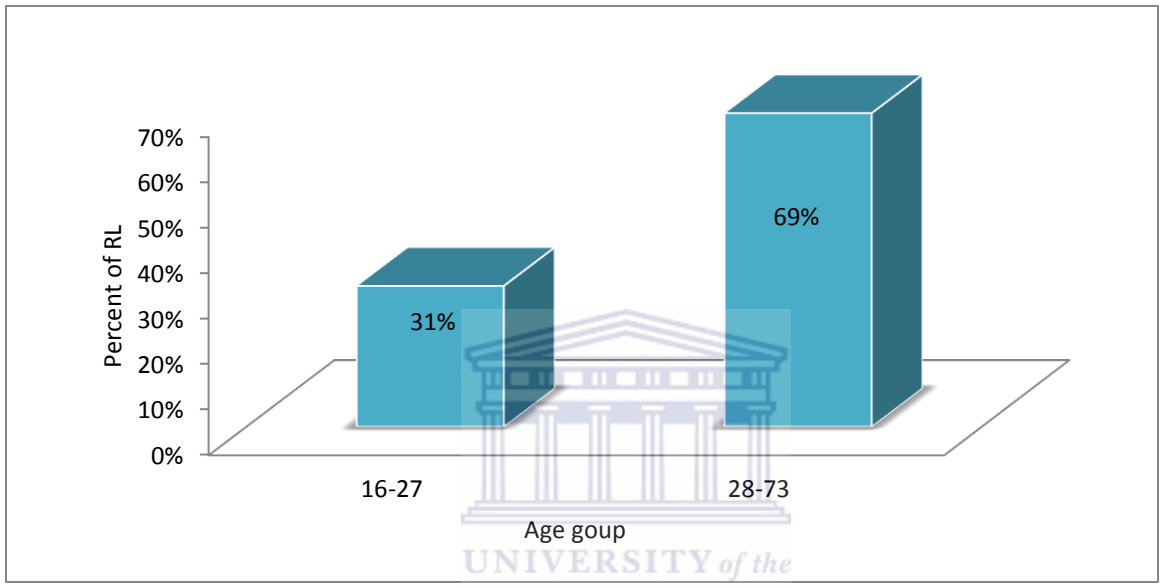

Figure 20: Depicting the prevalence of radiolucency in patients from different age groups.

CHAPTER FIVE: DISCUSSION

The regression in the human jaw size has been related to changes in civilization and nutritional habits which vary from one region to another (Syed *et al.,* 2013). Over the past few centuries, based on the evolution concept, the use of powerful mastication force has been reduced consequently. The upper and lower jaws decreased in size leaving insufficient space for third molars (Ajrish, 2015; Pillai and Kumar, 2015). Supporting this, a study conducted in India (Reddy, 2012) found that the prevalence of third molar impaction was approximately 14.92% in rural areas compared to 27.40% in urban areas. Another study by Olasoji and Odusanya, (2000) evaluated the prevalence of third molar impaction in countries with high living standards. The prevalence ranged from 9.5% -25% and the authors concluded that the change of nutritional habits might be a contributing factor for jaw/tooth discrepancy (Olasoji and Odusanya, 2000).

Therefore, it is noteworthy that the incidence and prevalence of the third molar impaction is due to a multitude of factors. The variations in the literature regarding the prevalence of impacted third molars in association with the age, gender and race demography have several possible justifications.

Firstly, the third molar has a high probability of becoming impacted, since it is the last tooth to erupt (Peterson, 1998).

Secondly, the third molar impaction is a multifactorial phenomenon (Bayoumi *et al*., 2016) in which local and environmental factors play a role e.g. bone density, ankylosis of deciduous or permanent dentition and retained teeth (Bayoumi *et al*., 2016; Pillai and Kumar, 2015; Silvestri *et al*., 2004). The degree of difference between the distal and mesial root growth could affect an impaction (Behbehani *et al*., 2006). The malposition of the tooth bud in the initial phase of calcification and root development can lead to an unfavourable path of eruption (Peck *et al.,* 2002; Richardson, 1992).

Thirdly, many theories have been suggested to demonstrate the prevalence and incidence of tooth impaction (Pokharel, 2016; Ajrish, 2015; Juodzbalys and Daugela, 2013; Syed *et al.,* 2013).

The three theories widely accepted for the aetiology of third molar impaction are:

- **Mendelian theory:** this theory is based on hereditary influences, thus if the person genetically inherits a small jaw from one parent chances of impaction is high due to lack of space (Pillai and Kumar, 2015).
- **Orthodontic theory:** this theory states that the development of the jaws occur in a downward and forward direction, while the growth of the jaw and teeth movement take place in a forward direction. Thus, any disturbances in this pattern of movement will cause an impaction (Ajrish, 2015; Chu *et al.*, 2003).
- **Phylogenic theory:** This theory states that disuse of the organs can eventually lead to slow regression, while using the organ enhances development (Ajrish, 2015). Accordingly, as the third molar is last to erupt, regression of the jaw size hinders the normal eruption and may result in tooth impaction in different angulations (Pillai and Kumar, 2015). Hence, any decrease in masticatory demand, especially during the growth period, can cause inadequate jaw development (Hichijo *et al*., 2014).

5.1 Gender and race in relation to the impacted third molars:

Out of the 563 patients sampled for the study, there were 304 (54 %) females and 259 (46 %) males. Females were found to be more affected by impaction which was deduced in other studies in the literature (Mehdizadeh *et al.,* 2014; Haghanifar and Emamverdizadeh, 2006). This could be due to the fact that the females' ratio was higher than males in the study or that females naturally have a smaller jaw size leading to lack of space for normal third molar eruption. Many studies in the literature have reported a higher female prevalence with third molar impaction (Mehdizadeh *et al.,* 2014; Haghanifar and Emamverdizadeh , 2006; Qirreish, 2005).

Conversely, Ren and Kumar (2014) reported a high prevalence of impacted third molars associated with males (36%) compared to (24%) in females, while in other studies the authors found no significant gender association with the prevalence of impacted third molar (Pokharel, 2016 and Gisakis *et al*., 2011). Unlike the rest of the dentition, the third molar develops after birth among all ethnic and racial groups; the third molar is the last tooth to erupt (Ren and Kumar, 2014; John *et al.*, 2012).

5.2 Age and gender in relation to impacted third molars:

The age range recorded for the 563 patients was from 16 to 73 years. The count in females was higher in the younger age group (32.3% below 27 years old) than in the older age group (21.7% above 27 years old). The male count was higher in the older age group (27.9 % above 27 years old) than in the younger age group (18.1% below 27 years old). Females seek treatment at the onset of complication (sooner than men would) which could be the reason why the female count was higher in the younger age group.

5.3 The prevalence of impaction types according to Winter's classification:

Winter identified six types of third molar impaction based on the long axis of the impacted tooth in relation to the long axis of the second molar. These include: MA, DA, V, H, INV and TSV (Winter, 1926). The results of this study showed that MA is the most prevalent type of impaction while INV impaction is the least prevalent impacted third molar tooth. This finding is echoed in previous findings by the likes of Tsabedze (2012); Sheikh *et al,* (2012); Khawaja *et al,* (2015) and Mehdizadeh *et al* (2014). {See table 2 below}

This is contradictory to findings by Qirreish (2005) where it was observed that the V position predominated with a frequency of 33.6%, followed by the MA which represents 32.4%. The findings of Qirreish (2005) however, reported that DA was the second least common TOI encountered (1.2%) which was similar to this study's findings. The least common TOI was INV which was observed in our findings and reported in a number of previous studies (Tsabedze, 2012; Sheikh *et al,* 2012; Khawaja *et al,* 2015 and Mehdizadeh *et al,* 2014).

Table 2: Comparison of different studies with the prevalence of impaction type:

TOI	This study	Sheikh 2012	Hashemipour 2013	Tsabedze 2012	Mehdizadeh 2014	Qirreish 2005
MA	65%	41%	48.3%	52%	41.9%	32.4 %
H	16.7%	27%	29.3%	13.5%	10.33%	28.1%
V	14.6%	22%	15.5%	15.5%	29.2%	33.6%
TVS	2%	3%	0.7%	0.9%	0%	4.6%
DA	1.2%	7%	6.3%	18.4%	18.30%	1.2%
INV	0.5 %	0%	0%	0%	0.3%	0%

Highest findings

Lowest findings

Our findings are similar to an Iranian study that reported that the highest impaction type was MA (48%), followed by H (29%), then V (15.5%) followed by DA (6.3%) and the least common was INV (0%) (Hashemipour *et al.*, 2013).

5.4 Prevalence of hard tissue features: Distal cervical caries; Root Resorption and RL/RO in association with impaction:

As a corollary to the earlier section where emphasis was on the prevalence of the different types of impaction, this section discusses the prevalence of hard tissue features according to the types of impaction outlined by Winter (1926). The discussion however will be limited to three hard tissue complications, DCC; ERR and RL/RO.

5.4.1: Distal cervical caries

This refers to the pattern and location of caries specific to the cervical region of the distal aspect of the second molar when associated with an impacted third molar. One possible interpretation for the high occurrence of DCC is because of the relative inaccessibility to these teeth for routine oral hygiene and the resultant accumulation of food and debris between the crowns leading to bacterial accumulation and the formation of plaque (Chu *et al.,* 2003; Shugars *et al.,* 2004). This is a possible precursor for the formation of caries.

Chu *et al.,* (2003) stated the reason behind DCC in second molars; he suggested that the partial exposure of lower third molars in the oral cavity may lead to the formation of plaque on the occlusal surfaces that accumulate eventually towards the distal crevices of second molars. Caries was implicated as the major factor for the third molar extraction even though the populated sample for the study was from younger male and female patients (Adeyemo *et al*, 2008).

Sandhya and Dharman, (2016) showed that the second molar adjacent to the impacted tooth was affected in almost 40 % of the study sample. This finding is similar to Polat *et al.,* (2008) who reported similar results in a study conducted amongst a Turkish population; Sheikh *et al.,* (2012) who reported 42.5%, while this study reported 27.5%. However, this is contradicted in other studies which reported that DCC in second molars was found in 7.9% (Al-Khateeb and Bataineh, 2006). This low incidence was also reported by both Chu *et al.,* (2003) and Shugars *et al.,* (2004) which indicated that DCC in second molars amounts to 7.9 %. We assume that this is probably an underestimation of the exact rate of dental caries because the diagnosis was made on digital pantomograms.

Özeç et al., (2009) reported a 20% DCC prevalence rate of second molars which is similar to our findings. An observation of 1001 panoramic radiographs Van der Linden *et al.,* (1995) reported 42.7% caries rate in second molars and 7.1% in impacted third molars which is considered one of the highest findings of DCC.

5.4.1 a: Distal cervical caries and type of impaction:

DCC is highly associated with MA and H impaction and least associated with DA impaction (Chu *et al.*, 2003; Allen *et al.*, 2009). The high DCC reported by Van der Linden *et al.,(*1995) was also associated with MA and TVS impaction type. In our study the results showed that it occurred mostly in MA impactions with 113 cases out of 366 representing (20%) of the total sample (p=0.0017). In respect to DCC complication in second molars, results were presented according to types of impaction. For MA, the results showed that it occurred in most of the cases, (20%) of the total sample**.** H follows with a frequency count of (5.5%).

The frequency rate of DCC with V impaction counts for: (1.6 %) TVS and INV both count for only (0.2 %). DCC was not associated with DA impaction.

Our findings agree with a study done by Allen *et al.*, (2009) who reported a 42% prevalence rate of DCC following the examination of the lower third molar with MA impaction in 420 patients and concluded that the relationship between MA impaction and distal cervical caries in second molars is significant and that DCC is the least associated with DA impaction. The higher association of DCC with MA and H TOI can be attributed to the contact between the impaction and the second molars which could allow the accumulation of plaque in between these two crowns. Other TOI allow more space between the second molars and the impacted third molar. Therefore, it is easier to maintain adequate oral hygiene and prevent the accumulation of plaque and therefore caries.

One possible interpretation for third molar caries according to Sandhya and Dharman, (2016) was that impacted third molar crowns may be positioned at the level of the adjacent root of second molars that leads to caries formation. Thus the bulbous shape of the crown lying adjacent to a flat surface might be an ideal location for the development of caries, and the lower height will make the second molar more susceptible to the caries than the third molar. A further plausible explanation for caries formation according to Brkić, (2012) is because the partially impacted tooth does not participate in mastication and this could lead to food and bacterial accumulation compared to fully erupted teeth.

5.4.1. b: Distal cervical caries and age group:

It was reported that DCC occurs in the older age population (Allen *et al*., 2009). Our study findings were similar as it was found to be higher in the older age group (28-73) representing 55% compared to the younger age group (16-27) representing 45 % (this difference was not statistically significant). The higher DCC rate in the older group may be due to the poor oral hygiene and not regularly going to the dentist, as distal caries takes years to form. A regular dental visit with clinical and radiographic examination would increase the chance of diagnosing DCC at an earlier age.

5.4.1. c: Distal cervical caries and gender:

DCC was reported in 28% of cases. 25.70% in females compared to 29.70% in males. There was no significance shown in association with gender. The ratio of females with impacted third molars and those who developed DCC is lower compared to the ratio in males. This may be due to females being more concerned about their oral hygiene or seeking treatment sooner than males.

The total number of caries in third molars in this study was 563 teeth, which represents 17%, with or without the association of second molar caries. The majority of V impactions with associated pericoronitis may have led to food entrapment with caries formation in the occlusal surface of the third molar. However, DCC isolated to the second molar was higher (27.50%). We deduced that the caries was more likely to be found in the second molars rather than the third molars.

Chu *et al*., (2003) also revealed caries prevalence of 3% in impacted mandibular third molars and a 7. 3 % prevalence rate in the adjacent second molars. Al-Khateeb and Bataineh, (2006) however reported that caries was more frequently observed in the third molars (13.6%) than in second molars (5%).

(Figure 21 and figure 22).

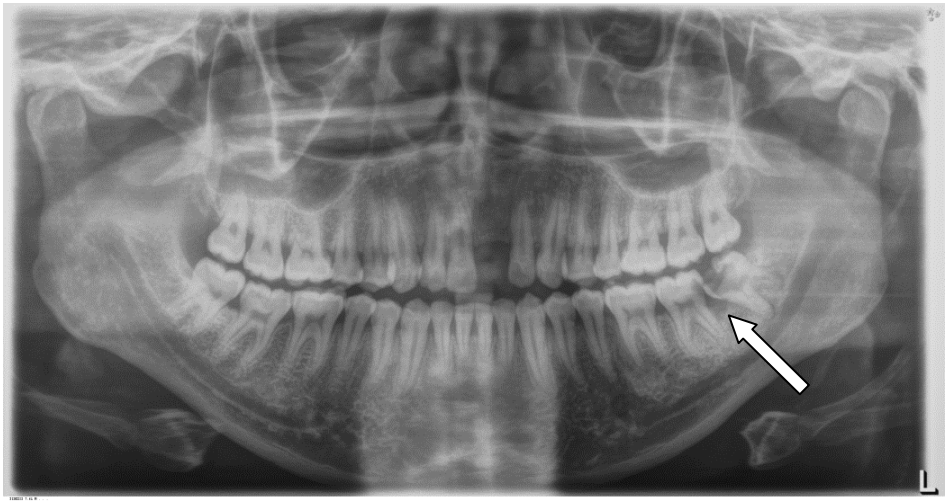

Figure 21: Panoramic radiograph showing distal cervical caries in 37 and mesial caries in impacted 38

Figure 22: Panoramic radiograph showing distal cervical caries in 37 and 47

5.4.2: Cyst and Tumours:

The lesions detected in our study were only reported as RL or RO due to the absence of confirmed pathology reports. Cystic and tumour lesions may present as homogeneous RL, mixed RL and RO lesions or completely RO in some tumours. The results of our study showed 16 cases of RL representing 2.8% and 1 case of RO (0.2%). The total percentage of RO and RL, therefore, count for (3%), which is comparable to Nazir *et al*., (2014) where they reported a prevalence of cystic changes (1.83%) and tumour (0.92%), a total of 2.75% of lesions observed. The study showed that the onset of cysts and tumours in the third molar probably remains asymptomatic for a while. The majority of them are incidental findings because of their asymptomatic nature.

Complications due to odontogenic cysts or tumours were more prevalent in patients in their thirties (Nazir *et al*., 2014). They also reported H impactions as the most common impaction associated with lesions. Similarly, Patil *et al*., (2015) reported a prevalence rate of cysts to be 2.24% with the most common cyst being the DC while ameloblastoma was the most common tumour. Their results further indicated that 3 tumours were malignant, which represents 0.05% of all pathology. The study also reported that patients had no symptoms suggestive of pathology. Farah and Savage, (2002) observed that the most common lesion was a DC.

A figure lower than ours was reported by Sandhya and Dharman, (2016) following a radiographic observation of 100 patients where ameloblastoma and DC were reported to be 0.62 % and 1.24% respectively. This finding is comparable to Chu *et al*., (2003) who showed that ameloblastoma might develop from the epithelial lining of the dental follicle or a DC epithelial lining. The study also implicated the progression of a DC due to unerupted and embedded teeth as a result of impaction. Adeyemo, (2006) also reported that the rate of tumours found in their study was almost 0.8% of which 0.02% was a malignant tumour. The incidence of ameloblastoma on the other hand was reported to be 2%. A study done by Shin *et al*., (2016) detected several lesions where DC was reported the highest among these complications followed by KCOT and the least were ameloblastomas.

There appears however to be a consensus on the low prevalence rate of RL and RO lesions associated with impacted third molars (Baykul *et al*., 2005; Adeyemo, 2006). Shear and Singh, (1978) reported an incidence rate of 0.001% and 0.0002% in the South African population (blacks and whites) which is far less than the findings reported in earlier studies. Diagnosing a DC by radiographic images may be underestimated due to the uncertainty whether the observed lesion is an enlarged follicle or DC. The normal extent of the dental follicle is considered to be 2.5 -4 mm beyond the crown. It is considered an early DC when the space extends more than 4mm. Therefore, radiographic imaging is not a final tool for diagnosing the lesions and should be considered only on histological confirmation (Kotrashetti *et al.,* 2010; Narang *et al.,* 2012).

5.4.2. a: Radiolucency, Radiopacity and Type of Impaction:

The majority of RL lesions were associated with the MA type of impaction compared to V and H types. DA, INV and TVS impactions were not associated with any RL lesion. One case of RO was found associated with H. This study showed no significance between the type of impaction and RL or RO lesions. The association between RL and type of impaction showed (*P* value =0.8393) and RO and type of impaction showed (*P* value =0.4174). Studies were done to evaluate the association of TOI cyst or tumour formation. This study showed that TOI has no influence on the development of cysts or tumours. The origin of such lesions may be developmental, idiopathic, inflammatory or hereditary but the angulations of impacted third molar have no association with its nature. Another study stated that V angulation is highly associated with lesion formation (Baykul, *et al.*, 2005).

5.4.2. b: Radiolucency, Radiopacity and Age:

The majority of RL (69%) lesions were found in the older age group while 31% were found in the younger age group. The relation between RL and age shows statistical significance with ***p* value = 0.0158**. This is similar to the findings reported in previous studies (Shin *et al*., 2016). The Association of American Oral and Maxillofacial Surgeons concluded that clinical complications associated with impacted third molars are more prevalent in patients who are

older. Shin *et al*., (2016) reported that the prevalence of cysts or tumours tended to increase after 50 years. The association of cysts and tumours with older age is higher as these lesions take years to develop. The higher the age the more chances for cyst and tumour development. Younger patients with symptomatic third molars may end up having it extracted at an early age; therefore lesion development is mainly seen in those who retain their impacted third molars.

5.4.2. c: Radiolucency, Radiopacity and Gender:

Radiolucent lesions occurred in 31.30% of females and in 68.80% of males. One case of RO was found in a male subject. Males had a higher count of RL as well as RO lesions associated with impaction. The association of gender and RL, RO lesions was significant (***P* Value= 0.04).** Males appear to be more affected with cysts and tumours although the reason still remains unexplained. It is suggested that the use of alcohol and tobacco may be a reason behind any association (Shin *et al*, 2016; Selvamani *et al*, 2012; Rakprasitkul, 2001).

(Figure 23)

Figure 23: Panoramic radiograph of multiocular radiolucency in the right angle of the mandible associated with impacted 48

5.4.3: External Root Resorption (ERR)

External Root Resorption is believed to be due to one of the following two theories:

The first theory claims that impacted wisdom teeth create a mechanical force on the distal roots. The second theory postulates that root surface resorption results due to the osteoclastic activity potentiated by the reduced enamel epithelium and dental follicle during the secretion of cytokines (Kaveri and Shobha, 2012).

Wang *et al*., (2016) reported a frequency of 21% in second molar ERRS. They concluded that age and depth of third molar impactions correlate significantly with the presence of ERR since the incidence is more prominent in patients above 24 years. This finding is similar to the results of Oenning *et al*., (2014) but is significantly more than Stanley *et al*., (1988) who observed 3% ERR. Sasano *et al*., (2003) reported a 5.5% incidence of ERR in second molars associated with third molar impaction. The results of this study are similar to their findings.

5.4.3.a: External Root Resorption and type of impaction:

A combined observation of patients from heterogeneous samples and the examination of radiographic images in a number of studies indicate a correlation between mesially impacted third molars and ERR (Oenning *et al*., 2014; Al-Khateeb and Bataineh, 2006; Yamaoka *et al*, 1999; Akarslan and Kocabay, 2009). Oenning *et al.,* (2014) reported that about 60% presented with at least one second molar resorbed by either a MA or H impacted third molar. Our study also reported that most occurrences of ERR were associated with MA impactions (66.7%) and H impactions (26. 7%). One case was observed with TVS impaction and there were no cases of ERR associated with DA, V or INV impaction. The study showed no significance of ERR with type of impaction (***p* value = 0.3896)**. Similarly, Almendros-Marques *et al.,* (2008) reported that (25%) of mesially impacted third molars were associated with ERR of the second molar. Other TOI do not directly contact the roots hence have no influence on them.

5.4.3. b: Root Resorption and Age:

Age has likewise been associated with ERR resulting from an impacted molar where it was noted in patients above 50 years (Yamaoka *et al.*, 1999), while Oenning *et al.*, (2014) reported an incidence of ERR in a younger age group, i.e. 24 years and above. This study showed a higher incidence rate of ERR (67%) in the older age group compared to 33% in the younger age group. This could be due to older patients being exposed for longer periods to the mechanical force exerted from the impacted molar on the roots of the second molars.

5.4.3. c: Root Resorption and Gender:

The prevalence of ERR (Figure 24) in men is postulated to be related to sex hormones (Wang *et al*., 2016). On the contrary, the findings reported in our study showed a higher prevalence rate in females (53.3%) than males (46.7%) which contradict the initial statement. Equal gender predilection was reported by (Oenning, *et al*, 2014; Al-Khateeb and Bataineh, 2006; Yamaoka *et al* 1999; Akarslan and Kocabay, 2009).

Figure 24: Panoramic radiograph showing potential ERR of 37 distal root due to impacted 38

CHAPTER SIX: CONCLUSION

In comparing the findings of previous studies with our findings, MA impaction was shown to be the most prevalent among all populations, genders and age groups. This may be due to the normal inclination of the third molars relative to the preceding teeth and the normal angulation that molars assume in eruption. The least common types were DA, TVS and INV. Interestingly, INV, which is considered to be a rare phenomenon, 0.5% in our study and 0.3% by Mehdizadeh *et al.*, (2014), was not reported in previous studies. TVS was less common than DA in all studies except in this study as well as Qirreish, (2005) which coincidentally were both conducted in South Africa, Cape Town. Thus a representation of the population seemed to have a lesser incidence in DA impaction than TVS.

While most previous studies seem to have a consensus on the most common and the least common types of impaction, there is however variation on the positive association between the prevalence of each type of impaction.

This incongruence between prevalence rate and types of impaction is understandable because of gender and demographic factors, e.g. age, gender, geographical location and the type of food eaten.

Females were more affected with third molar impaction. The tendency to form DCC in second molars associated with impacted third molars was found higher in males and in the older age group. Caries in impacted molars itself was common, especially in association with V impaction and pericoronitis lesions. RL and RO formation were also more prevalent in males and in the older age group.

External root resorption is a rare phenomenon; it was found to be higher in females although some studies have stated the opposite and linked the higher rate of predilection to the sex hormones. Some studies reported no ERR in association with impactions.

All complications related to third molar impaction (Distal cervical caries, External Root Resorption, Radiolucency and Radiopacity) were shown to occur in the older age group, which

indicated that they take a while to develop. The sooner the patient seeks treatment the better the prognosis.

The variation in results across the world during the past few decades could imply a changing nature in the effect of impactions and hard tissue features. Another decade or so might provide different results and thus ongoing research is suggested. More awareness needs to be raised in South Africa to encourage patients to seek treatment of symptomatic and asymptomatic third molars before complications arise. The choice of preserving the impacted teeth or performing a prophylactic extraction is still a debate in most parts of the world. Clear protocols with universal consensus are required. We suggest the annual radiographic examination of third molars from the age of 16-19 until this issue is resolved.

REFERENCES:

Adelsperger, J., Campbell, J., Coates, D., Summerlin, D. and Tomich, C. 2000. Early soft tissue pathosis associated with impacted third molars without pericoronal radiolucency. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, 89(4), pp.402-406.

Adeyemo, W. 2006. Do pathologies associated with impacted lower third molars justify prophylactic removal? A critical review of the literature. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, 102(4), pp.448-452.

Adeyemo, W.L., James, O., Ogunlewe, M.O., Ladeinde, A.L., Taiwo, O.A. and Olojede, A.C. 2008. Indications for extraction of third molars: a review of 1763 cases. *The Nigerian Postgraduate Medical Journal*, *15*(1), pp.42-46.

Ajrish, G. S. 2015. The prevalence of impacted third molars and their associated pathologies in adult patients with age group 25–60. *Journal of Pharmaceutical Sciences and* Research, 7(10), pp. 871-872.

Al-Khateeb, T.H. and Bataineh, A.B. 2006. Pathology associated with impacted mandibular third molars in a group of Jordanians. *Journal of Oral and Maxillofacial Surgery*, *64*(11), pp.1598-1602.

Allen, R.T., Witherow, H., Collyer, J., Roper-Hall, R., Nazir, M.A. and Mathew, G. 2009. The mesioangular third molar–to extract or not to extract? Analysis of 776 consecutive third molars. *British Dental Journal*, *206*(11), pp. E23-E23.

Almendros-Marqués, N., Alaejos-Algarra, E., Quinteros-Borgarello, M., Berini-Aytés, L. and Gay-Escoda, C. 2008. Factors influencing the prophylactic removal of asymptomatic impacted lower third molars. *International Journal of Oral and Maxillofacial Surgery*, 37(1), pp.29-35.

Akarslan, Z. and Kocabay, C. (2009). Assessment of the associated symptoms, pathologies, positions and angulations of bilateral occurring mandibular third molars: Is there any similarity?

Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology, 108(3), pp.e26-e32.

Baykul, T., Saglam, A., Aydin, U. and Başak, K. 2005. Incidence of cystic changes in radiographically normal impacted lower third molar follicles. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, 99(5), pp.542-545.

Bayoumi, A.M., Baabdullah, R., Bokhari, A.F. and Nadershah, M. 2016. The prevalence rate of third molar impaction among Jeddah Population. *International Journal of Dentistry and Oral Health*, *2*(4), pp.1-5.

Behbehani, F., Årtun, J. and Thalib, L. 2006. Prediction of mandibular third-molar impaction in adolescent orthodontic patients. *American Journal of Orthodontics and Dentofacial Orthopedics*, 130(1), pp.47-55.

Brkić, A. 2012. Impacted teeth and their influence on the caries lesion development, contemporary approach to dental caries, Dr. Ming-Yu Li (Ed.), ISBN: 978-953-51-0305-9

Cabay, R.J. 2014. An overview of molecular and genetic alterations in selected benign odontogenic disorders. *Archives of Pathology and Laboratory Medicine*, *138*(6), pp.754-758.

Chang, S., Shin, S., Kum, K. and Hong, J. 2009. Correlation study between distal caries in the mandibular second molar and the eruption status of the mandibular third molar in the Korean population. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, 108(6), pp.838-843.

Chu, F.C.S., Li, T.K.L., Lui, V.K.B., Newsome, P.R.H., Chow, R.L.K. and Cheung, L.K. 2003. Prevalence of impacted teeth and associated pathologies-a radiographic study of the Hong Kong Chinese population. *Hong Kong Medical Journal*, *9*(3), 158-163.

Curran, A., Damm, D. and Drummond, J. 2002. Pathologically significant pericoronal lesions in adults: Histopathologic evaluation. *Journal of Oral and Maxillofacial Surgery*, 60(6), pp.613-617.

Elsey, M. and Rock, W. 2000. Influence of orthodontic treatment on development of third molars. *British Journal of Oral and Maxillofacial Surgery*, 38(4), pp.350-353.

Elter, J., Offenbacher, S., White, R. and Beck, J. 2005. Third molars associated with periodontal pathology in older Americans. *Journal of Oral and Maxillofacial Surgery*, 63(2), pp.179-184.

Farah, C. and Savage, N. 2002. Pericoronal radiolucencies and the significance of early detection. *Australian Dental Journal*, 47(3), pp.262-265.

Fejerskov, O. and Kidd, E.A.M. 2008. Dental caries: the disease and its clinical management. *Oxford: Blackwell*, pp.163-187.

Friedman, J W. 2007. The prophylactic extraction of third molars: A public health hazard. *American Journal of Public Health*, *97*(9), 1554-1559.

Fu, P., Wang, J., Wu, Y., Huang, T., Chen, W., Tseng, Y., Tseng, C. and Hung, C. 2012. Impacted mandibular second molars. *The Angle Orthodontist*, 82(4), pp.670-675.

Fuss, Z., Tsesis, I. and Lin, S. 2003. Root resorption - diagnosis, classification and treatment choices based on stimulation factors. *Dental Traumatology*, 19(4), pp.175-182.

Gisakis, I. G., Palamidakis, F.D., Farmakis, E. T., Kamberos, G. and Kamberos, S. 2011. Prevalence of impacted teeth in a Greek population. *Journal of Investigative and Clinical Dentistry*, *2*(2), pp.102-109.

Glosser, J. and Campbell, J. 1999. Pathologic change in soft tissues associated with radiographically ‘normal’ third molar impactions. *British Journal of Oral and Maxillofacial Surgery*, 37(4), pp.259-260.

Güven, O., KeskIn, A. and Akal, Ü.K., 2000. The incidence of cysts and tumors around impacted third molars. *International Journal of Oral & Maxillofacial Surgery*, *29*(2), pp.131-135.

Haghanifar, S. and Emamverdizadeh, P. 2006. Radiographic evaluation of impacted teeth prevalence dental faculty of Babol 2004-2006. *Journal of Ghasr-e-Baran*, 1(1), pp.14-17.

Hashemipour, M.A., Arashlow, M.T. and Hanzaei, F.F. 2013. Incidence of impacted mandibular and maxillary third molars: a radiographic study in a Southeast Iran population. *Medicina Oral, Patologia Oral y Cirugia Bucal*, *18*(1), pp. e140-145.

Hichijo, N., Kawai, N., Mori, H., Sano, R., Ohnuki, Y., Okumura, S., Langenbach, G.E.J. and Tanaka, E. 2014. Effects of the masticatory demand on the rat mandibular development. *Journal of Oral Rehabilitation*, *41*(8), pp.581-587.

John, J., Nambiar, P., Mani, S.A., Mohamed, N.H., Ahmad, N.F. and Murad, N.A. 2012. Third molar agenesis among children and youths from three major races of Malaysians. *Journal of Dental Sciences*, *7*(3), pp.211-217.

Jung, Y. and Cho, B. 2013. Prevalence of missing and impacted third molars in adults aged 25 years and above. *Imaging Science in Dentistry.* 43(4), pp. 219–225.

Juodzbalys, G. and Daugela, P. 2013. Mandibular third molar impaction: review of literature and a proposal of a classification. *Journal of Oral & Maxillofacial Research*, *4*(2), p.e1.

Kaveri, G.S., Shobha, P. 2012. Third Molars: A Threat to Periodontal Health? *Journal of Oral and Maxillofacial Surgery.* 11(2), pp. 220–223.

Khan, N.B., Chohan, A.N., AlMograbi, B., AlDeyab, S., Zahid, T. and AlMoutairi, M. 2006. Eruption time of permanent first molars and incisors among a sample of Saudi male schoolchildren. *Saudi Dental Journal*, *18*(1), pp.18-24.

Khan, A., Khitab, U. and Khan, M., T. 2010. Impacted mandibular third molars: pattern of presentation and postoperative complication. *Pakistan Oral & Dental Journal*. 30(2), pp. 325-31.

Khawaja, N.A., Khalil, H., Parveen, K., Al-Mutiri, A., Al-Mutiri, S. and Al-Saawi, A., 2015. A retrospective radiographic survey of pathology associated with impacted third molars among patients seen in Oral & Maxillofacial Surgery clinic of College of Dentistry, Riyadh. *Journal of International Oral Health*, *7*(4), p.13.

Knutsson, K., Brehmer, B., Lysell, L. and Rohlin, M. 1996. Pathoses associated with mandibular third molars subjected to removal. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, 82(1), pp.10-17.

Kotrashetti, V., Kale, A., Bhalaerao, S. and Hallikeremath, S. 2010. Histopathologic changes in soft tissue associated with radiographically normal impacted third molars. *Indian Journal of Dental Research*, 21(3), p.385.

Kruger, E., Thomson, W. and Konthasinghe, P. 2001. Third molar outcomes from age 18 to 26: Findings from a population-based New Zealand longitudinal study. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, 92(2), pp.150-155.

Larson, T.D., 2009. Causes and treatment of root resorption. *Northwest Dentistry*, *89*(3), pp.45-47.

Leone, SA., Edenfield, J., Cohen, M.1986. Correlation of acute pericoronitis and the position of the mandibular third molar. *Oral Surgery, Oral medicine and Oral Pathology.* 6245250.

Lin, H.P., Wang, Y.P., Chen, H.M., Cheng, S.J., Sun, A. and Chiang, C.P. 2013. A clinicopathological study of 338 dentigerous cysts. *Journal of Oral Pathology & Medicine*, *42*(6), pp.462-467.

Lyons, C., Bruce, R., Frederickson, G. and Small, G. 1980. Age of patients and morbidity associated with mandibular third molar surgery. *The Journal of the American Dental Association*, 101(2), pp.240-245.

Mehdizadeh, M., Haghanifar, S., Seyedmajidi, M., Bijani, A. and Soufizadeh, R. 2014. Radiographic evaluation of impacted third molars and their complications in a group of Iranian population. *Journal of Research and Practice in Dentistry*, pp.m1-11.

Montevecchi, M., Checchi, V. and Bonetti, G.A. 2012. Management of a deeply impacted mandibular third molar and associated large dentigerous cyst to avoid nerve injury and improve periodontal healing: case report. *Journal Canadian Dental Association*, *78*(2), pp.59-62.

Nakata, K., Naitoh, M., Izumi, M., Ariji, E. and Nakamura, H. 2009. Evaluation of correspondence of dental computed tomography imaging to anatomic observation of external root resorption. *Journal of Endodontics*, 35(11), pp.1594-1597.

Narang, R., Manchanda, A., Arora, P. and Randhawa, K. 2012. Dentigerous cyst of inflammatory origin—a diagnostic dilemma. *Annals of Diagnostic Pathology*, 16(2), pp.119-123.

Nazir, A., Akhtar, M.U. and Ali, S. 2014. Assessment of different patterns of impacted mandibular third molars and their associated pathologies. *Journal of Advanced Medical and Dental Sciences Research*, 2(2), pp. 14-22.

Nemcovsky, C., Libfeld, H. and Zubery, Y. 1996. Effect of non-erupted 3rd molars on distal roots and supporting structures of approximal teeth. A radiographic survey of 202 cases. *Journal of Clinical Periodontology*, 23(9), pp.810-815.

Odusanya, S.A. and Abayomi, I.O. 1991. Third molar eruption among rural Nigerians. *Oral Surgery, Oral Medicine, Oral Pathology*, 71(2), pp. 151-4.

Oenning, A., Neves, F., Alencar, P., Prado, R., Groppo, F. and Haiter-Neto, F. 2014. External root resorption of the second molar associated with third molar impaction: Comparison of panoramic radiography and cone beam computed tomography. *Journal of Oral and Maxillofacial Surgery*, 72(8), pp.1444-1455.

Oenning, A., Sousa Melo, S., Groppo, F. and Haiter-Neto, F. 2015. Mesial inclination of impacted third molars and its propensity to stimulate external root resorption in second molars—A cone-beam computed tomographic evaluation. *Journal of Oral and Maxillofacial Surgery*, 73(3), pp.379-386.

Olasoji, H.O. and Odusanya, S.A., 2000. Comparative study of third molar impaction in rural and urban areas of South-Western Nigeria. *Odonto-stomatologie Tropical Dental Journal*, *23*(90), pp.25.

Özeç, İ., Siso, Ş.H., Taşdemir, U., Ezirganli, Ş. and Göktolga, G., 2009. Prevalence and factors affecting the formation of second molar distal caries in a Turkish population. *International Journal of Oral and Maxillofacial Surgery*, *38*(12), pp.1279-1282.

Özen, T., Kamburoğlu, K., Cebeci, A.R.I., Yüksel, S.P. and Paksoy, C.S., 2009. Interpretation of chemically created periapical lesions using 2 different dental cone-beam computerized tomography units, an intraoral digital sensor, and conventional film. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, 107(3), pp.426-432.

Pandis, N., Nasika, M., Polychronopoulou, A. and Eliades, T. 2008. External apical root resorption in patients treated with conventional and self-ligating brackets. *American Journal of Orthodontics and Dentofacial Orthopedics*, 134(5), pp.646-651.

Patil, S., Halgatti, V., Khandelwal, S., Santosh, B. and Maheshwari, S. 2014. Prevalence of cysts and tumors around the retained and unerupted third molars in the Indian population. *Journal of Oral Biology and Craniofacial Research*, 4(2), pp.82-87.

Peck, S., Peck, L. and Kataja, M. 2002. Concomitant occurrence of canine malposition and tooth agenesis: evidence of orofacial genetic fields. *American Journal of Orthodontics and Dentofacial Orthopedics*. 122(6), pp. 657-60.

Pell GJ, Gregory, B.T. 1933. Impacted mandibular third molars: classification and modified techniques for removal. *Dent Digest, 39,* pp.330-338.

Peterson, L.J., 1998. Principles of management of impacted teeth. *Contemporary oral and maxillofacial surgery*, *4*.

Pillai, S., Kumar, M.P.S. 2015. Incidence of agenesis, impactions, angular positions and pathologies related to third molar teeth. *Journal of Pharmaceutical Sciences and Research* 7(11), pp. 1039-1040.

Pokharel, P.K. 2016. Assessment of prevalence and pattern of impacted third molar among Kathmandu population: A retrospective analysis. *International Journal of Contemporary Medical Research,* 3(6), pp. 1658-1660.

Polat, H., Özan, F., Kara, İ., Özdemir, H. and Ay, S. 2008. Prevalence of commonly found pathoses associated with mandibular impacted third molars based on panoramic radiographs in Turkish population. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, 105(6), pp. e41-e47.

Qirreish, E.E.Y.J., 2005. Radiographic profile of symptomatic impacted mandibular third molars in the Western Cape, South Africa (Doctoral dissertation, University of the Western Cape).

Quek, S., Tay, C., Tay, K., Toh, S. and Lim, K. 2003. Pattern of third molar impaction in a Singapore Chinese population: a retrospective radiographic survey. *International Journal of Oral and Maxillofacial Surgery*, 32(5), pp.548-552.

Rakprasitkul, S., 2001. Pathologic changes in the pericoronal tissues of unerupted third molars. *Quintessence International*, *32*(8), pp.633-638.

Reddy, K.V.G. 2012. Distribution of third molar impactions among rural and urban dwellers in the age group of 22–30 years in South India: a comparative study. *Journal of Maxillofacial and Oral Surgery*, *11*(3), pp.271-275.

Ren, C.G.C. and Kumar, B.S., 2014. Prevalence of eruption of third molar tooth among South Indians and Malaysians. *Journal of Academy of Dental Education*, 1(1), pp.32-35.

Richardson, M. 1992. Changes in lower third molar position in the young adult. *American Journal of Orthodontics and Dentofacial Orthopedics*. 102(4), pp. 320-327.

Sandhu, S. and Kaur, T. 2008. Radiographic study of the positional changes and eruption of impacted third molars in young adults of an Asian Indian population. *Journal of Oral and Maxillofacial Surgery*, 66(8), pp.1617-1624.

Sandhya, R., Dharman, S. 2016. Radiographic findings associated with impacted third molars. *International Journal of Recent Advances in Multidisciplinary Research*, (3), pp. 1334-1338.

Sasano, T., Kuribara, N., Iikubo, M., Yoshida, A., Satoh-Kuiriwada, S., Shoji, N. and Sakamoto, M. (2003). Influence of angular position and degree of impaction of third molars on development of symptoms: Long-term follow-up under good oral hygiene conditions. *Tohoku J. Exp. Med.*, 200(2), pp.75-83.

Selvamani, M., Donoghue, M. and Basandi, P. 2012. Analysis of 153 cases of odontogenic cysts in a South Indian sample population: a retrospective study over a decade. *Brazilian Oral Research*, 26(4), pp.330-334.

Shear, M. and Singh, S. 1978. Age-standardized incidence rates of ameloblastoma and dentigerous cyst on the Witwatersrand, South Africa. *Community Dentistry and Oral Epidemiology*, 6(4), pp.195-199.

Sheikh, M.A., Riaz, M. and Shafiq, S., 2012. Incidence of distal caries in mandibular second molars due to impacted third molars - A clinical and radiographic study. *Pakistan Oral & Dental Journal*, *32*(3), pp. 364-370.

Shiller, W.R. 1979. Positional changes in mesio-angular impacted mandibular third molars during a year. *The Journal of the American Dental Association*, *99*(3), pp.460-464.

Shin, S., Choi, E. and Moon, S. 2016. Prevalence of pathologies related to impacted mandibular third molars. *SpringerPlus*, *5*(1), p.915.

Shugars, D., Jacks, M., White, R., Phillips, C., Haug, R. and Blakey, G. 2004. Occlusal caries experience in patients with asymptomatic third molars. *Journal of Oral and Maxillofacial Surgery*, 62(8), pp.973-979.

Silvestri, A.R., Connolly, R.J. and Higgins, M.T. 2004. Selectively preventing development of third molars in rats using electrosurgical energy. *The Journal of the American Dental Association*, *135*(10), pp.1397-1405.

Spiotto, M., Juodzbalys, G. and Daugela, P.2013. Mandibular third molar impaction: review of literature and a proposal of a classification. *Journal of Oral and Maxillofacial Research*, 4(2).

Stanley, H., Alattar, M., Collett, W., Stringfellow, H. and Spiegel, E. 1988. Pathological sequelae of "neglected" impacted third molars. *Journal of Oral Pathology and Medicine*, 17(3), pp.113-117.

Stathopoulos, P., Mezitis, M., Kappatos, C., Titsinides, S. and Stylogianni, E. 2011. Cysts and tumors associated with impacted third molars: Is prophylactic removal justified? *Journal of Oral and Maxillofacial Surgery*, 69(2), pp.405-408.

Syed, K.B., Kota, Z., Ibrahim, M., Bagi, M.A. and Assiri, M.A. 2013. Prevalence of impacted molar teeth among Saudi population in Asir region, Saudi Arabia -a retrospective study of 3 years. *Journal of International Oral Health*, *5*(1), pp.43.

Tsabedze, V.N., 2012. Prevalence of impacted mandibular third molar teeth at Medunsa Oral Health Centre (Doctoral dissertation, University of Limpopo (Medunsa Campus).

Van der Linden, W., Cleaton-Jones, P. and Lownie, M. 1995. Diseases and lesions associated with third molars. Review of 1001 cases. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, 79(2), pp.142-145

Vigneswaran, A. and Shilpa, S. 2015. The incidence of cysts and tumors associated with impacted third molars. *Journal of Pharmacy and Bioallied Sciences*, 7(5), p.251-254.

Wang, D., He, X., Wang, Y., Li, Z., Zhu, Y., Sun, C., Ye, J., Jiang, H. and Cheng, J. 2016. External root resorption of the second molar associated with mesially and horizontally impacted mandibular third molar: evidence from cone beam computed tomography. *Clinical Oral Investigations*, pp.1-8.

Winter, G.B. 1926. The principles of exodontia as applied to the impacted third molars: A complete treatise on the operative technic with clinical diagnoses and radiographic interpretations. St. Louis, Missouri: American Medical Book Co., pp. 241-279.

Yamaoka, M., Furusawa, K., Ikeda, M. and Hasegawa, T. 1999. Root resorption of mandibular second molar teeth associated with the presence of the third molars. *Australian Dental Journal*, 44(2), pp.112-116.

Yamaoka, M., Tambo, A. and Furusawa, K. 1997. Incidence of inflammation in completely impacted lower third molars. *Australian Dental Journal*, 42(3), pp.153-155.

Yuasa, H. and Sugiura, M. 2004. Clinical postoperative findings after removal of impacted mandibular third molars: prediction of postoperative facial swelling and pain based on preoperative variables. *British Journal of Oral and Maxillofacial Surgery*, 42(3), pp.209-214.

Zhang, L., Yang, R., Zhang, L., Li, W., MacDonald-Jankowski, D. and Poh, C. 2010. Dentigerous cyst: a retrospective clinicopathological analysis of 2082 dentigerous cysts in British Columbia, Canada. *International Journal of Oral and Maxillofacial Surgery*, 39(9), pp.878-882.

APPENDICES:

Appendix 01

Data collection sheet

Demographic factors				
File number		Age	Gender	
Type of impaction				
Findings				
Cervical Distal caries in second molars	External Root resorption	Radiolucency	Radiopacity	Any other findings /features

Appendix 02

Microsoft Excel 2011® spread sheet

File no	Demographic factors		Type of impaction	Radiographical findings			
	Gender	Age		Cervical Distal caries	External Root resorption	Radiolucency	Radiopacity
*coding							

Gender code

1= male

2=female

findings code

1= yes

2= No

Type of impaction

MA= Mesioangular H=Horizontal

DA=Distoangular V=Vertical

TVS=Transverse INV=Inverted

Appendix 03:

CORRELATION BETWEEN CLINICAL CONDITIONS AND DEMOGRAPHIC VARIABLES

TABLE2: CONTINGENCY TABLE SHOWING LEVEL OF SIGNIFICANCE CORRELATION BETWEEN PREVALENCE OF DCC AND TYPES OF IMPACTION

			TOI						P	
			DA	H	INV	MA	TVS	V	value	
	DCC	Yes	0.00%	5.50%	0.20%	20.10%	0.20%	1.60%	0.0017	
		No	1.20%	11.20%	0.40%	44.90%	1.80%	13.00%		
	ERR	Yes	0.00%	0.70%	0.00%	1.80%	0.20%	0.00%	0.3896	
		No	1.20%	15.90%	0.50%	63.30%	1.80%	14.60%		
	RL	Yes	0.00%	0.5%	0.00%	1.6%	0.00%	0.7%	0.8393	
		No	1.2%	16.2%	0.5%	63.3%	2.0%	13.9%		
	RO	Yes	0.00%	0.2%	0.00%	0.00%	0.00%	0.00%		
		No	1.2%	16.5%	0.5%	64.9%	2.0%	14.6%	0.4174	
	Gender	Female	0.50%	8.30%	0.40%	35.30%	0.90%	8.50%		
		Male	0.70%	8.30%	0.20%	29.70%	1.10%	6.00%	0.8248	

TABLE 3: CONTINGENCY TABLE SHOWING LEVEL OF SIGNIFICANCE CORRELATION BETWEEN AGE GROUP AND PREVALENCE OF RADIOLUCENCY.

		Age Group			
		16-27	28-73	P Value	
Gender	Female	32.3%	21.7%		
	Male	27.9%	18.1%	0.856329263	
TOI	DA	0.5%	0.7%		
	H	7.6%	9.1%		
	INV	0.00%	0.5%		
	MA	42.5%	22.6%	0.003164684	
Complication	TVS	1.1%	0.9%		
	V	8.5%	6.0%		
DCC	Yes	15.3%	12.3%		
	No	44.9%	27.5%	0.157630168	
ERR	Yes	1.8%	0.9%		
	No	58.6%	38.7%	0.616464706	
RL	Yes	0.9%	2.0%		
	No	59.4%	37.7%	0.015892403	
RO	Yes	0.2%	0.00%		
	No	60.1%	39.7%	0.416916848	

TABLE 4: CONTINGENCY TABLE SHOWING LEVEL OF SIGNIFICANCE CORRELATION BETWEEN GENDER AND RADIOLUCENCY

		Gender		
		Female	Male	P value
DCC	Yes	13.90%	13.70%	0.162702
	No	40.10%	32.30%	
RL	Yes	0.02%	0.04%	0.04
	No	0.98%	0.96%	
ERR	Yes	0.01%	0.01%	0.574264
	No	0.53%	0.45%	
RO	Yes	0.00%	0.20%	0.459075
	No	54.10%	45.70%	
TOI	DA	0.50%	0.70%	0.824837
	H	8.30%	8.30%	
	INV	0.40%	0.20%	
	MA	35.30%	29.70%	
	TVS	0.90%	1.10%	
	V	8.50%	6.00%	