AMELOBLASTOMA OF THE MANDIBLE: A RADIOLOGICAL AND CLINICAL STUDY AT THE UNIVERSITY OF THE WESTERN CAPE ORAL HEALTH CENTRE

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A mini-thesis submitted for fulfilling the requirements for the Degree of Magister Chirurgiae Dentium in the discipline of Maxillo-Facial and Oral Surgery, Faculty of Dentistry, University of the Western Cape.

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KEYWORDS

Ameloblastoma

Mandible

Odontogenic tumour

Panoramic radiography

Pantomograph

Radiographic features

Retrospective study

Conventional ameloblastoma

Unicystic ameloblastoma

ABBREVIATIONS

3-D Three-dimensional

CA Conventional ameloblastoma

CBCT Cone beam computed tomography

CT Computed tomography

MRI Magnetic resonance imaging

PA Peripheral ameloblastoma

T1WI T1-weighted image

T2WI T2-weighted image

UA Unicystic ameloblastoma

WHO World Health Organisation

GLOSSARY

The terms below are defined for the purpose of this study:

Cortication: The presence of a radiopaque rim around the margins of a lesion. It typically characterises the body's response to a tumour by deposition of new bone at the periphery of the lesion resulting in the formation of a radiopaque margin.

Curettage: A surgical procedure in which a curette is used to remove diseased tissue by scooping or scraping.

Enucleation: A surgical technique in which the entire tumour or lesion is removed without the need for any dissection.

Excision: The surgical removal of a foreign body or of tissue.

Expansion: The ability of a lesion to expand and increase in size within bone.

Infiltration: The ability of a lesion to invade and infiltrate the surrounding tissue.

Loculation: The radiographic appearance of a lesion consisting of either multiple compartments within the bone (multilocular) or a single compartment (unilocular).

Margin of the lesion: The border or interface between the lesion and the normal surrounding tissue.

Opacification: A pathologic change in a lesion which leads to a radiopaque presentation on radiograph.

Resection: A surgical procedure whereby a diseased body part is completely or partially removed.

Septa: A term used to define bony walls within a lesion. These walls can be coarse or fine and in certain lesions, they separate the tumour into numerous compartments.

ABSTRACT

Ameloblastoma of the mandible: A radiological and clinical study at University of the Western Cape Oral Health Centre

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MChD (MFOS) mini-thesis, Department of Maxillo-Facial and Oral Surgery, Faculty of Dentistry, University of the Western Cape.

Introduction: Ameloblastoma is the most common benign tumour of odontogenic origin and presents five times more in the mandible than in the maxilla (Reichardt *et al*. 1995). Although benign, it exhibits an invasive behavioural growth pattern with a high rate of recurrence if not managed appropriately. Ameloblastoma occurs in all age groups, but is most common in patients between the ages of 20 and 40 years. Males and females are equally affected. Clinically, ameloblastoma presents as a slow-growing, painless tumour, which if left untreated, can grow to enormous proportions. Radiographically, the lesion presents as either multilocular or unilocular radiolucency. The internal appearance of multilocular lesions may resemble a soap-bubble, honeycomb or spider-like pattern. Combinations of these patterns are not unusual.

Aim: The aim of this study was to analyse clinical, radiological and histological data using medical records of patients with ameloblastoma involving the mandible that

presented at the Department of Maxillo-Facial and Oral Surgery and Diagnostics and Radiology of the University of the Western Cape Oral Health Centre.

Methodology: The study consisted of a retrospective, case-series, descriptive study of all cases involving histopathologically diagnosed ameloblastoma of the mandible at the Departments of Maxillo-Facial and Oral Surgery and of Diagnostics and Radiology at the Faculty of Dentistry, University of the Western Cape. This records-based study documented patient demographic information, pantomographic presentation and histopathological features of ameloblastoma in the mandible over a period of 45 years from 1972 to 2017.

Patient's age, gender and ethnicity were recorded. Radiographic features that were noted included the size, location, density, margins, locularity, cortical expansion and its effect on adjacent dentition. Based on the WHO 2017 classification of head and neck tumours, histopathological information was recorded either as a conventional or unicystic.

Results: A total number of 148 cases were included in the study. The male to female ratio was nearly equal (1.055:1). The majority of patients were below 50 years of age (83.77%).

The mandibular posterior region was most affected and the majority of lesions had a multilocular appearance (68.24%). The majority of these multilocular lesions (83.16%) presented between the ages of 10 and 50 years. In contrast, more than half (61.70%) of unilocular lesions presented in patients below 30 years of age.

Conclusion: This study showed that the clinical, radiographic and histopathological findings of ameloblastoma of the mandible are similar to those in studies that were undertaken in other countries.

DECLARATION

I declare that 'Ameloblastoma of the mandible: A radiological and clinical study at University of the Western Cape Oral Health Centre' is my own work, that it has not been submitted for any degree or examination at any other university, and that all sources I have used or quoted have been indicated and acknowledged by complete references.

Sanjay Ranchod

Signed: 

June 2019

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The completion of this research project could not have been accomplished without the willingness and guidance of the following individuals:

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- Lastly, a big thank you to Dr Amir Afrogheh who assisted me with obtaining histological slides of the specimens for the study.

DEDICATION

This thesis is dedicated to my beloved wife and daughter. My wife's love and support throughout the years has been exemplary. I am truly grateful and humbled by her sacrifice.

I also dedicate this thesis to my late father, late grandmother and dearest mother for all their love and support. By providing me with a solid foundation, I was able to reach my full potential and achieve my goals.

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Chapter 1

INTRODUCTION

The expansion of the jaws may be a consequence of a multitude of benign tumorous lesions of the jaw. These entities may be categorised into odontogenic and non-odontogenic tumours (whether from tooth origin or not) and further subdivided into benign or malignant entities, according to their malignant potential (Kahairi *et al*. 2008).

Ameloblastoma is the most common benign tumour of odontogenic origin. It develops from epithelial cellular elements and dental tissue in their various phases of development. Ameloblastoma in the mandible is approximately five times more prevalent than in the maxilla (Reichardt *et al*. 1995). Its clinical presentation is that of an asymptomatic, slow-growing tumour with a plethora of radiological and clinico-pathological features. Despite being a benign tumour, it exhibits an invasive behavioural growth pattern with a high rate of recurrence if not managed appropriately.

This study describes a case-series of all histopathologically confirmed mandibular ameloblastoma cases, recorded between 1972 and 2017 at the Departments of Maxillo-Facial and Oral Surgery and of Diagnostics and Radiology of the Faculty of Dentistry, Tygerberg Oral Health Centre, University of the Western Cape, Cape Town, South Africa.

Chapter 2

LITERATURE REVIEW

2.1. Background

Ameloblastoma is derived from the French word “amel”, meaning enamel, and the Greek word “blastos”, meaning germ (Cuzack 1827). Cuzack originally described the tumour in 1827 and in 1885, a French physician by the name of Louis-Charles Malassez coined the term “adamantinoma”, meaning hard substance (Malassez 1885). In 1930, the term "ameloblastoma" was officially coined by Ivey and Churchill (Ivey and Churchill 1930).

According to the World Health Organisation (WHO) ameloblastoma is known as the prototype of odontogenic tumours of epithelial origin. The WHO further defines the ameloblastoma as a benign, slow-growing, locally invasive lesion of epithelial odontogenic neoplasm of putative enamel origin and divides the lesion into three clinico-pathological types viz.: conventional ameloblastoma (CA), unicystic ameloblastoma (UA), and peripheral ameloblastoma (PA) (El-Naggar *et al*. 2017).

2.2. Epidemiology

Ameloblastoma comprises 1% of all oral and maxillo-facial tumours and 12 % of all odontogenic tumours (Masthan *et al.* 2015). This 1% frequency shows variable geographic prevalence with China and Africa recording it as the most prevalent benign odontogenic tumour and the United States of America and Canada recording it as the

second most common after the odontoma (McClary *et al*. 2015). However, if one considers the odontoma to be a hamartoma, then the ameloblastoma becomes the most commonly occurring odontogenic tumour (Masthan *et al.* 2015). Considering its prevalence in Africa, ameloblastoma accounts for 11% to 24% of all odontogenic tumours (Bassey *et al*. 2014, Adebayo *et al*. 2002, Arotiba *et al.* 1997).

A study by Siar *et al.* (2012) indicated that ameloblastoma in a Malaysian population group correlated well with ameloblastoma in Asian population groups showing a high relative frequency, slight male predilection, a wide age distribution and a peak incidence in the second decade of life. In contrast, an earlier study by Ledesma-Montes *et al.* (2007) showed that ameloblastoma in a Latin American population group occurred at a lower frequency and with an even gender split when compared to lesions found in Malaysian and Asian population groups.

An extensive study reviewing the biological profile of 3,677 cases of ameloblastomas by Reichart *et al.* (1995) indicated that ameloblastoma was more prevalent in black population groups and people of Asian descent. That review showed that the average age of presentation was 36 years with an equal gender distribution and that the tumour occurred in the mandible five times more frequently than in the maxilla.

2.3. Clinical presentation

Clinically ameloblastomas present as a slow-growing painless tumour, which may reach a considerable size before an extra-oral swelling is noticeable. The size of the tumour may vary from microscopic to enormous. Tumours of the jaw are generally hard on palpation and show lingual and buccal expansion. Crepitation occurs upon palpation

where the cortex is very thin (Pindborg *et al.* 1974). Symptoms include swelling, malocclusion and malalignment of teeth. Paraesthesia, pain and pathological fracture of the involved area rarely occur (Becelli *et al*. 2002).

Agbaje *et al.* (2018) analysed 1,103 mandibular ameloblastomas and showed that the tumour presents most commonly in the posterior region of the mandible. This predilection for the posterior mandible is consistent with findings in other studies (Malik *et* al. 2018, Buchner *et al.* 2006, Kim and Jang 2001, Sirichitra and Dhiravarangkura, 1984).

The 2017 WHO classification of odontogenic tumours states that ameloblastoma exhibits different clinico-pathological presentations. These include CA (75%-86% of all cases), UA (13-21% of all cases), PA (1%-4% of all cases) and metastasizing (less than 1% of all cases) (El-Naggar *et al*. 2017). These tumours are further subdivided based on the histological pattern observed.

2.4. Radiological features

2.4.1. Radiological description

Ameloblastoma may be described radiologically in terms of its shape, periphery, internal structure and its effects on surrounding structures (Farman *et al.* 1993).

2.4.1.1. Shape

With regards to its shape, mandibular lesions may be unicystic or multilocular. The periphery of mandibular lesions appears well-defined, corticated, smooth and curved.

2.4.1.2. Periphery

When viewed on a pantomograph mandibular ameloblastomas may present either as having a well-defined or an ill-defined margin.

2.4.1.3. Internal structure

The internal structure may vary from totally radiolucent to a mixed radiolucent-radiopaque caused by the presence of bony septa creating internal compartments. These septa may give rise to soap-bubble (large loculations), honeycomb (small and numerous loculations), or mother-and-daughter cell appearances. On occasion strands of bony septa may appear to radiate from the centre producing a spider-like appearance. The appearance of septa on the radiograph usually represents differential resorption of the cortical plate by the tumour and not actual separation of tumour portions. A study by Adekeye (1980) found that 10% of tumours presented with unilocular radiolucencies and 90% had a soap-bubble or honeycomb appearance. In multilocular lesions, the cystic lesions appear larger in the posterior and smaller in the anterior portions of the mandible.

2.4.1.4. Effect on surrounding structures

Structures surrounding the tumour are commonly affected. Teeth may be displaced by a considerable distance, and the inferior alveolar canal may be inferiorly displaced due to tumour growth (Farman *et al.* 1993). Root resorption is also a common feature and, where associated with the ameloblastoma, appears to have a knife-edge appearance as adjacent roots are cut off along a single linear plane, corresponding to the margin of the lesion. A study by Sirichitra and Dhiravarangkura (1984) showed root resorption occurring in 39% of cases. Another study by Ueno and colleagues (1986) found that an impacted tooth was

as result of ameloblastoma formation in 38% of cases, with 82% of these being an impacted third molar.

An extensive review by Small and Waldron (1955) described the radiological features of 1,036 ameloblastomas as often being lytic, expansile, multilocular, honeycomb and soap-bubble like. The lesions vary from small unilocular lesions resembling a dental cyst to large, multilocular lesions visible in the ramus, body and trans-symphyseal region. Another large review of ameloblastoma of the jaws by Reichart *et al.* (1995) evaluated 1,234 conventional radiographic descriptions. In this review, a unilocular appearance occurred in 51.1% of cases, with the remaining 48.9% showing a multilocular appearance.

2.4.2. Worth's radiographic description

Worth (1963) described, in detail, four radiographic patterns of ameloblastoma especially applicable to mandibular lesions, which is still relevant in current literature.

The first pattern resembles a dentigerous cyst without septa, often seen in the ramus. According to Worth (1963) a differential diagnosis for an ameloblastoma should be included if the patient is older than 30 years, the lesion extends from the body to the ramus of the mandible and partial loculation with septa are present and if a portion of the anterior, and sometimes also the superior ramus wall, is missing. Worth (1963) also indicated that when there is a cyst-like cavity with some wall deficiency, and faint septa are visible within the lesion, then the diagnosis is almost guaranteed to be an ameloblastoma.

The second pattern, which Worth (1963) believed to be the most common, consists of a cystic-appearing cavity with distinctive septa. The trabeculae may vary widely in their shape and arrangement, but strands radiating from the centre of the lesion occur frequently. He also indicated that a “gross caricature of a spider” may be seen in cases, which is pathognomonic for ameloblastoma. Some of the trabeculae are curved and may be thin or coarse. Similar to the first category, the anterior or superior wall of the ramus and body of mandible, respectively, may be missing. Invariably the angle of the mandible is preserved and convex expansion of the inferior border may occur with the cortex appearing eggshell-thin.

The third pattern described by Worth (1963) is more common than the first, but less common than the second. He indicated that this pattern showed a multilocular cystic "soap-bubble" appearance in the posterior portion of the mandible and ramus. Two or more cavities may appear in continuity, with thin septa separating them. If the patient is older than 30 years and there is loss of continuity of one of the free walls of the mandible, then the lesion is highly suggestive of an ameloblastoma. As with the second pattern, convex expansion of the inferior border may be present.

The fourth pattern described by Worth (1963) relates to the solid type of this tumour. Normal bone is replaced by small cavities, which are fairly uniform in size, giving rise to a honeycomb appearance. The honeycomb may consist of a few to hundreds of small cavities. The cavity walls are coarse, and the margins of the lesion are lobulated in conformity with the adjacent cavities while the margins separating normal bone from the tumour are denser than normal bone. He further indicated that it is unusual for an unerupted tooth to be associated with this tumour variant.

2.5. Imaging

2.5.1 Cone beam computed tomography

Cone beam computed tomography (CBCT) is a computed tomographic image utilising a cone-shaped radiographic beam to demonstrate hard tissues. It emits a lower radiation dose than most computed tomography (CT) units (Pauwels 2015, Loubele *et al.* 2009) and allows three-dimensional (3-D) navigation in axial, sagittal and coronal planes (Figure 1) thus producing precise locations of anatomic structures (Lim *et al.* 2018). It also has the advantage of the absence of magnification and distortion (Lim *et al.* 2018) resulting in highly accurate information of bony structures.

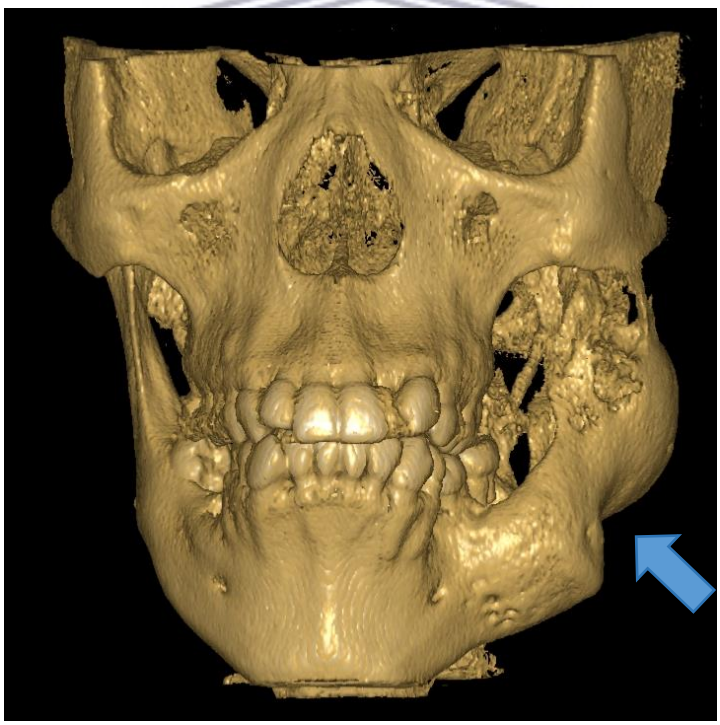


Figure 1: Depicting a CBCT 3-D reconstruction of a large ameloblastoma of the left mandible.

Cortical thinning, perforation and destruction due to ameloblastoma is easily demonstrated with this modality (Lim *et al*. 2018). CBCT can also reveal the direction in

which expansion occurs (Luo *et al.* 2014) while the superimposition that occurs with conventional imaging is negated. This is especially important in the anterior mandible where conventional radiography causes superimposition of the cervical vertebrae (Suomalainen *et al.* 2015). In addition, it can easily identify internal septations within a lesion (Lim *et al*. 2018).

A major drawback of CBCT is its poor soft tissue definition. This makes it impossible to accurately assess the contents of the lesion, which means that it becomes difficult to differentiate between an ameloblastoma and an odontogenic cyst. Other drawbacks include susceptibility to artefacts from metallic restorations, patient motion, inadequate scanner calibration, and higher radiation dose when compared to conventional radiography (Lim *et al.* 2018).

2.5.2 Computed tomography

Computed tomography (CT) images are achieved when multiple x-ray beams are transmitted to a detector, which is linked to a computer for image reconstruction. The computer, with the aid of software, produces images with multiple slices in the axial dimension. (Parks 2001, Mitchell and Mitchell 2005). The software also converts the information retrieved by the detector into coronal, sagittal and 3-D reconstructed views as shown in Figure 2 (Parks 2001). This allows visualisation of the lesion in many planes and provides detailed information of the lesion with respect to the surface, margins, approximation to vital structures as well as internal architecture of the tumour.

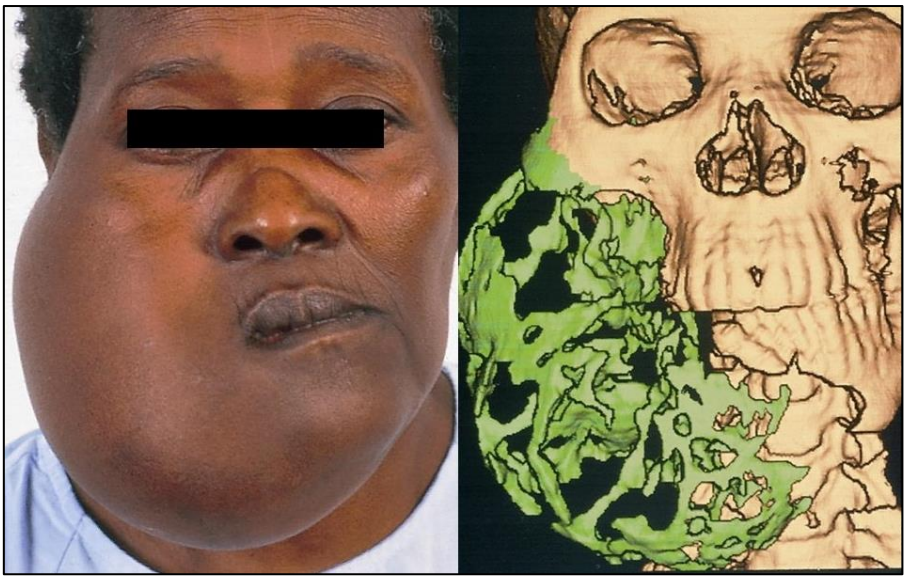


Figure 2: Depicting a 3-D reconstruction of a large ameloblastoma of the right mandible. (Courtesy of Prof J Morkel)

The advantage of CT is the speed of image acquisition and the relatively low cost compared to magnetic resonance imaging (MRI) making CT a desirable diagnostic aid (Van Rensburg and Nortjé 1992).

In comparison to conventional radiographs, CT assists in defining the contours of the lesion, the presence of cortical perforations, and extension into soft tissues (Ariji *et al.* 2011, Cihangiroglu *et al.* 2002). Furthermore, CT allows differentiation between cystic and solid contents within ameloblastomas (Ariji *et al.* 2011). Visualisation of a slightly proteinaceous fluid in the cystic regions of ameloblastomas is achievable by the use of contrast-enhanced CT imaging (Ariji *et al.* 2011). It may even provide the identification of a mural nodule in unicystic ameloblastomas allowing differentiation from a dentigerous cyst (Minami *et al.* 1992, 1996, Han *et al.* 1995). Contrast-enhanced CT has also been reported to produce different densities for different histopathological subtypes of ameloblastoma (Crusoe´-Rebello *et al.* 2009).

A drawback of CT is patient exposure to relatively high ionizing radiation compared to CBCT and conventional imaging techniques. In addition, artefacts may appear due to metal dental restorations and to visualise soft tissues, intravenous contrast media is required. (Van Rensburg and Nortjé 1992).

2.5.3 Magnetic resonance imaging

Magnetic resonance imaging (MRI) is based on how hydrogen ions in tissues react to a strong magnetic field. Hydrogen ions are essentially protons and are present in abundance in water and fat (Langlais *et al.* 2000, Brooks 2001). This proton varies with the type of molecule to which it is bound. The signals created by these protons upon exposure to a magnetic field and radiofrequency is processed to create an image.

In addition to superior soft tissue visualisation when compared to CT, MRI allows the assessment of the internal contents of a lesion (Van Rensburg and Nortjé 1992, Lenz *et al.* 2000, Apajalahti *et al.* 2015,). In addition, MRI allows vascular tissues to be viewed without the need for intravenous contrast agent (Van Rensburg and Nortjé 1992).

According to Van Rensburg (2004) the features that ameloblastomas show on MRI correlate with their macroscopic appearance. Another study by Asaumi *et al.* (2005), demonstrated that ameloblastomas showed, on MRI, various signal intensities reflecting their polymorphic features.

Adipose tissue appears white or bright with T1-weighted images (T1WI's), while water and other tissue fluid, such as CSF, appear black (Figure 3). Unlike T1, water and other fluids appear white on T2-weighted images (T2WI's) (Langlais *et al.* 2000) (Figure 3).

Because pathological tissues contain more water, T2WI's are generally used for detection of pathological processes.

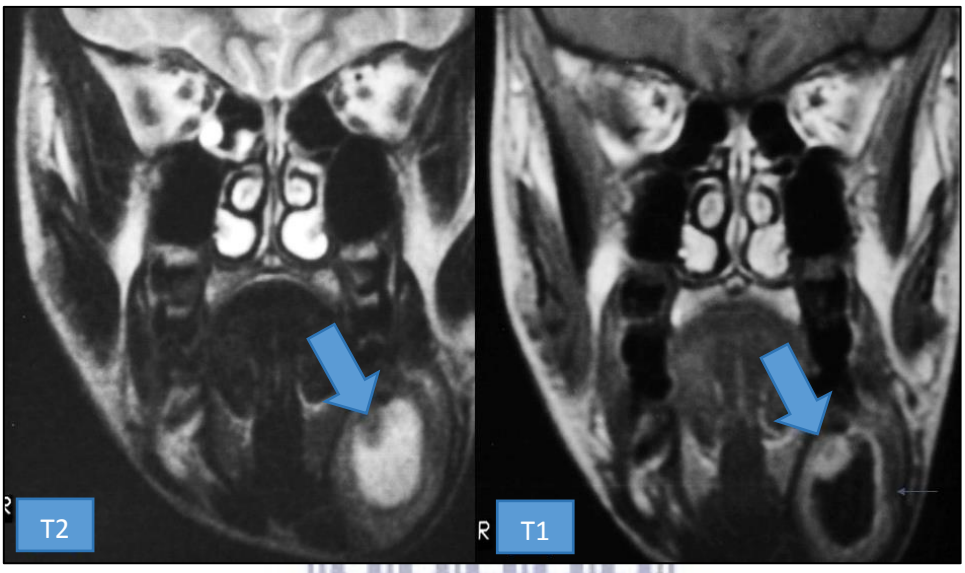


Figure 3: T2 and T1-weighted MR depicting a nodule in an ameloblastoma of the left mandible. (Courtesy of Prof J Morkel)

T1WI's exhibit low signal intensity for both solid and cystic components within the lesion. If hyperintensity is observed with T1WI, it usually indicates the presence of high proteinaceous fluid or recent haemorrhage. When viewing T2WI's, the solid component or papillary projections within the lesion are hypointense, however, cystic regions appear as hyperintense areas (Janse van Rensburg 2004, Asaumi *et al.* 2005) (Figure 3). In addition, Apajalahti *et al.* (2015) also agreed that the cystic contents in mulicystic ameloblastomas appear as homogeneous, bright, high signal intensities on T2WI's which relates to non-proteinaceous cystic content.

Apajalahti *et al.* (2015) demonstrated that 70% of all multicystic ameloblastomas showed varying combinations of solid and cystic contents on contrast-enhanced CT as well as

MRI. They suggest that contrast-enhanced CT and MRI are able to differentiate multicystic ameloblastomas from odontogenic cysts. This differentiation is possible due to the thin rim enhancement exhibited by the fluid within odontogenic cysts. This feature is not visible in ameloblastomas that contain solid contents (Hisatomi *et al.* 2003).

With respect to unicystic ameloblastomas, MRI allows for enhanced detection of small intraluminal or mural components (Apajalahti *et al.* 2015).

The disadvantages of MRI include long acquisition times, relatively high cost, limited availability, and that the patient has to bear a considerable amount of noise (Langlais *et al.* 2000, Van Rensburg and Nortjé 1992). This noise may cause a susceptible patient to become emotionally or psychologically distressed especially when confined to the scanner (Brooks 2001, Langlais *et al.* 2000).

In summary, ameloblastoma causes expansion and perforation of the cortex, with invasion into the surrounding soft tissue. The full extent of the tumour cannot be assessed by conventional imaging alone. Therefore, CBCT, CT and MRI play a vital role in assessing the 3-D architecture of the lesion and its relation to surrounding tissues.

2.6. Histopathological subtypes

In the WHO 2005 classification of head and neck tumours, ameloblastomas were sub-divided into solid/multicystic, extraosseous/peripheral, desmoplastic and unicystic types (Gardner *et al.* 2005). In 2017, an updated classification was drafted for amongst others, odontogenic tumours (Figure 4).

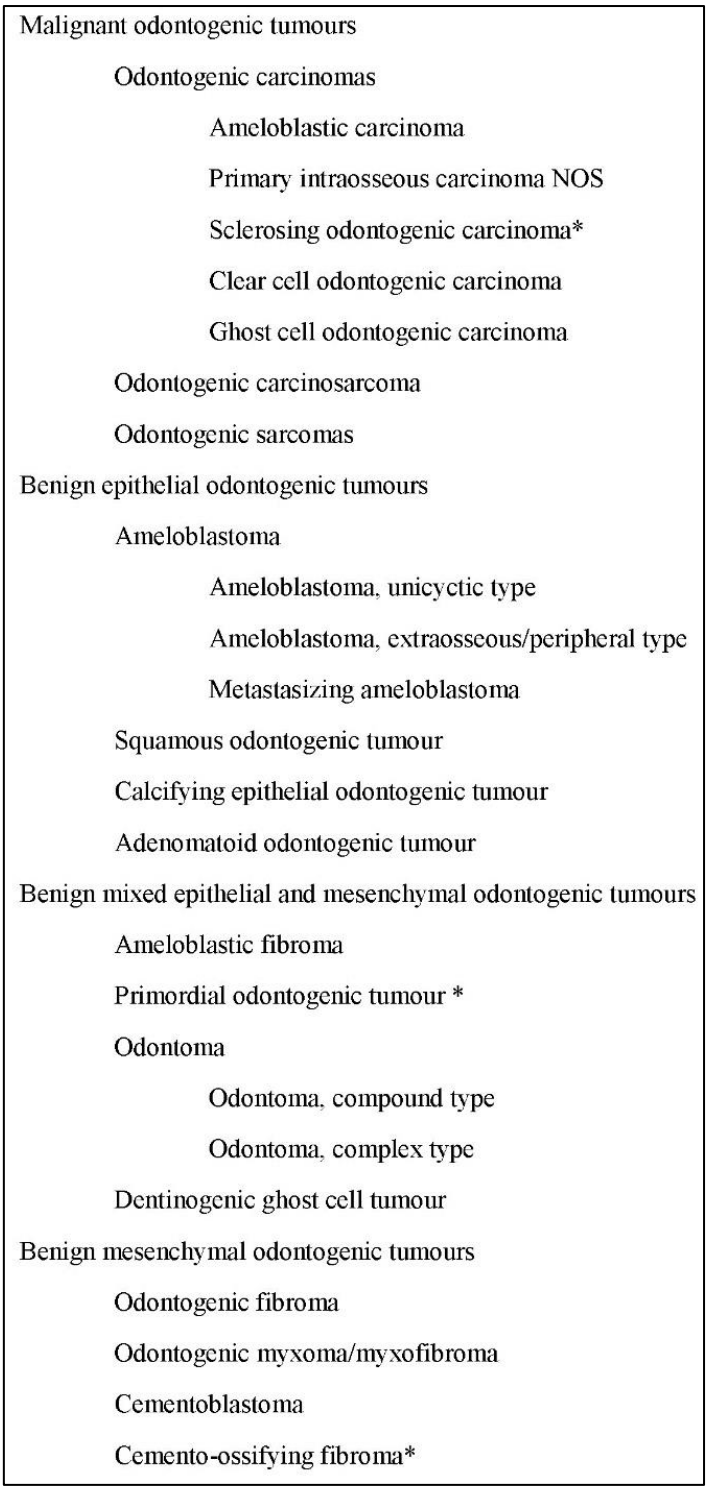


Figure 4: 2017 WHO classification of Odontogenic Tumours. (*New entities or terminology since 2005.)

The term conventional ameloblastoma (CA) was decided upon instead of solid/multicystic ameloblastoma (El-Naggar *et al.* 2017). The desmoplastic ameloblastoma is no longer regarded as a specific type of ameloblastoma, but rather as a histological variant of CA (El-Naggar *et al.* 2017). The commonly occurring patterns include the follicular, plexiform and acanthomatous subtypes. Other histological variants include follicular, plexiform, acanthomatous, basal cell, papilliferous kerato-ameloblastoma, clear cell, and haemangiomatous ameloblastoma (Van Rensburg 2004). These patterns may occur simultaneously within in a single tumour (Van Rensburg 2004). As a diagnostic entity, there is no evidence of any differences in behaviour between the various histological variants that belong to the CA type (Speight and Takata 2018).

The unicystic ameloblastoma (UA) possesses unique behavioural and clinico-pathological characteristics and has three histological variants. They include the luminal type, which is a simple cyst lined by ameloblastomatous epithelium and the intraluminal type, which is similar but with luminal projections of ameloblastomatous epithelium (often of the plexiform variant). These two types are considered to have a good prognosis and rarely recur even after simple enucleation (Speight and Takata 2018). The third type is the mural UA. This type shows proliferation of ameloblastomatous epithelium that penetrate the cyst wall. Evidence indicates that this unicystic variant behaves in a similar fashion to CA in terms of its recurrence rate (Li *et al.* 2000).

Chapter 3

AIMS AND OBJECTIVES

3.1. Aim

The aim of this study was to analyse clinical, radiological and histological data using medical records of patients with ameloblastoma involving the mandible who presented at the Departments of Maxillo-Facial and Oral Surgery and Diagnostics and Radiology of the University of the Western Cape Oral Health Centre.

3.2. Objectives

1. To record the demographic information
2. To describe the pantomographic features
3. To describe the clinico-pathological diagnosis
4. To investigate possible association between the demographic information of patients and the radiographic and clinic-pathological features of ameloblastoma of the mandible

Chapter 4

MATERIALS AND METHODS

4.1. Study design

This was a retrospective, case-series, descriptive study of ameloblastoma of the mandible. It was records-based and patient demographic information, conventional radiographic presentation and histopathological features of ameloblastoma in the mandible which was documented during a 45-year period from 1972 to 2017.

The study population comprised of the records of 148 patients who were diagnosed with this odontogenic tumour of the mandible at the Department of Maxillo-Facial and Oral Surgery and the Department of Diagnostics and Radiology of the Faculty of Dentistry, Tygerberg Oral Health Centre, University of the Western Cape, Cape Town, South Africa.

4.2. Sample size

The sample size consisted of 148 records of patients with ameloblastoma of the mandible. These records were obtained from the archives of the Departments of Maxillo-Facial and Oral Surgery, and of Diagnostics and Radiology at University of the Western Cape, Tygerberg Oral Health Centre, Cape Town, South Africa. The archive contained records of patients with various types of oro-facial pathology where the patient records were catalogued according to their specific pathology. Records

for patients with ameloblastoma of the mandible were retrieved and the relevant information was recorded.

4.2.1. Selection criteria

Inclusion criteria:

1. Patient records with a histologically confirmed diagnosis of ameloblastoma
2. Completed patient records (demographic details; histological report; pantomograph)

Exclusion criteria:

1. Ameloblastomas in the maxilla
2. Incomplete patient records
3. Pantomographs of poor diagnostic quality (Due to deterioration of the radiograph and inability to identify related anatomical structures as determined by consensus between the two observers).

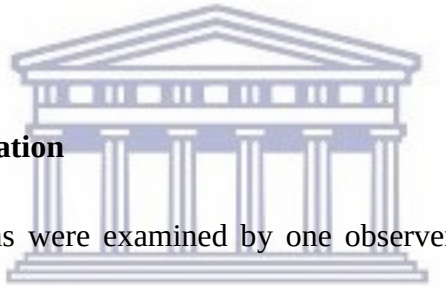
4.3. Data collection

Data collection included the recording of patient demographic information, radiographic features as noted on pantomograph, and the histopathological diagnosis as confirmed by a histology report. All data collected for this study were recorded on a data collection sheet (Appendix 1). The format of the data sheet was based on the objectives set out in this study. This data were collated by means of a Microsoft Excel spreadsheet. The data

included the patient's age, gender and ethnicity. Radiographic features including location, radio-density, margins, locularity, multilocular appearance, its effect on adjacent dentition, size and expansion of cortex were noted.

4.3.1. Demographic information

Once the histological diagnosis of ameloblastoma was confirmed, the patient's age, in years, was calculated using the date of birth. The gender and ethnicity of the patient was retrieved from archive records as noted in the demographic information section of the clinical records.



4.3.2. Radiological examination

All archived pantomographs were examined by one observer (principle investigator). Every image available for the study was examined by the observer. In cases where there was uncertainty in the findings, a second observer (maxillofacial radiologist) was consulted and the final decision was taken by consensus.

The pantomographs used in this study were taken with either a GE-3000 (General Electric, Milaukkee, WI) or Cranex Tome CEPH (Soredex, Helsinki, Finland). In order to standardise the settings for interpretation, all radiographs examined in this study were observed on a bright and evenly illuminated light-reflecting radiograph viewing box within an enclosed room with no light entry. The viewing box was placed in a comfortable position for the investigator. The digital radiographs were observed on a standardised

monitor in an enclosed room with no light entry. Magnifying glasses were used as adjunctive tools to allow for detailed examination of the radiographs when necessary.

4.3.2.1. Location

The location of the lesion was categorised into five different regions in the mandible. The first region was the anterior mandible which extended from the left canine (33) to right canine (43) and in edentulous patients from the left to right mental foramina. The second was the posterior region of the mandible extending from canine to the angle of the mandible, for both left and right sides. The third region was noted as the ramus of the mandible, which extended from the angle of the mandible to the sigmoid notch. The fourth and fifth regions were represented by the extension of the lesion into the coronoid process or condylar head respectively.

4.3.2.2. Radiodensity

Radiodensity was classified as either radiolucent, radiopaque or mixed (radiolucent and radiopaque in appearance).

4.3.2.3. Margins

Margins that were discernable from the surrounding unaffected bone were classified as well-defined. Those margins that could not be visualized were classified as ill-defined.

4.3.2.4. Locularity

Lesions were then further classified as either unilocular (when only one compartment was present) or multilocular (when numerous adjacent compartments were present).

4.3.2.5. Multilocular appearance

By referring to Worth's radiographic (1963) description of ameloblastomas in the mandible, multilocular lesions were recorded as either being soap-bubble, honey-comb or spider-like in appearance. If the lesion did not resemble either of those descriptions, it was noted as appearing as 'other'.

4.3.2.6. Effect on dentition

Signs of root resorption and/or tooth displacement were documented to demonstrate the lesion's ability to affect adjacent structures.

4.3.2.7. Size

The size of the lesion was measured in millimetres along the widest diameter of the lesion from one border to the opposite border.

4.3.2.8. Expansion of cortex

The expansile nature of the lesion was noted by studying the effect it had on the cortex of the mandible.

4.3.3. Histopathological diagnosis

The histopathological reports were retrieved from the archive and noted accordingly. Certain lesions that were not confirmed as an ameloblastoma were excluded from the study. Due to the changes in classification of lesions between 1972 and 2017, information gathered regarding the specific histopathology was attained according to the report provided. Using the WHO 2017 classification of head and neck tumours, they were then classified as either conventional or unicystic types. Certain reports confirmed the diagnosis of ameloblastoma, but did not specify the type. These were classified as unspecified type.

4.4. Data analysis

Microsoft Excel was used to calculate and present the data. Data was analysed with StataCorp 2017 (Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC) in consultation with a statistician to compare the radiographic and histopathological findings and to compare these findings with different demographic parameters such as age, gender and ethnicity. Associations between categorical variables were tested by using the χ^2 test if assumptions were met. If the assumptions were not met, the *Fisher exact test* was used. For continuous data, an independent-samples t-test was run to determine if there were differences in the means between two groups. Furthermore, if more than two groups were present, a *One-way ANOVA* test was used to compare the differences between the means. The level of significance was set at $p < 0.05$.

4.5. Ethical considerations

This was a retrospective study of patient records from the Departments of Maxillo-Facial and Oral Surgery and of Diagnostics and Radiology, Faculty of Dentistry, Tygerberg Oral Health Centre, University of the Western Cape, Cape Town, South Africa. Permission was obtained from the relevant departments before commencement of this study. Permission to access patient records was requested via a letter to the Dean's office (Appendix 2).

The file number and other identifiable patient data (names, date of birth, addresses, etc.) were associated to a catalogue number. Only the latter was recorded on the data capturing sheet (see Appendix 1). The data identifying the catalogue number of a patient remained anonymous. This number was used for record purposes only and was only kept for the duration of the study. Patient records were stored on a password protected computer and printed information was stored in a locked office. Radiographs investigated in this study did not jeopardise patient identity, and prior consent was obtained from the patient when clinical photos were used to display the lesion.

This mini-thesis proposal was presented to the Faculty of Dentistry of the University of the Western Cape Research Committee and was approved by the Senate Research Ethics Committee (approval number: BM/16/5/17) of the University of the Western Cape (Appendix 3).

Chapter 5

RESULTS

A total of 209 cases were diagnosed with ameloblastoma from 1972 to 2017 at the Departments of Maxillo-Facial and Oral Surgery and of Diagnostics and Radiology, University of the Western Cape Oral Health Centre. Seven cases were noted to be in the maxilla and were excluded from the study. Of the remaining 202 cases, 148 records had complete demographic information, radiographic evidence and a confirmed histopathological diagnosis. Records with incomplete demographic, clinico-radiological or histopathological information were excluded from the study.

5.1. Demographic data

5.1.1. Age

In this study, the patient ages at time of diagnosis ranged from 11 to 83 years with a mean age of 32.99 years. The majority of patients were below 50 years old (83.77%) (Table 1). Those between 20 and 29 years were most affected with 48 patients (32.43%) falling within this group. Only one patient (0.68%) was noted in the 80 to 89 year-old group.

5.1.2. Gender

The male to female ratio was found to be nearly equal at 1.055:1. There were 76 (51.3%) males and 72 (48.7%) females (Table 1). The prevalence of ameloblastoma had no statistically significant association between gender and age, as assessed by Fisher's exact test ($p = 0.503$).

Table 1: Distribution of ages and gender of patients diagnosed with ameloblastoma.

Age Group	No. patients	Percentage	No. Males	No. Females
10-19	29	19.59	10	19
20-29	48	32.43	25	23
30-39	25	16.89	14	11
40-49	22	14.86	18	8
50-59	13	8.78	7	6
60-69	7	4.73	4	3
70-79	3	2.04	2	1
80-89	1	0.68	0	1
Total	**148**	**100**	**76**	**72**

5.1.3. Ethnicity

In this sample, the data consisted of three ethnic groups. There were 87 patients (58.8%) in the Black African group, 54 (36.5%) in the mixed race group and seven (4.7%) in the Caucasian group. There was no statistical significance in the prevalence of

ameloblastoma among race and age categories as assessed by Fisher's exact test (p = 0.852) (Table 2).

Table 2: Distribution of ages and ethnicity of patients diagnosed with ameloblastoma

Age Group	Race		
	Black African	**Caucasian**	**Mixed race**
10-19	18	2	9
20-29	26	3	19
30-39	17	2	6
40-49	14	0	8
50-59	7	0	6
60-69	4	0	3
70-79	1	0	2
80-89	0	0	1
Total	**87**	**7**	**54**

5.2. Radiological features

5.2.1. Location

Thirty (20.3%) lesions involved only one region. Of these 30 lesions, only four (13.3%) presented anteriorly and 26 (86.7%) presented posteriorly. There were no lesions that presented in isolation in the ramus, coronoid and condyle.

One-hundred and eighteen (79.7%) lesions extended across multiple regions. Of the 118 lesions, 46 (39.0%) lesions affected both the anterior and posterior regions while two lesions (1.7%) affected the anterior, posterior and ramus region. Four lesions involved (3.4%) the anterior, posterior, ramus and coronoid regions. The posterior region and ramus were affected by 26 lesions (22.0%) with the posterior, ramus and coronoid being affected by 22 lesions (18.6%). The posterior, ramus, coronoid and condyle were involved 13 times (11.0%), and the ramus and coronoid as well as the ramus and condyle were only affected by one (0.8%) lesion each. Three (2.5%) lesions involved all five sites. Fifty-one lesions (34.46%) crossed the midline.

5.2.2. Radiodensity

Pantomographic examination revealed that 76 lesions (51.35%) had a radiolucent appearance and 71 (47.97%) lesions had both radiolucent and radiopaque features (mixed density) (Figures 5 & 6). Only one lesion (0.68%) had a radiopaque only appearance. This lesion was unilocular in appearance.

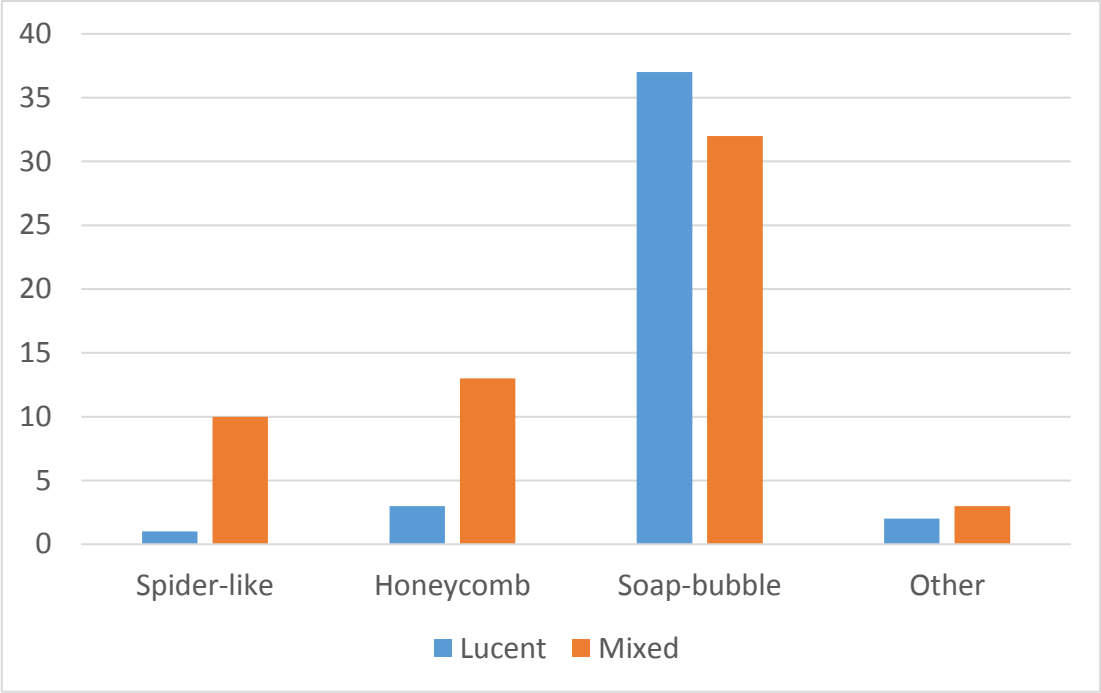


Figure 5: Bar graph comparing the density of ameloblastoma with its radiological pattern

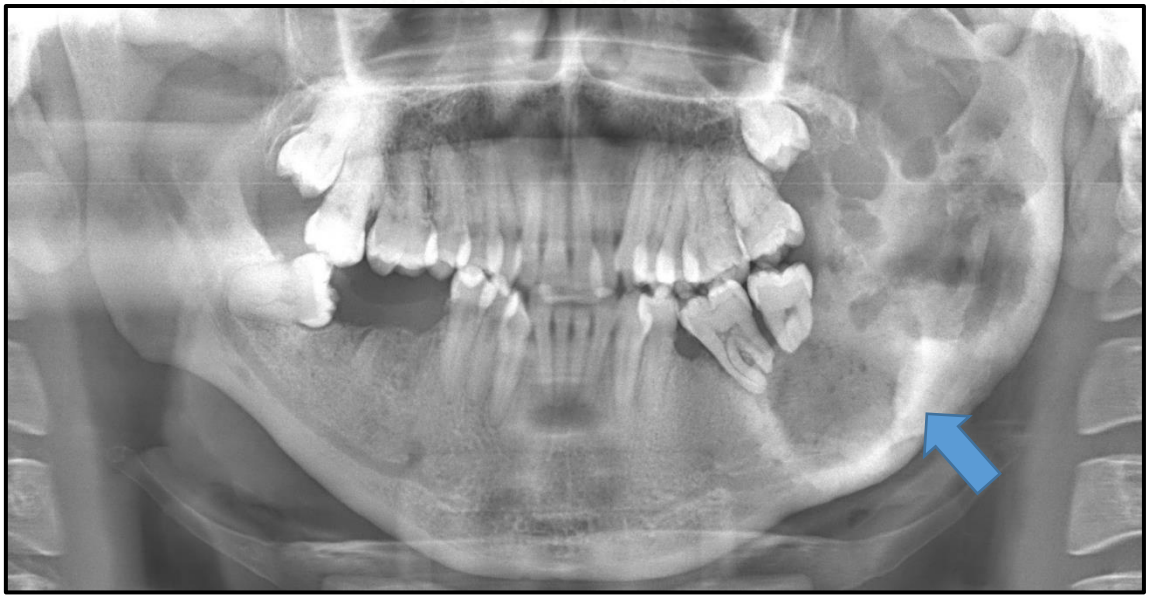


Figure 6: Pantomograph showing both radiolucent and radiopaque appearance (mixed density) of an ameloblastoma in the left mandible.

5.2.3. Margins

One hundred-and-eighteen (79.73%) lesions presented with well-defined margins discernable from the surrounding unaffected bone. The remaining 30 lesions (20.27%) presented with ill-defined margins.

5.2.4. Locularity

Approximately two-thirds (68.24%) appeared as a multilocular entity (Figure 7). The remaining 47 lesions (31.76%) appeared unilocular on a pantomograph (Figure 8). The majority of multilocular lesions (83.16%) were present in patients between the ages of 10 and 50 years. In contrast, more than half (61.70%) of unilocular lesions presented in patients below 30 years of age. However, there was no statistically significant association between loculation and age categories in ameloblastoma prevalence as assessed by Fisher's exact test ($p = 0.391$) (Table 3).

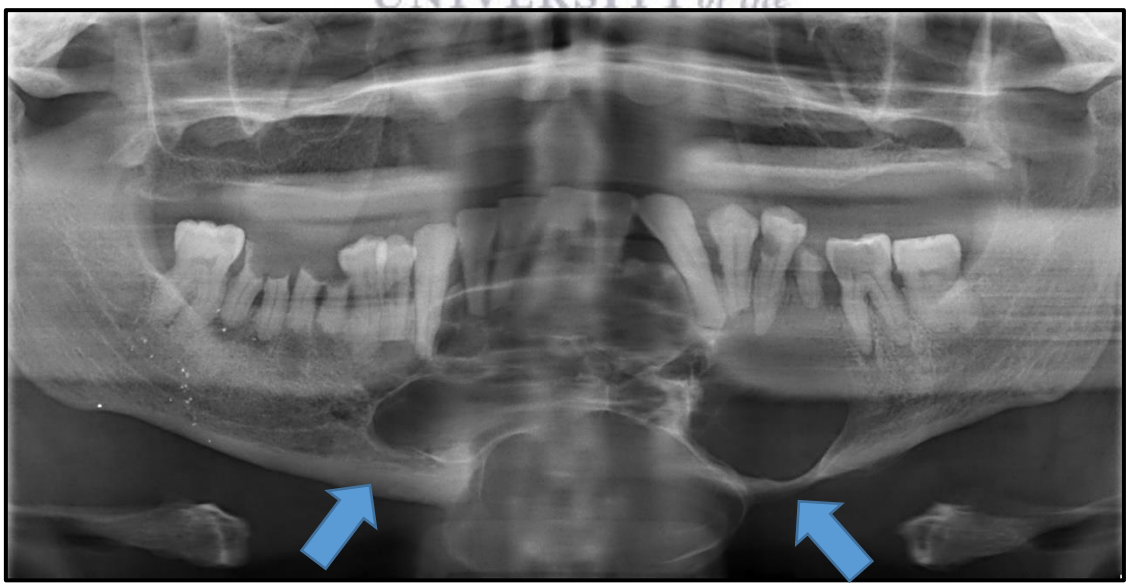


Figure 7: Multilocular appearance of an ameloblastoma in the anterior and posterior regions of the mandible.

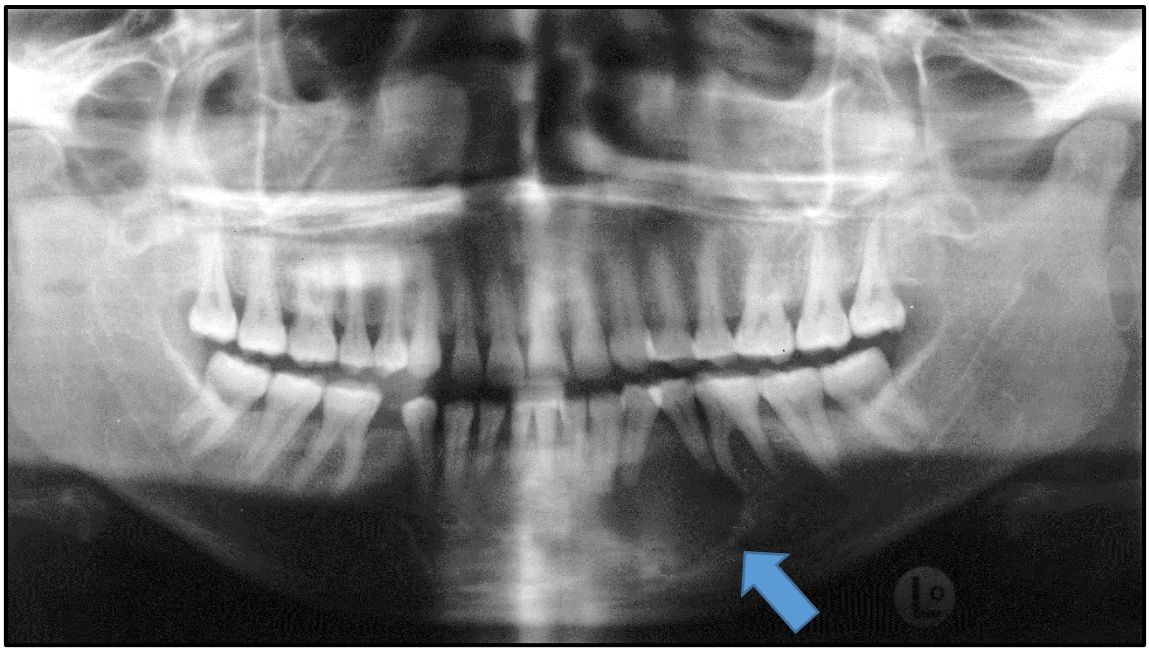


Figure 8: Pantomograph showing unilocular appearance of an ameloblastoma in the left posterior region of the mandible.

Table 3: Distribution of ages and radiographic locularity of ameloblastoma.

Age Group	Unilocular	Multilocular
10-19	14	15
20-29	15	33
30-39	4	21
40-49	7	15
50-59	4	9
60-69	2	5
70-79	1	2
80-89	0	1
Total	**47**	**101**

5.2.5. Multilocular appearance

Approximately two-thirds (68.32%) exhibited a soap-bubble appearance (Figure 9). Sixteen lesions (15.84%) showed a honeycomb pattern, with 11 lesions (10.69%) appearing spider-like (Figure 10). The remaining five lesions (4.95%) did not resemble any of the patterns stated above. Thus, the majority of multilocular lesions in this study had a soap-bubble pattern and appeared either as lucent or of mixed density and was statistically significant as assessed by Fisher's exact test ($p = 0.004$) (Table 4).

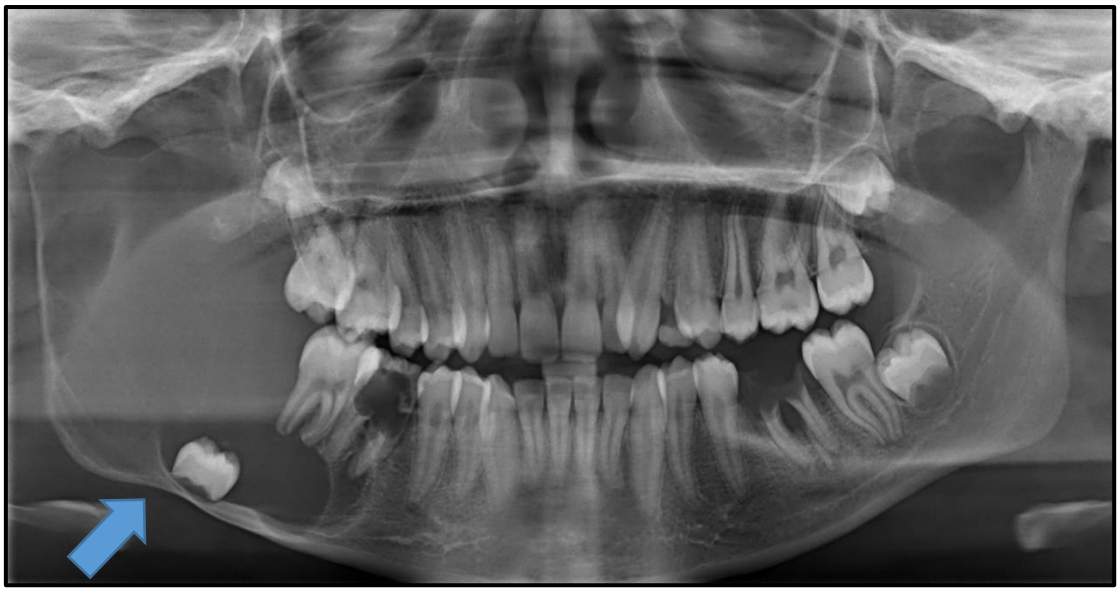


Figure 9: Pantomograph showing multilocular, soap-bubble appearance of an ameloblastoma in the right mandible.

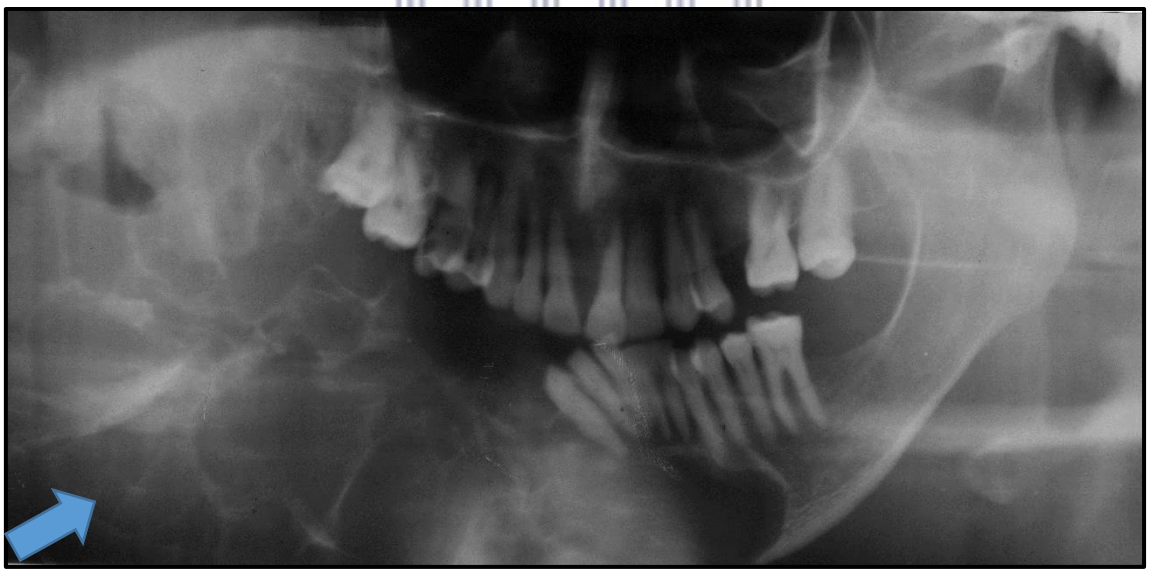


Figure 10: Pantomograph showing multilocular lesion with a spider-like appearance of an ameloblastoma in the mandible.

Table 4: Comparison of multilocular appearance and radiodensity on pantomograph

Multilocular appearance	Radiodensity		Total
	Lucent	Mixed	
Spider-like	1	10	11
Honeycomb	3	13	16
Soap-bubble	37	32	69
Other	2	3	5
Total	**43**	**58**	**101**

5.2.6. Effect on dentition

There was a nearly equal distribution between root resorption (26.72%) and root/tooth displacement (27.59%). Over a third (39.66%) of all lesions had the effect of causing both root resorption and root/tooth displacement. Only seven (6.03%) lesions had no effect on the adjacent dentition (Figure 11). In the remaining 32 cases (21.62%), there were no teeth present or in close proximity to the lesion.

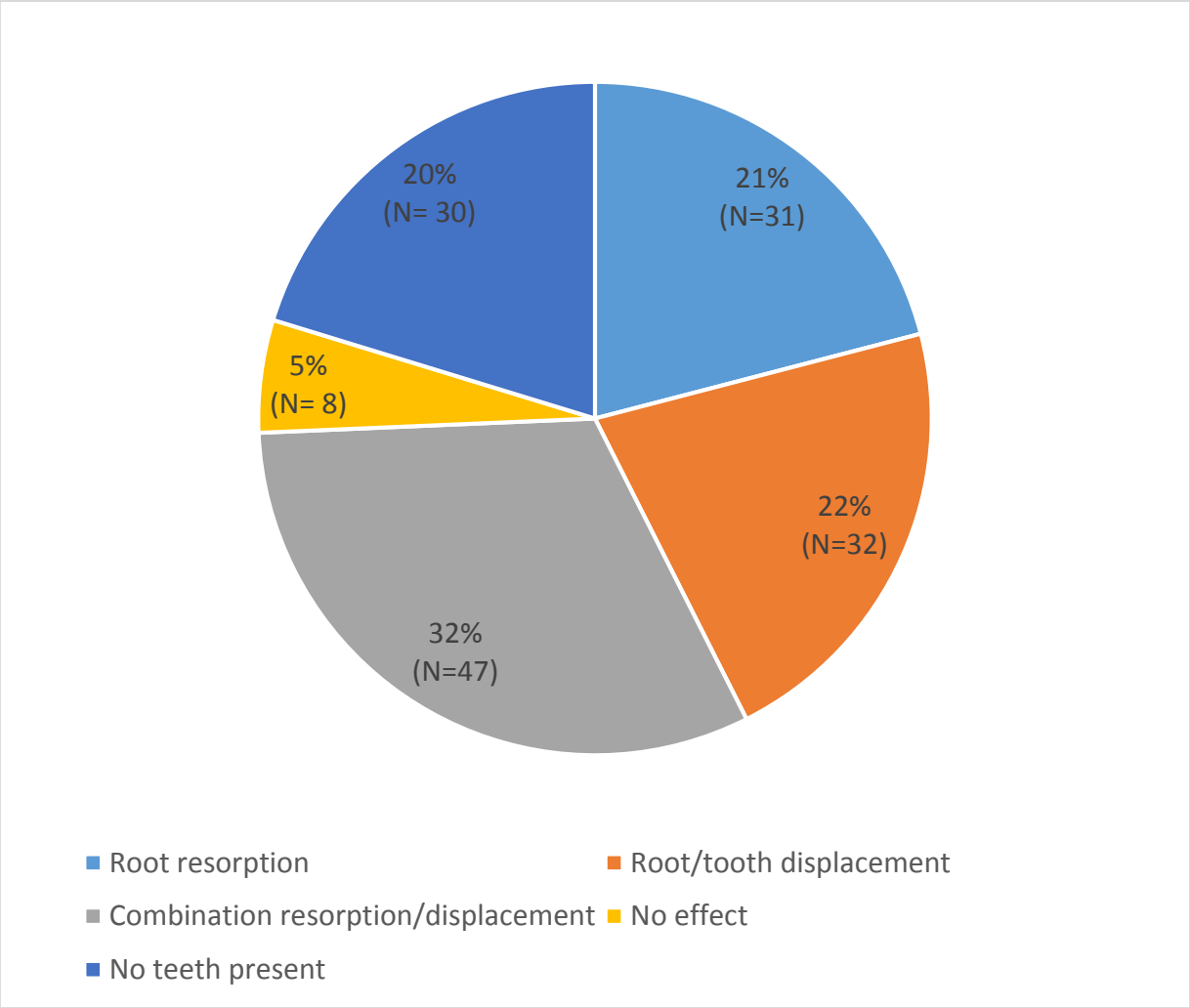


Figure 11: Pie chart showing the effect of unicystic and multicystic ameloblastomas on dentition

By comparing the multilocular appearance of ameloblastoma and its possible effects on the dentition, the association between the various radiological appearances of the multilocular lesions were shown not to have any statistically significant effect on the dentition, even though, the soap-bubble type of multilocular appearance was most evident (Figure 12). This was assessed by Fisher's exact test ($p = 0.56$) (Table 5).

Table 5: Multilocular appearance of ameloblastoma and its effects on dentition

Multilocular appearance	Effect on dentition					Total
	Root resorption	Root/Tooth displacement	Resorption and displacement	No effect	No teeth	
Spider-like	2	3	5	0	1	11
Honeycomb	4	3	4	0	5	16
Soap-bubble	15	12	24	3	15	69
Other	0	3	0	0	2	5
Total	**21**	**21**	**33**	**3**	**23**	**101**

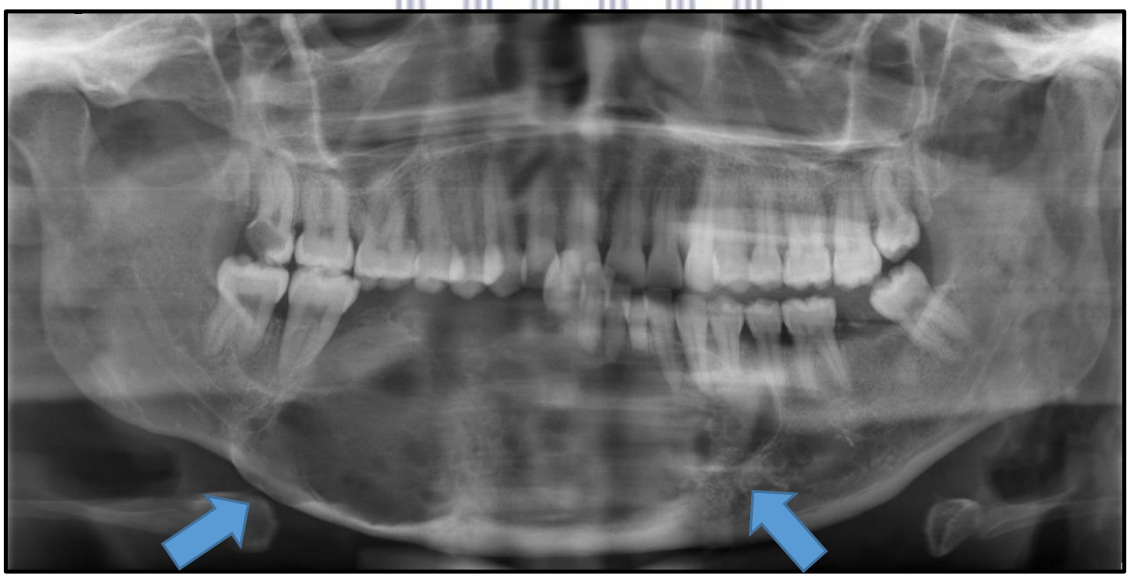


Figure 12: Pantomograph showing an ameloblastoma that crosses the midline causing root resorption and displacement of associated teeth.

5.2.7. Size

When measured from one border to the opposite border, the size of lesions on pantomographs ranged from 9 mm to 209 mm along the widest diameter. The mean size was 86.39 mm. One-way ANOVA was conducted to determine whether the size of the ameloblastoma differed among age groups. Data showed an even distribution for patient ages as assessed by the Shapiro-Wilk test ($p > 0.05$) (Figure 13). The differences between these age groups was not statistically significant ($p = 0.1598$).

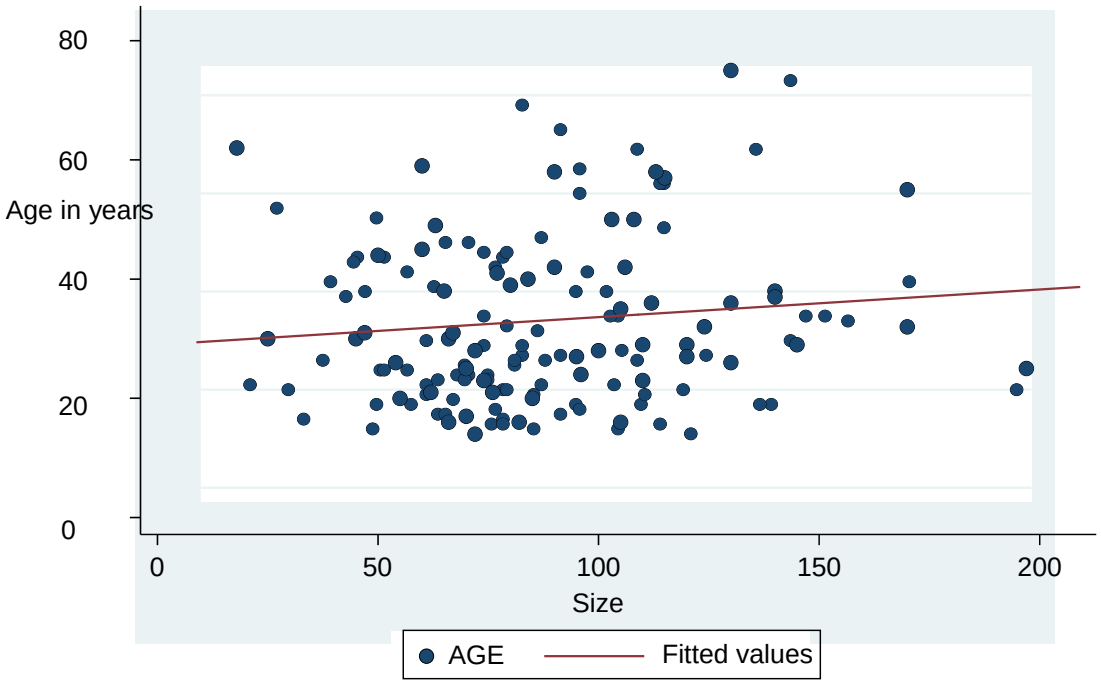


Figure 13: Scatterplot of size versus age in patients with ameloblastoma

A one-way ANOVA was conducted to determine if there was a difference in ameloblastoma sizes among the three different race groups in the study (Figure 14). Ameloblastoma size in the Black African group (mean 93.70mm) was significantly larger when compared to the mixed race group (mean 75.98mm) ($p = 0.018$).

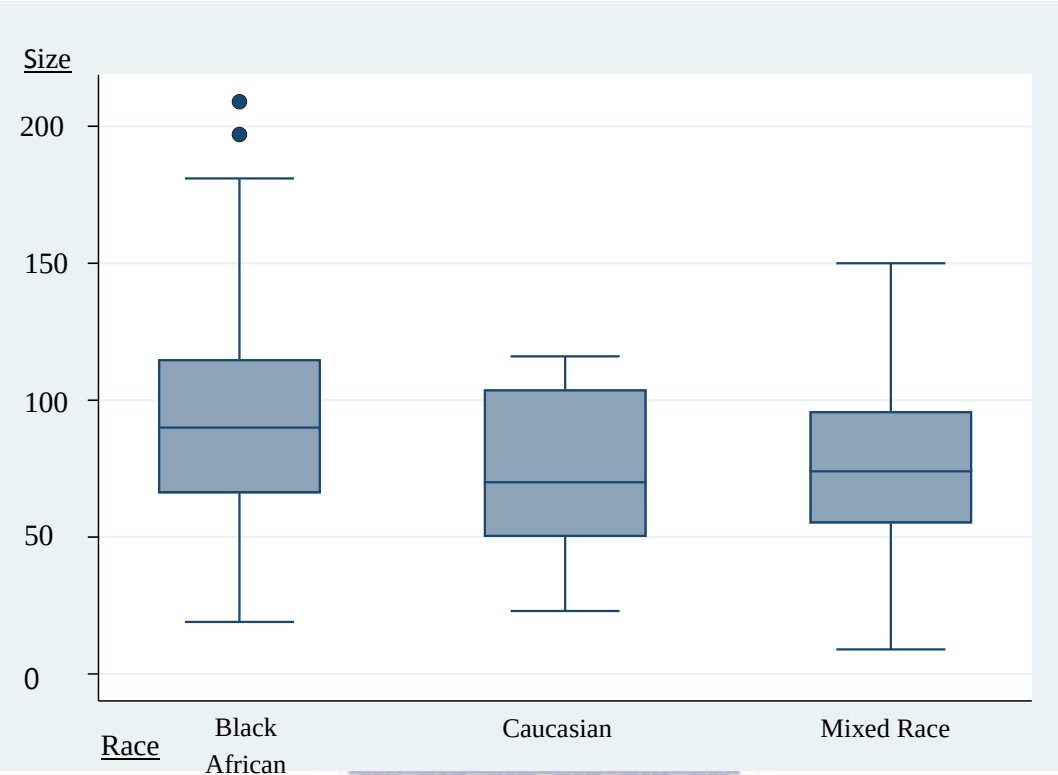


Figure 14: Box plot of size of ameloblastoma in relation to race

5.2.8. Expansion of the cortex

Ameloblastoma caused expansion of the mandibular cortex in 103 patients (69.59%).

5.3. Histopathological diagnosis

5.3.1. Conventional ameloblastoma

A total of 72 specimens (48.65%) were diagnosed as CA according to the WHO 2017 head and neck odontogenic tumour classification. The subtypes included 37 follicular, 12 plexiform (Figure 15), three acanthomatous, two granular cell (Figure 16) and two desmoplastic histopathological patterns.

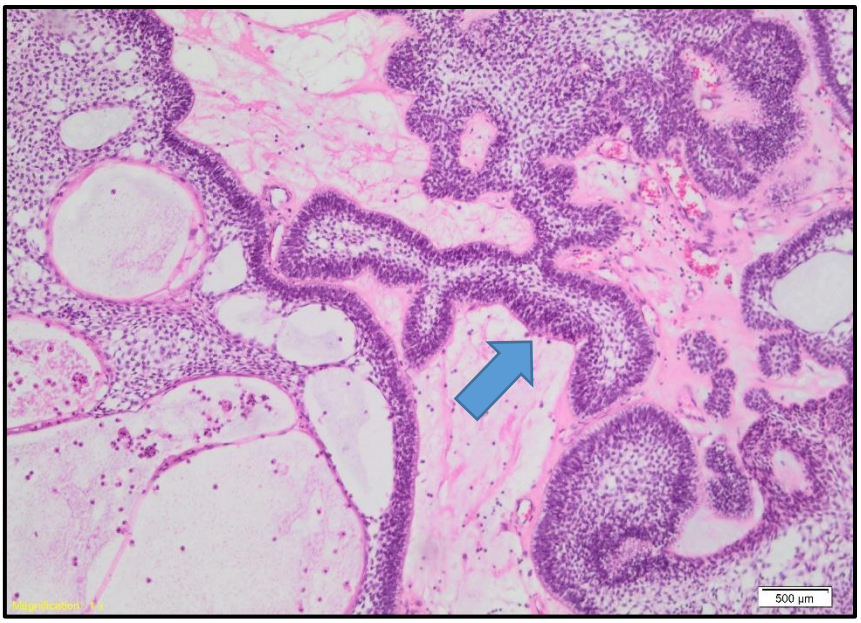


Figure 15: H&E stained specimen showing plexiform ameloblastoma.

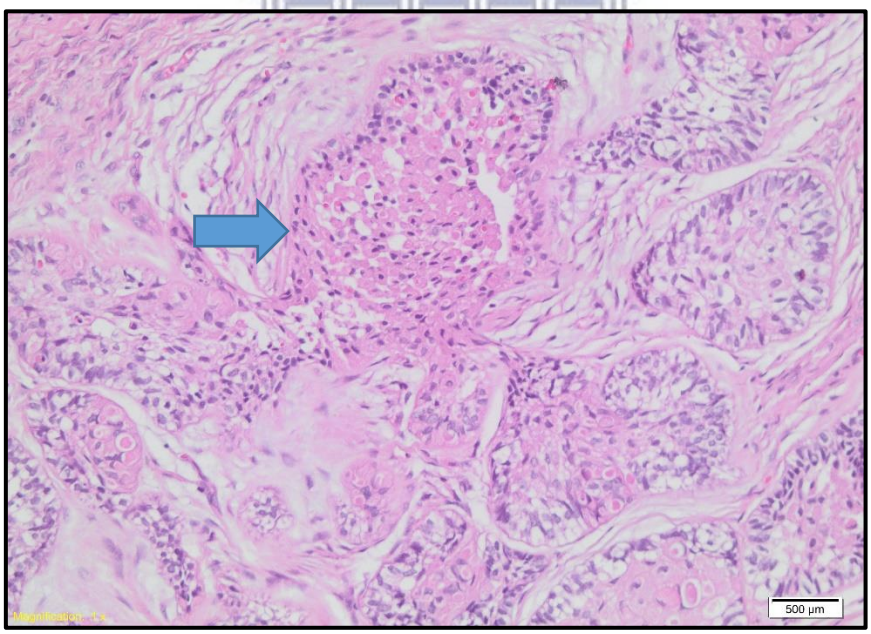


Figure 16: H&E stained specimen showing follicular ameloblastoma with granular cell change.

Certain patterns combined within one lesion. Combinations of histopathological subtypes comprised the following: - 10 follicular-plexiform (Figure 17), three follicular-plexiform-acanthomatous, two follicular-acanthomatous (Figure 18) and one plexiform-acanthomatous.

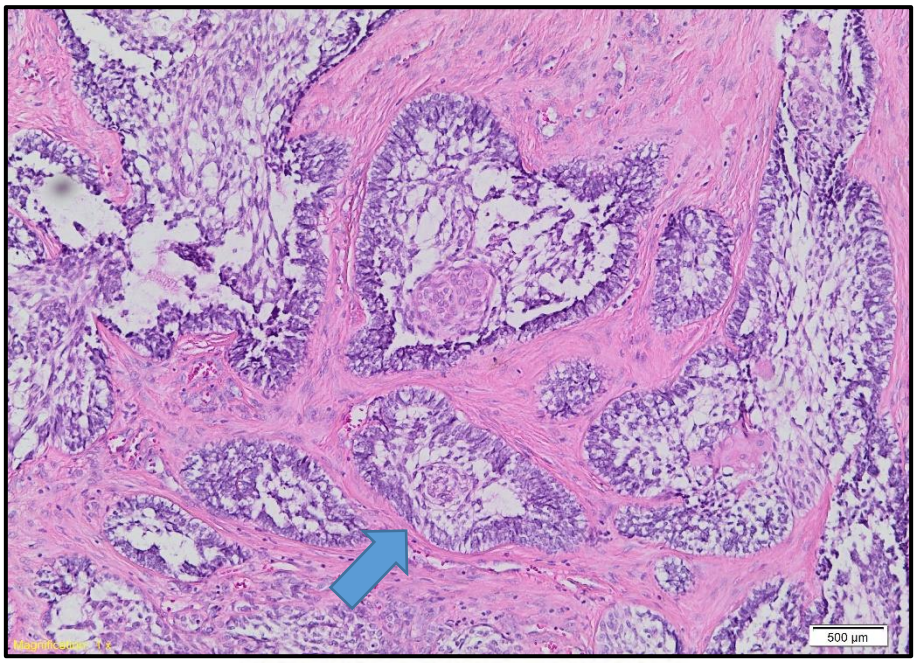


Figure 17: H&E stained specimen showing follicular-plexiform ameloblastoma.

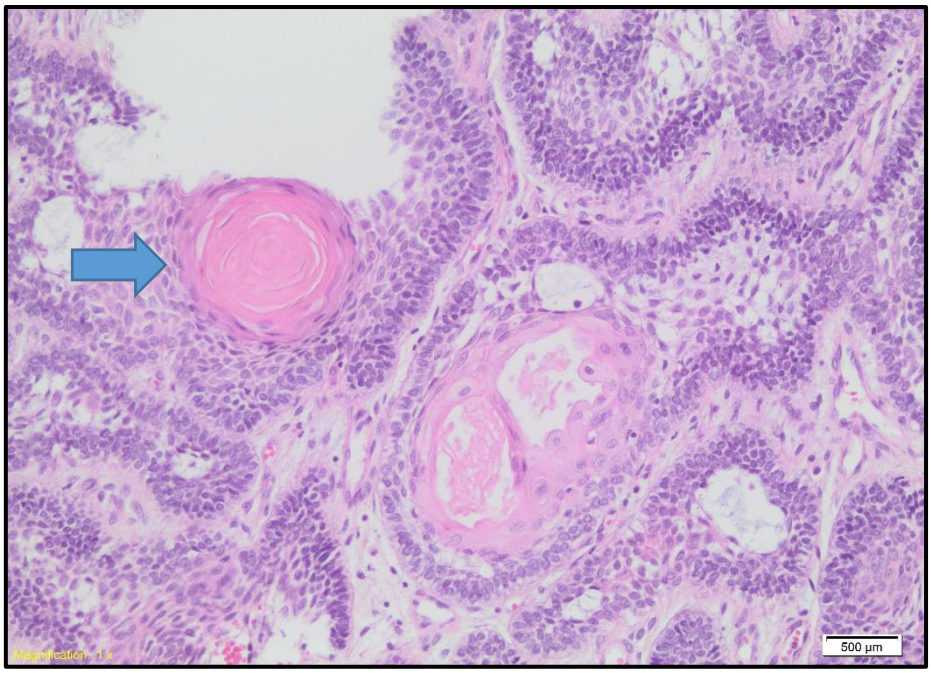


Figure 18: H&E stained specimen showing follicular ameloblastoma with acanthomatous change.

5.3.2. Unicystic ameloblastoma

Nineteen lesions (12.84%) were diagnosed as UA (Figure 19). The subtypes included the following: - seven mural, two luminal and two intraluminal. Eight tumours were classified as unspecified UA's.

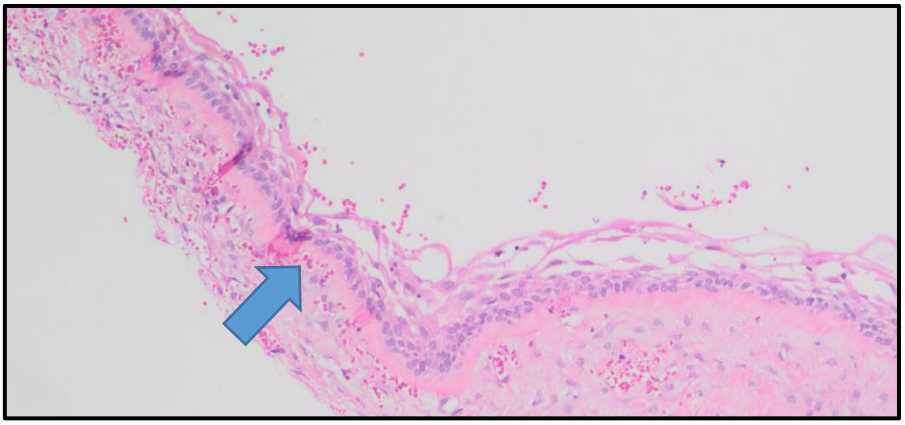


Figure 19: Low powered H&E stained specimen showing features of unicystic ameloblastoma.

5.3.3. Unspecified ameloblastoma

Fifty-seven (38.51%) histopathological reports did not specify the type, but the diagnosis of ameloblastoma was confirmed (Table 6).

Table 6: Histopathological types of ameloblastoma

Histopathological type	**No. of lesions**	**Percentage**
Conventional	72	48.65
Unicystic	19	12.84
Unspecified	57	38.51
Total	**148**	**100**

Chapter 6

DISCUSSION

This study entailed the recording of demographic information, radiological features and histopathological diagnosis of 148 patients with ameloblastoma in the mandible that presented at the Departments of Maxillo-Facial and Oral Surgery and of Diagnostics and Radiology at the University of the Western Cape Oral Health Centre. To the best of our knowledge, this is the largest descriptive study on ameloblastoma of the mandible undertaken in a South African population group.

Another study conducted in South Africa was by Shear and Singh (1978). They reported on 42 cases of ameloblastoma over a 10-year period. Over the last decade, the majority of studies have emanated from Indian and Nigerian units (Tatapudi *et al*. 2018, Oginni *et al*. 2015, Bassey *et al*. 2014, Chawla *et al*. 2013).

When one compares the results of this study to the findings in studies of other population groups, a number of similarities as well as a few differences emerge. These comparisons will be discussed further.

6.1. Demographic information

6.1.1. Age

The wide age range (11-83 years) presented in this study is comparable to other studies (Agbaje *et al.* 2018, Siar *et al.* 2012, Reichardt *et al.* 1995). This age range is also demonstrated in a systematic review by MacDonald-Jankowski *et al.* in 2004.

The mean age of patients in this study was 32.99 years. Krishnapillai *et al.* (2010), who conducted a study on an Indian population group, showed similar results. Furthermore, this result is supported by a large review of 2444 cases involving mandibular ameloblastomas by Reichardt *et al.* (1995), which showed a mean age of 35.2 years old. In contrast, in another Indian study, More *et al*. (2012) showed a slightly higher mean age of 39.81 years. This discrepancy in mean age may have been due to the small sample size in the study by More *et al.* (2012).

6.1.2. Gender

A nearly equal distribution between males and females was found in this study as well as in a study by Chukweneke *et al.* (2016). In contrast, a slight male predilection was shown in studies by Chawla *et al.* (2013), Siar *et al.* (2012) and More *et al*. (2012), with ratios of male and female patients being 1.2:1, 1.4:1 and 1.2:1, respectively. Interestingly, the current study showed that more than double the number of male patients (18) compared to female patients (8) presented with this lesion in the 40-49 year age group. This is possibly due to the inherent culture of male patients seeking professional medical assistance later in the disease process than their female counterparts (Thompson *et al.* 2016).

6.1.3. Ethnicity

More than half of all patients (58.8%) that presented with ameloblastoma of the mandible in this study were of Black African descent. Even though the mixed race population is in the majority in the Western Cape, this study shows that ameloblastomas tend to occur more often in the Black African population than in the other Western Cape population groups. This result concurs with the only other study undertaken in South Africa (Shear and Singh 1978). In saying this, the University of the Western Cape Oral Health Centre received referrals from as far as the Eastern Cape and Namibia. Therefore, this may not have been accurately representative of the Western Cape population. Reviews by Macdonald-Jankowski *et al.* (2004) and Reichardt *et al.* (1995) also show that this tumour has a predilection for Black population groups. Oginni *et al.* (2015) tend to disagree with this notion.

6.2 Radiological presentation

Radiological investigation forms an integral part in formulating a diagnosis. The Department of Maxillo-Facial and Oral Surgery at the University of the Western Cape utilizes, in addition to conventional radiography, advanced digital imaging modalities (CBCT and/or CT and/or MRI) for the radiological investigation of bony pathology.

When assessing ameloblastoma of the mandible, these modalities are invaluable in determining the size, extent, internal structure, margins and its effect on adjacent structures. In the age of advanced digital imaging, conventional radiography may appear outdated. However, in a rural setting or developing world, where advanced technology is

unavailable or is too costly to implement, it still provides adequate information to assist in provisional diagnosis prior to histopathological confirmation.

6.2.1 Location

Large reviews by Agbaje *et al.* (2018), Ruslin *et al.* (2018), Siar *et al.* (2012), Reichardt *et al.* (1995) and Small and Waldron (1955) show that the mandibular posterior region is the site most commonly affected by ameloblastoma. The results from this study corroborates these findings. However, Chukweneke *et al.* (2016), Adekeye *et al.* (1980) and Akinosi *et al.* (1969) showed that the anterior region was more commonly involved. The reason for the difference in location in various population groups is largely unknown and may be influenced by ethnic and geographical differences in the histological and molecular characteristics of the tumour.

6.2.2 Radiodensity

This study showed nearly an equal distribution between lesions that had a radiolucent and a radiolucent-radiopaque (mixed) appearance. This is in vast contrast to the results shown in a systematic review by Macdonald-Jankowski *et al.* (2004), in which a radiolucent appearance predominated. Siar *et al.* (2012) also showed that a large proportion of lesions were radiolucent as opposed to being mixed. Mixed lesions are frequently seen in the desmoplastic subtype of conventional ameloblastoma (Goaz *et al*. 1997). The reason for the large percentage of patients in this study having a mixed density is unknown, as only two lesions were of the desmoplastic subtype.

6.2.3 Margins

A large percentage of lesions found in this study showed well-defined, corticated borders and were easily identifiable from the adjacent, unaffected bone. Malik *et al.* (2018) and More *et al.* (2012) also reported a high proportion of these lesions showing this feature. The majority of tumours that exhibited ill-defined margins were associated with larger lesions. These lesions appeared to destroy the cortices and involve the surrounding soft tissue. It may be argued that, due to the expansile nature of this tumour, larger lesions tend to destroy the cortex, which in turn gives rise to an ill-defined margin.

6.2.4 Locularity

In this study, just over two-thirds of lesions appeared as multilocular entities. This is comparable to other studies (Intapa 2017, Chawla *et al.* 2013, Ogunsalu *et al.* 2006). However, the data in the literature are conflicting. Some studies (as above) indicate a multilocular predominance, whereas others (Tatapudi *et al.* 2018, Kim and Jang 2001), show that the unilocular appearance is more prevalent.

Even though the Fisher's exact test found no statistically significant association (p=0.391) between the loculation and age of the patient, it is evident from this sample that in a younger age category, the majority of lesions appeared as unilocular entities as opposed to multilocular lesions. Tatapudi *et al.* (2018) also showed that the unilocular entity occurs at a younger age when compared to the multilocular variety.

6.2.5. Multilocular appearance

According to Worth (1963), the "spider-like" pattern is the most common radiological appearance. This is followed by the "soap-bubble" pattern. However, in the current study the "soap-bubble" pattern predominated (68.32%). The "spider-like" pattern was present in only a small percentage (10.69%) of lesions seen. In addition, the "soap-bubble" pattern presented almost equally in both radiolucent and radiolucent-radiopaque (mixed) lesions.

6.2.6. Effect on dentition

Considering that 21.62% of lesions presented in edentulous regions of the mandible, those that caused root resorption in isolation or in combination with tooth displacement amounted to a substantial proportion (66.38%). In a study by Struthers and Shear (1976), it was shown that the incidence of root resorption in association with ameloblastomas was high (81%). Therefore, the inclusion of ameloblastoma as part of a differential diagnosis is paramount when root resorption occurs in the presence of a cystic lesion, especially if the posterior region of the mandible is involved.

Low cystic pressure described by Toller (1948) may be involved in inducing root resorption of teeth when associated with ameloblastoma. Tooth displacement may be related to other factors in addition to cystic pressure. These factors may be attributed to the expansile nature and associated bone loss that occurs with ameloblastoma. One may hypothesise that higher cystic pressures may contribute to tooth displacement in addition to root resorption.

6.2.7. Size

A study by Fulco *et al.* (2010) reported the average size of ameloblastoma as 43 mm. Results from this study showed that the average size of lesions (86.39mm) was more than double the average size (43 mm) reported in the literature. This difference in size could possibly be attributed to late presentation as a result of limited access to advanced healthcare.

6.3. Histopathological diagnosis

Amongst the histopathological subtypes in this review, the CA was encountered most frequently (48.65%). Within this subtype, the follicular variant was predominant (51.39%). This is in accordance with other studies in the literature (Chukweneke *et al.* 2016, Fulco *et al.* 2010). The plexiform variant was the second most prevalent (16.66%) in this study. In contrast, Saghravanian *et al.* (2016) showed that the plexiform pattern was the most commonly occurring variant (41.93%).

Only a small percentage (12.84%) of lesions were diagnosed as UA's. However, Tatapudi *et al*. (2018), Chawla *et al*. (2013) and Krishnapillai (2010) showed that UA presented respectively in 37%, 34% and 36% of specimens. According to their results, the UA was the most commonly occurring subtype.

This study showed a substantial percentage (38.51%) of lesions that were histopathologically diagnosed as unspecified ameloblastoma, This finding could be

explained by referring to Adebiyi *et al*. (2006) and Waldron and El-Mofty (1987) who reported that ameloblastomas are made up of a variety of histological patterns. According to them, this is especially true for large ameloblastomas.

Chapter 7
LIMITATIONS

This retrospective study dates back to 1972. Thus, the radiographic quality could not be standardised. Conventional plain film in addition to digital panoramic machines were used and the radiation exposure varies with each image. Routine panoramic radiography forms part of the diagnostic investigation for screening for pathology. However, panoramic radiography cannot discern between certain lesions that resemble ameloblastomas. These include odontogenic keratocyst, fibromyxoma, fibrosarcoma, haemangioma, aneurysmal bone cyst and giant cell tumour. In addition, other limitations include the inadequate visualisation of bony margins of the tumour, as well as obscurity at the interface between the tumour and normal soft tissue. Furthermore, ameloblastomas have a tendency to cause perforation of the cortex, which is an important feature when formulating a differential diagnosis. This feature cannot always be visualised by conventional radiography (Apajalahti *et al* 2015). CBCT, CT and MRI are far superior in showing these important diagnostic features (Apajalahti *et al.* 2015). Another drawback of conventional radiography is the inability to assess the internal contents of the lesion. Contrast-enhanced CT and MRI are modalities, which are helpful in this regard (Ariji *et al* 2011). Even though advanced imaging is desired, in most instances it is not achievable due to the lack of availability and high cost.

Another limitation of this study includes the large number of lesions diagnosed histologically as unspecified ameloblastoma. The majority of this information was

retrieved from histopathological reports stored in the archives of the Departments of Maxillo-Facial and Oral Surgery and of Diagnostics and Radiology at the University of the Western Cape Oral Health Centre. The original specimens were not re-examined to provide a more detailed diagnosis as this study was a records-based review. Advanced imaging modalities were not used in this study. These modalities may have provided additional information to enable a more specific diagnosis. In the current study, the pantomographic size of the lesions was recorded. Because pantomographic machines may differ in magnification and that pantomographs were recorded on a variety of machines in the study, the measurement of size could not be regarded as absolutely accurate and could thus be seen as a limitation.

Chapter 8

CONCLUSION

In this study, ameloblastoma presented more often in the Black African population group, had a very slight male predilection and occurred more frequently in patients below 50 years of age. It was found to favour the posterior region of the mandible. If left untreated, these tumours are capable of causing grotesque facial expansion. Radiographically, the majority of lesions occurred in the posterior region of the mandible, were well-defined and had a multilocular appearance. Histologically, the conventional ameloblastoma presented more frequently, with the follicular pattern being the most common subtype.

Panoramic radiographs serve as an important diagnostic aid for numerous lesions that present in the maxillofacial region. This diagnostic adjunct is especially valuable for those lesions that involve bone especially when advanced imaging is not available. Radiologically, ameloblastoma of the mandible presents with certain distinct features that are evident on conventional radiography. This study indicates that one should suspect an ameloblastoma when these features occur; however, the final diagnosis is dependent on histopathological confirmation.

Chapter 9

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APPENDIX 1

Data Collection Sheet

1. Record number				
2. Folder number				
3. Age				
4. Gender	M (1)		F (2)	
5. Race	Black African (1)	Caucasian (2)	Mixed race (3)	Indian (4)
6. Location:	Anterior	Posterior	Ramus	
			Coronoid	Condyle
7. Size (mm)				
8. Radiodensity	Opaque (1)	Lucent (2)	Mixed (3)	
9. Margins of lesion	Well-defined (1)		Ill-defined (2)	
10. Loculation	Unilocular (1)		Multilocular (2)	
11. Multilocular appearance	Spider-like (1)	Honeycomb (2)	Soap-bubble (3)	Other (4)
12. Effect of dentition	Root resorption (1)	Tooth/Root displacement (2)		Combination (3)
13. Expansion of cortex	Yes (1)		No (2)	
14. Histopathological diagnosis	Conventional	Unicystic	Unspecified	
15. Crossing midline	No (1)	Yes (2)		

APPENDIX 2

Permission to access information

Faculty of Dentistry & WHO Oral Health Collaborating Centre,
University of the Western Cape

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South Africa
Telephone: +27 21 937 3087/6
Fax: +27 0865156459

The Dean's Office

Prof Y Osman/ Prof ME Parker

Faculty of Dentistry

UWC

Dear Professors

REQUEST FOR PERMISSION TO ACCESS PATIENT INFORMATION

I am a registered Master's student in the Department of Maxillo-Facial and Oral Surgery at the University of the Western Cape. My supervisor is Prof JA Morkel.

The proposed topic of my research is "AMELOBLASTOMA OF THE MANDIBLE: A RADIOLOGICAL AND CLINICAL STUDY AT THE UNIVERSITY OF THE WESTERN CAPE ORAL HEALTH CENTRE."

The objectives of the study are to describe the radiographic features and evaluate the possible association between the demographic profile of patients and histopathological diagnosis in patients presenting with ameloblastoma.

I am hereby requesting your permission to access patient data in respect of demographic, clinical, radiological and histopathological information. To assist you in reaching a decision, the following ethical considerations will be adhered to:-

- The patient's file number and identifiable patient data (names, date of birth, addresses, etc.) will not be recorded in the study.
- The data that will be utilised to maintain anonymity will be the patient's record number. This number will be used for record purposes only and will only be kept for the duration of the study.
- Patient records will be stored on a password protected computer and printed information will be stored in a locked office.
- Radiographs displayed in this study will not jeopardise the patient's identity, and if clinical photos are used to display the lesion, prior consent will be obtained from the patient.

Should you require any further information, please do not hesitate to contact me.

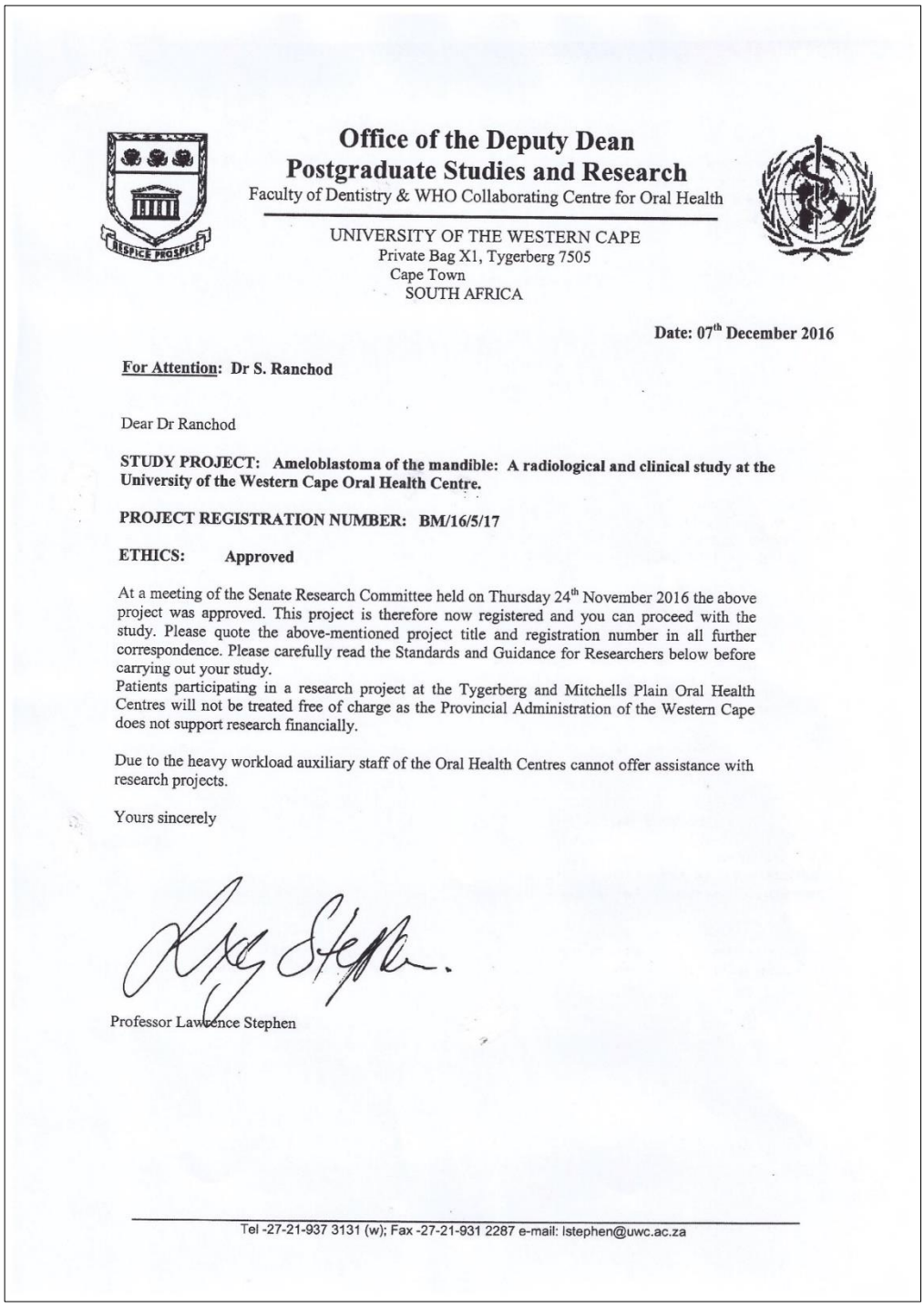
Your permission to access this information will be appreciated.

Yours sincerely

Sanjay Ranchod

APPENDIX 3

Ethics approval and project registration number



Office of the Deputy Dean
Postgraduate Studies and Research
Faculty of Dentistry & WHO Collaborating Centre for Oral Health

UNIVERSITY OF THE WESTERN CAPE
Private Bag X1, Tygerberg 7505
Cape Town
SOUTH AFRICA

Date: 07th December 2016

For Attention: Dr S. Ranchod

Dear Dr Ranchod

STUDY PROJECT: Ameloblastoma of the mandible: A radiological and clinical study at the University of the Western Cape Oral Health Centre.

PROJECT REGISTRATION NUMBER: BM/16/5/17

ETHICS: Approved

At a meeting of the Senate Research Committee held on Thursday 24th November 2016 the above project was approved. This project is therefore now registered and you can proceed with the study. Please quote the above-mentioned project title and registration number in all further correspondence. Please carefully read the Standards and Guidance for Researchers below before carrying out your study.
Patients participating in a research project at the Tygerberg and Mitchells Plain Oral Health Centres will not be treated free of charge as the Provincial Administration of the Western Cape does not support research financially.

Due to the heavy workload auxiliary staff of the Oral Health Centres cannot offer assistance with research projects.

Yours sincerely

Professor Lawrence Stephen

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