T.C.
YEDİTEPE UNIVERSITY
INSTITUTE OF HEALTH SCIENCES
DEPARTMENT OF ORAL AND MAXILLOFACIAL SURGERY

EVALUATION OF JAW CYST SHRINKAGE IN THE POSTERIOR MANDIBLE AFTER DECOMPRESSION THERAPY WITH CONE BEAM COMPUTED TOMOGRAPHY: 3D VOLUMETRIC ANALYSIS

DOCTOR OF PHILOSOPHY THESIS

BURAK SAYDAM, DDS, MSc.

İSTANBUL-2024

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DECLARATION

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree except where due acknowledgment has been made in the text.

Burak SAYDAM

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SYMBOLS AND ABBREVATIONS

%: Percentage

CT: Computed Tomography

DICOM: Digital Imaging and Communications in Medicine

CBCT: Cone-Beam Computed Tomography

3D-CT: Three-dimensional Computed Tomography

2D: Two-Dimensional

3D: Three-Dimensional

PGE-2: Prostaglandin-2

PGE-3: Prostaglandin-3

WHO: World Health Organization

PC: Paradental Cyst

MBBC: Mandibular Buccal Bifurcation Cyst

CE: Cemento Enamel

OKC: The Odontogenic Keratocyst

KOT: Keratinizing Odontogenic Tumor

KCOT: Keratinizing Cystic Odontogenic Tumor

NBCCS: Nevoid Basal Cell Carcinoma Syndrome

PCNA: Proliferating Cell Nuclear Antigen Marker of Cell Replication

MSCT: Multiple Sliced Computed Tomography

OPT: Orthopantomography

FOV: Field of view

TMJ: Temporomandibular Joint

ETC: Et cetera

JPEG: Joint photographic experts group

TIFF: Tagged image file format

DCM: Digital Imaging and Communications in Medicine

RS: Rate of Shrinkage

IT: Information Technology

HU: Hounsfield unit

mm^3: Cubic millimeters

PRV: Percentage Reduction in the Volume

IBM: International Business Machines

SPSS: Statistical Package for the Social Sciences

RVS: Relative Velocity of Shrinkage

AVS: Absolute Velocity of Shrinkage

IAN: Inferior Alveolar Nerve

ABSTRACT

SAYDAM B. 2024. Evaluation of Jaw Cyst Shrinkage in the Posterior Mandible after Decompression Therapy with Cone Beam Computed Tomography: 3D Volumetric Analysis. Yeditepe University Institute of Health Sciences, Department of Oral and Maxillofacial Surgery, Doctorate Thesis, Istanbul.

The aim of this study was to evaluate volume reduction after decompression therapy in cyst patients and assess the correlation between several parameters with volume reduction and bone healing and formation using Cone-Beam Computed Tomography (CBCT). For the sampling, the CBCT images of the patients with the diagnosis 'cyst' between the years 2011 and 2023 were retrieved from the archives of the Department of Dentomaxillofacial Radiology at Yeditepe University, the Faculty of Dentistry. Three hundred and sixty-five scans were reviewed initially. All scans were taken using the same imaging device (i-CAT Imaging Science International, Inc. Hatfield, PA, USA). Based on inclusion and exclusion criteria and G power analysis carried out based on the published study of ***U. Consolo et al.***, 12 patients were considered eligible for the study. The software Mimics 20.0 (Materialize Medical, Leuven, Belgium) was used to measure the volume of the cystic lesion. The CT digital imaging and communication in medicine (DICOM) datasets were imported into the program and sliced in the axial, coronal, and sagittal planes. The cross-section of the lesion was delineated on CT images, and the delineated images were then integrated to reconstruct three-dimensional structures prior to volumetric analysis. Then the program automatically calculated the cyst volumes. Among 12 patients (8 keratocyts and 4 dentigerous cysts), it was determined that all patients had a decrease in cyst volumes after treatment ($p<0,05$). Patients were classified according to gender, age, initial volume of the lesion, duration, presence of involved teeth, cortical bone expansion, cortical bone perforation, smoking, drain localization, drain type, extraction and pathological diagnosis. Considering all these parameters, it was found that there was no correlation or statistically significant difference between these parameters and volume reduction of cystic lesions ($p>0,05$). In conclusion, CBCT plays an important role in detecting and evaluating cystic lesion shrinkage after decompression therapy and to determine the right time for enucleation. In addition, the results obtained in the study revealed that decompression treatment was effective in causing changes in the procedures

and behaviors of the cyst and reducing the complications that may arise during and after the treatment.

Keywords: *Cyst, Odontogenic Cyst, Decompression, CBCT*

ÖZET

SAYDAM B. 2024 Mandibula Posterior Bölgedeki Çene Kistlerinin Dekompresyon Tedavisi Sonrası Küçülmesinin Konik Işınlı Bilgisayarlı Tomografi ile Retrospektif Olarak Değerlendirilmesi. Yeditepe Üniversitesi Sağlık Bilimleri Enstitüsü Ağız, Diş ve Çene Cerrahisi Doktora Tezi, İstanbul.

Bu çalışmanın amacı, kist hastalarında dekompresyon tedavisi sonrası hacim azalmasını değerlendirmek ve Konik Işınlı Bilgisayarlı Tomografi (KIBT) kullanarak hacim azalması ve kemik iyileşmesi ve oluşumu ile çeşitli parametreler arasındaki ilişkiyi değerlendirmektir. Örneklem için Yeditepe Üniversitesi Diş Hekimliği Fakültesi Ağız, Diş ve Çene Radyoloji Anabilim Dalı arşivinden 2011-2023 yılları arasında 'kist' tanısı konulan hastaların KIBT görüntüleri alındı. Başlangıçta üç yüz altmış beş tarama incelendi. Tüm taramalar aynı görüntüleme cihazı (i-CAT Imaging Science International, Inc. Hatfield, PA, ABD) kullanılarak yapıldı. Dahil etme ve hariç tutma kriterlerine ve U. Consolo ve arkadaşlarının yayınlanmış çalışmasına dayanarak gerçekleştirilen G gücü analizine dayanmaktadır. 12 hasta çalışmaya uygun görüldü. Kistik lezyonun hacmini ölçmek için Mimics 20.0 yazılımı (Materialize Medical, Leuven, Belçika) kullanıldı. BT dijital görüntüleme ve tıpta iletişim (DICOM) veri kümeleri programa aktarıldı ve eksenel, koronal ve sagittal düzlemlerde dilimlendi. Lezyonun enine kesitinin sınırları BT görüntülerinin dilimleri üzerinde belirlendi ve sınırları çizilmiş görüntüler hacimsel ölçümden önce 3 boyutlu yapıları yeniden oluşturmak için dolduruldu. Daha sonra program kist hacimlerini otomatik olarak hesapladı. 12 hastadan (8 keratokist ve 4 dentigeröz kist) tüm hastaların tedavi sonrası kist hacimlerinde azalma olduğu belirlendi ($p<0,05$). Hastalar cinsiyet, yaş, lezyonun başlangıç hacmi, süresi, ilgili diş varlığı, kortikal kemik genişlemesi, kortikal kemik perforasyonu, sigara kullanımı, drenin lokalizasyonu, drenin tipi, çekimi ve patolojik tanıya göre sınıflandırıldı. Tüm bu parametreler dikkate alındığında bu parametreler ile kistik lezyonlardaki hacim azalması arasında korelasyon olmadığı veya istatistiksel olarak anlamlı bir fark olmadığı belirlendi ($p>0,05$). Sonuç olarak, KIBT, dekompresyon tedavisi sonrası kistik lezyondaki küçülmenin saptanması, değerlendirilmesi ve enükleasyon için doğru zamanın belirlenmesinde önemli bir rol oynamaktadır. Ayrıca çalışmada elde edilen sonuçlar, dekompresyon tedavisinin kistin işlem ve davranışlarında değişiklik yaratmada, tedavi

sırasında ve sonrasında ortaya çıkabilecek komplikasyonları azaltmada etkili olduğunu ortaya koydu.

Anahtar kelimeler: *Kist, Odontogenik Kist, Dekompresyon, KIBT*

1. INTRODUCTION AND PURPOSE

Cysts represent one of the commonest lesions observed in the Orofacial region. They are more commonly identified in the maxilla and mandible than in other anatomical regions (1-3). A cyst is defined as a pathological epithelial cellular cavity, composed of liquid or semisolid substance. While cyst removal is indicated, enucleation of these lesions carries the risk of infection, jaw fracture, or nerve injury (4-7).

Although distinct procedures, marsupialization and decompression are based on the same fundamental principle. Marsupialization involves forming a huge opening in osseous tissue, subsequently attaching the intra cystic wall to the oral environment. This results in a lesion with a large surface area that drains effectively. In contrast, decompression involves making a small incision in the cyst and anchoring a catheter or stent for sewerage and soaking (5, 8, 9).

With decompression therapy, jaw cyst lesions can be treated with minimally invasive approach with considerable successful results with the benefit of maintenance of preserving the tooth vitality, periodontal support of teeth closed to the cyst, to avoid harming the inferior alveolar nerve, antrum, nasal structures, evolving tooth and to prevent osseous fracture.

Two-dimensionally (2D) evaluation of a space which is a three-dimensional (3D) structure, would be potentially limited and prone to errors. Three-dimensional computed tomography (3D-CT) enables the accurate and dependable measurement of diameters and volumes, as well as the delineation of lesion and displaced tooth borders. Additionally, it facilitates the visualization of the lesion's relationship with vital organs and anatomical structures. In this regard, a 3D volumetric evaluation appears as a more eligible option to better assess these structures. Although the computed tomography (CT) is considered the golden standard, it brings about a high radiation dose which is a significant disadvantage, especially for children. Furthermore, cone beam computed tomography (CBCT), is also replacing CT in various studies, due to its several advantages. With the increased usage of CBCT in dentistry, more cyst patients are undergoing CBCT scanning before decompression treatment. The CBCT image provides a 3D view by allowing visualization of structures in all three planes (2,6,10).

To our knowledge, there are few recent studies about 3D evaluation of jaw cyst reduction after decompression therapy. In recent studies, there were certain variables that authors investigated whether these variables have an effect on the volume reduction of jaw cystic lesions. There are few studies in the literature about this certain topic. Further research is required to evaluate the volume reduction correlated with different parameters.

The aim of this study was to evaluate the effectiveness of decompression therapy with 3D volumetric analysis, the volumetric reduction of the cysts in the posterior mandible or ramus after decompression therapy and assessment of the correlation with certain parameters. In this context, this study will provide further information for other scientific studies with the choice of the mandibular posterior region and different variables.

The hypothesis of this study was that we assume shrinkage of the cyst volume after decompression therapy in cyst patients depends on several variables and these variables might affect the shrinkage of the cysts and bone formation. The null hypothesis of this study was that there was no statistically significant correlation between shrinkage of the cyst volume and these variables.

2. LITERATURE REVIEW

2.1 Cysts

A cyst is described as an encapsulated lesion comprising a connective tissue wall and an inner lining, which is composed of epithelioid structures. These lesions may be unilocular or multilocular radiolucencies with well-defined radiopaque boundaries. Cysts of the jaws can be categorized into two principal groups, namely odontogenic and non-odontogenic cystic lesions. Characteristics of these lesion are:

Epithelioid lining and liquid loaded

Diffuse volume, displace or replace adjacent structures

Can resorb or displace adjacent teeth

Can be a reason for expansion of the bone

Can be a reason for neurosensorial alterations

It is generally accepted that this lesions do not affect tooth vitality. (11).

A cyst represents one of the most frequently observed pathological conditions within the oral and maxillofacial region. A cyst, typically designated a follicle, is a cavity circumscribed by connective tissue with an epithelial lining enveloped by either soft or hard tissue. The contents of the cavity are typically liquid or semisolid. The substances within the cyst generate a high osmotic pressure, which facilitates its growth. The disease necessitates prompt diagnosis and treatment, as it has the potential to destroy surrounding bone and soft tissue (12).

They are defined as an encompassed pouch shaped by the aggregation of cells. A defining property of this lesions is the presence of cells within the exterior layering of the pouch that exhibit aberrant characteristics compared to the overlying healthy units of the area. Cysts can be classified into various categories and are observed in numerous locations throughout the whole anatomy. The prevalence is high. Cysts exhibit a wide range of sizes, from microscopic to macroscopic. In some cases, particularly with larger cysts, they can displace surrounding normal anatomical structures (13, 14).

Cysts may be observed in the osseous and soft tissues of the maxillofacial complex. The presence of epithelioid unit is observed in direct contact to evolving maxilla and mandible results in a higher incidence of cysts lined by an epithelium in the jaw bones compared to other regions of the body. Such cysts are therefore referred to as 'true' cysts (Figure 2.1). In contrast, pseudocysts lack an epithelioid layer. A cyst is considered as a morbid lesion characterized by the presence of a cavity inside called as a lumen. The lesion is surrounded by an exterior fibrotic connecting tissue wall, which is distinct from the overlying healthy regions. The internal surface of the wall is coated with a layer of epithelial tissue, predominantly stratified squamous epithelium. In certain instances, the lining may comprise an alternative epithelial type besides squamous epithelium (14) (Figure 2.2).

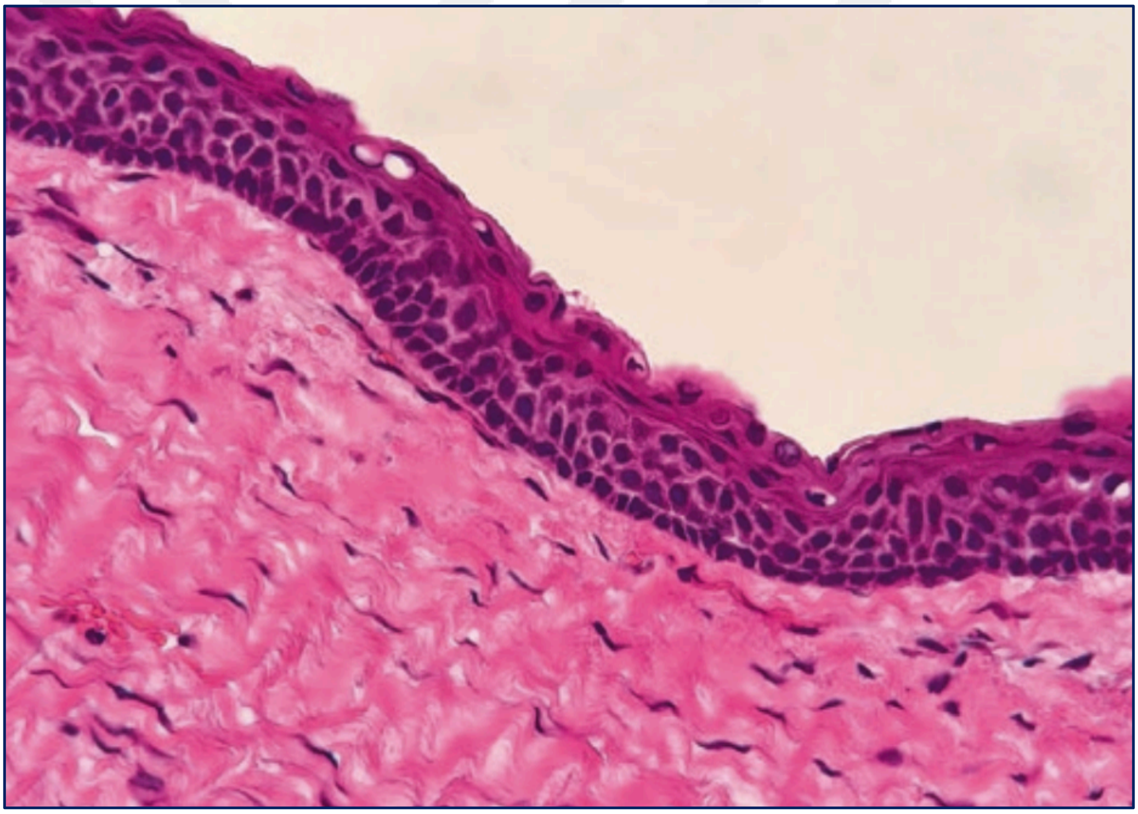


Figure 2.1. Histological picture of a true cyst (13)

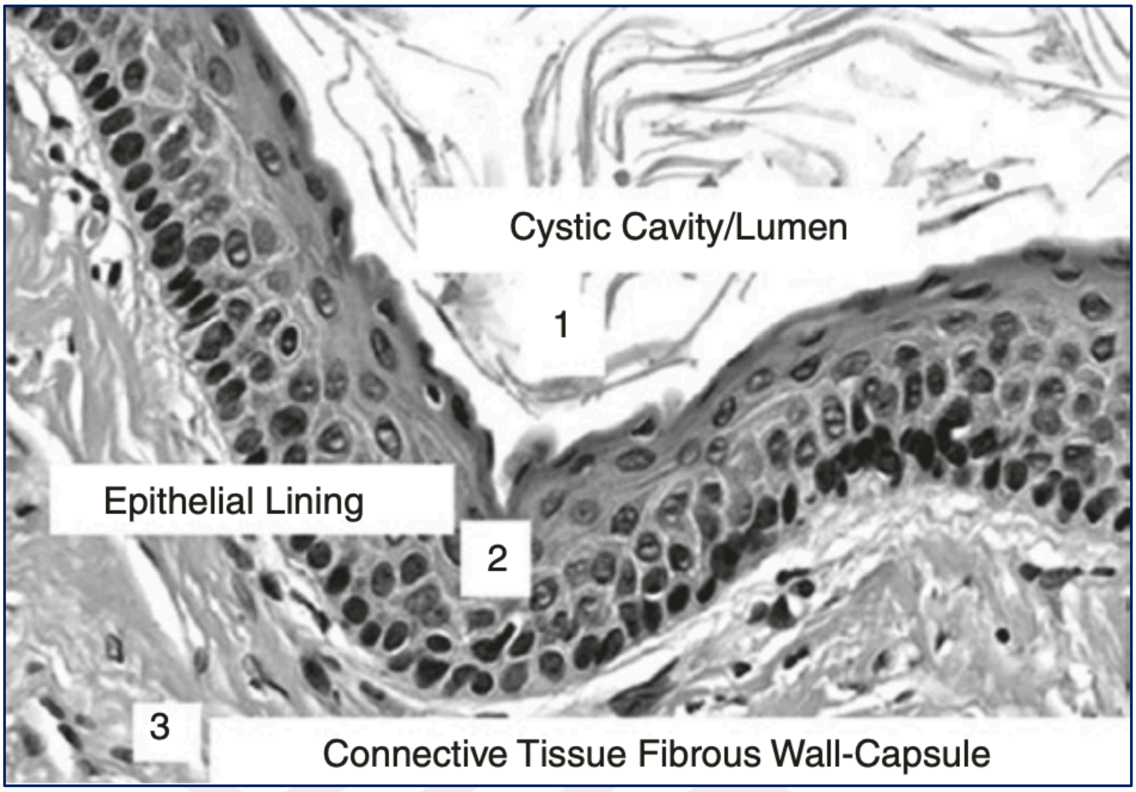


Figure 2.2. Histopathological components of a cyst (13)

2.1.1. Etiology

The etiology of orofacial cysts can be attributed to the persistence of the intricate biological phenomena of prenatal tissue that are held for the maxillary and mandibular evaluation. A conversion of this nature is not observed in any other region of the body.

True cysts are formed from epithelioid residuals that exhibit a robust proliferative capacity and the ability to remodel bone tissue. Odontogenic cysts have their origin in the residual epithelial tissue of the stomodeum, whereas inflammatory cysts result from an infectious process.

Induction Phase - It is hypothesized that an unidentified stimulus prompts the swift proliferation of epithelioid cells by cytokine synthesis. The considerations thought to be liable for the initiatory stage of cyst formation are primarily genetic, loss of the immune system's ability to monitor and respond to changes in the body, as well as the presence of mediators that cause inflammation and other biological causes, or local factors such as reduced O2 and elevated CO2 tension. It is postulated that remaining epithelial cells are involved in the early stages of cyst formation. This is followed by the rapid growth of epithelial cells and the formation of the lesion (13).

Evolution Phase - Following induction, epithelial cell increase creates an accumulation within the pouch. As the intra center units are located away from the nutritional source, they become deprived of nutrients and a blood supply, resulting in a lack of nourishment. The most internal cells are deprived of an adequate blood supply, absence of blood supply to the center of the tissue, leading to the development of a cavity that is circled by evolving epithelioid units. An increase in subcellular fluid retention and acid phosphatase activity gives rise to the micro lesions, that subsequently develop into a larger cyst (13).

Expansion Phase - Following its formation, the cyst undergoes a gradual enlargement over the course of several months. The process is comparable for all epithelial-lined cysts, with some distinctions. A number of competing theories proposed about the underlying structure of cyst enlargement (17).

2.1.2 Mechanism of Cyst Growth

- Epithelial increase
- The expansion of the cystic sac is attributed to the proliferation of units and the separation of surrounding epithelioid units. This results in a growth in the content of the cyst, followed by enlargement at the periphery and the aggregation of cellular components (17, 18).

Enlargement / Expansion - Fluid movement into and expansion of the cyst are influenced by the density in the lumen and differential tension between the cystic cavity. The cystic structure begins to expand and enlarge, with a concomitant increase in intra-cystic pressure resulting from the influx of fluids from the peripheral environment into the cystic space.

It should be noted that this rise in lesion diameter differs from the progress of independent development, which is observed in tumour units. Peripheral increase of epithelioid units is therefore a consequence of the elevated volumetric tension within the lesion, as a result of osmosis. The formation of an osmoregulatory collection degrade is the consequence of the absorption of collection and metabolic descendent within the lesion. The substantial acceleration in osmotic gradient results in the diffusion of fluid from the neighboring area into the inner side of the lesion, leading to an elevation in internal hydrostatic pressure and, consequently, an expansion of the cyst (18, 19) (Figure 2.3).

Bone Breakdown

The breakdown of the adjacent osseous tissue also contributes to the enlargement of the osseous part in intraosseous cysts.

Characteristics of the Cyst Proliferation

The degradation of bone tissue in the jawbone is caused by the action of collagenase, which facilitates the destruction of collagen. This process creates an environment conducive to the formation of cysts. In response to the breakdown of connective tissue, the body's immune system activates cytokines and growth factors, which contribute to the activation and increase of epithelioid units in the affected area. A review of the scientific literature reveals that collagenase activities within the cystic capsule lead to osseous degradation through the breakdown of collagen (19, 20).

The process of bone degradation, which is brought about by the metabolism of acidic matter that is generated within the cysts, contributes to the expansion of the lesion development. The compounds made by the lesion itself comprise prostaglandin 2 (PGE-2) and interleukin 1. In conjunction with mitotic activity of epithelial cells is the enlargement of the cyst within the jawbone, due to the degradation of bone by osteoclastic activity, stimulated by prostaglandins. Bone degradation is facilitated as a consequence of the formation of PGE-2 and prostaglandin 3 (PGE-3) by dental cysts. Prostaglandin 2 can be produced as a result of the triggering of the interleukin-1 pathway. As summarized by ***Meghji et al.***, odontogenic cysts have been observed to induce the production of interleukin 1, a factor which has been shown to induce the synthesis of prostaglandin 2. This in turn has been demonstrated to result in osteoclastic bone degradation and increase in size of the cyst (21, 22).

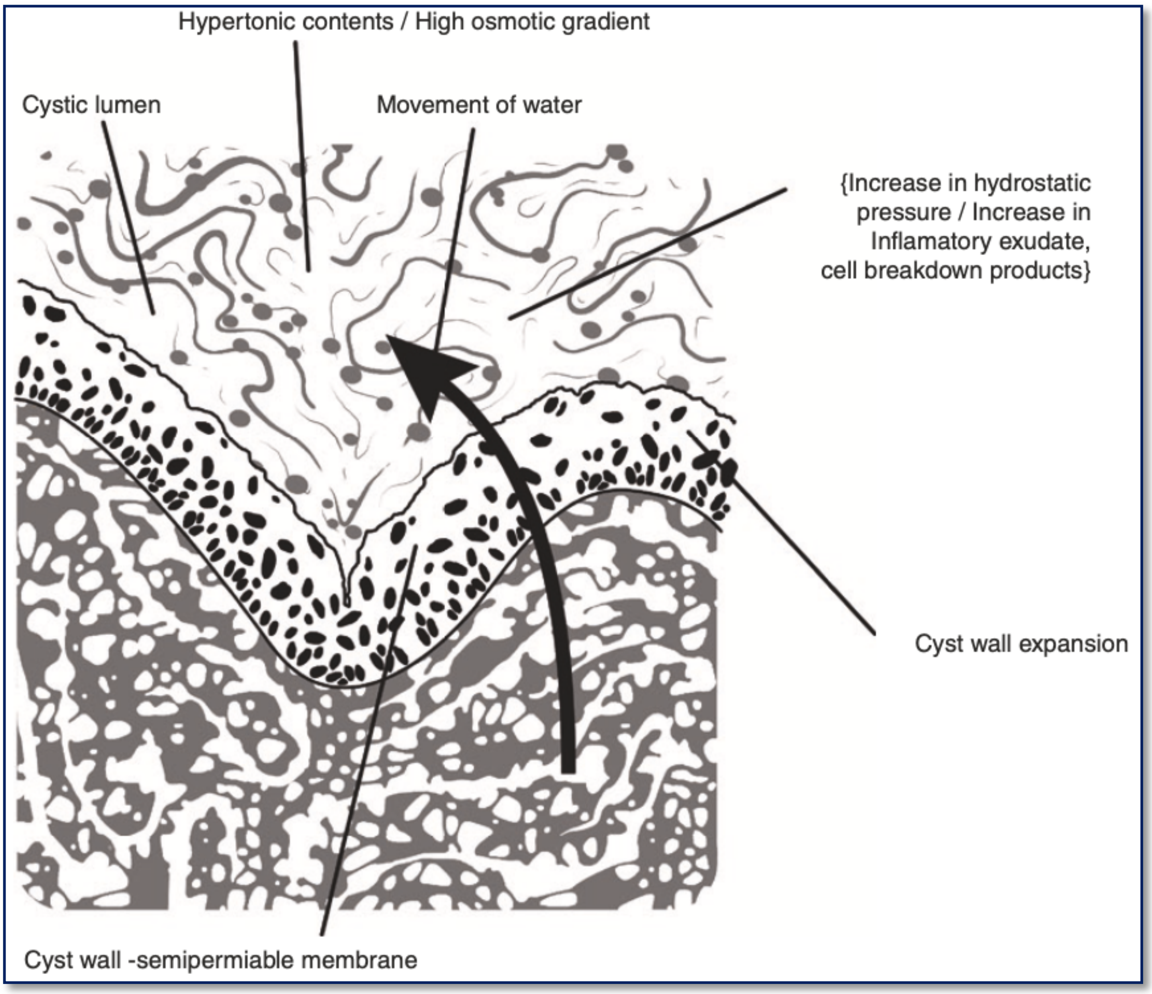


Figure 2.3. Enlargement of a cyst (Phases) (13)

2.2 Odontogenic Cysts

The occurrence of jaw cysts is more prevalent than that of cysts occurring in other bones of the human body. The occurrence of odontogenic cysts in the jaws is more common than nonodontogenic cysts. The most prevalent forms are periapical cysts (65%), dentigerous cysts (24%), and the odontogenic keratocysts (5-8%). It can occur at any age, from the first decade of life to the ninth. The age at which the condition is most prevalent is between 21 and 30 years. The male to female occurrence ratio is 1.4 to 1.0. A synthesis of the literature indicates a predilection for the mandible, which may suggest a heightened propensity for the transformation of cell rests into cystic lesions in this region (23, 24).

Odontogenic cysts have their origin in the enamel tissue. Epithelial origins include cell rests of Malassez, reduced enamel epithelium, and remnants of the dental lamina. The most frequently encountered non-odontogenic cystic lesions are traumatic bone cavity, aneurysmal bone cysts and nasopalatine cysts. It is recommended that all lesions be treated on an individual basis, with consideration given to their distinctive histopathological characteristics, aggressiveness, and both clinical and radiographic evaluation (11).

Odontogenic cysts exhibit a distinctive histological composition, characterized by the presence of epithelial components derived from odontogenic epithelium. Following the embryonic period, the jaw bones exhibit a greater density of epithelial structures than other skeletal elements. This phenomenon contributes to the increased prevalence of cystic formations in the maxilla and mandible relative to other regions. According to the World Health Organization (WHO) classification of 2017 (25, 26), odontogenic cysts are examined in two different categories: developmental and inflammatory. The World Health Organization (WHO) Classification of odontogenic lesions has now been made available in a convenient online site, and it is available to access as of March 2022. This version is based on the same fundamental framework as the previous categorization of odontogenic lesions. According to the 2017 categorization, odontogenic cysts of the jaws were separated into two main categories: odontogenic cysts of inflammatory origin and developmental cysts that were both odontogenic and non-odontogenic in nature. In contrast to the previous edition, the 2022 classification utilizes a more encompassing designation, "cysts of the jaws," which is applied without further delineation (27-29, Table 2.1, 2.2).

Table 2.1. The World Health Organization classification of odontogenic cysts 5^{th} edition 2022 (25)

Cysts of the jaws
Radicular Cyst
Surgical Ciliated Cyst
Inflammatory Collateral Cyst
Nasopalatine Duct Cyst
Gingival Cyst
Orthokeratinised Odontogenic Cyst
Lateral Periodontal Cyst
Botryoid Odontogenic Cyst
Calcifying Odontogenic Cyst
Glandular Odontogenic Cyst
Dentigerous Cyst
Odontogenic Keratocyst

Table 2.2. Properties of the cysts of the jaws (27)

Cyst of the jaws	Age-gender-Region	Diagnosis
Radicular cyst • *Residuel cyst*	• 4th-5th decades • Slightly male • Anterior maxilla	• Non-vital tooth for Residuel cyst • Edentulous area for Residuel cyst • Non-keratinized stratified squamous lining epithelium
Inflammatory Collateral Cyst • *Paradental cyst (PC)* • *Mandibular buccal bifurcation cyst (MBBC)*	• 4th decades for PC • 1st-2 decades for MBBC • Male • Mandibular third molars for PC • Buccal aspect Mandibular second molars for MBBC	• Associated for partially or recently erupted vital teeth • Radiolucency distinct from dental follicle • Intact lamina dura • Non-keratinized stratified squamous lining epithelium
Gingival Cyst • *Adult cyst* • *Infant cyst*	• 5th -6th decades for adults • Neonates for infants • No gender predilection • Gingiva of mandibular premolar-canine region for adult type • Anywhere on the edentulous alveolar ridge for infant type	Adults: • Site in attached gingiva • Thin epithelial lining Infants: • Site in alveolar ridge • Less than 3 months(age)
Dentigerous Cyst	• 2-3rd decades • Male • Third molars	• Well-defined radiolucency associated with crown of an unerupted tooth • Cyst attached to cementoenamel junction • Non-keratinized stratified squamous lining epithelium without palisaded basal cells
Orthokeratinised Odontogenic Cyst	• 3-4th decades • Male • Mandible (angle-ramus region)	• Tooth bearing areas of jaw

Table 2.2. Properties of the cysts of the jaws (27)

Botryoid Odontogenic Cyst	• 5^{th} -7^{th} decades • male • Canine-premolar region mandible	• Site on the lateral aspect or between the roots of vital erupted teeth, mandibular cuspid-premolar • Characteristic whorled epithelial plaques
Calcifying Odontogenic Cyst	• 2-3 decades • No gender predilection • Almost equally in the maxilla	• Numerous ghost cells • Cystic architecture
Glandular Odontogenic Cyst	• 5^{th} -7^{th} decades • No gender predilection • Anterior mandible	• Radiolucent cystic lesion of tooth-bearing area of the jaw • Epithelial lining variable thickness
Odontogenic Keratocyst	• 3-4^{th} decades; a second smaller peak in the elderly • Slightly male • Posterior mandible and ramus	• Site in jaws • Parakeratinized epithelial lining • Palisaded hypercromatic basal cells
Surgical Ciliated Cyst	• 5^{th} -7^{th} decades • No gender predilection • Posterior maxilla	• A history of surgery • respiratory epithelium lining • radiolucent well demarcated cyst
Nasopalatine Duct Cyst	• 4^{th} -6^{th} decades • Male • Midline of anterior hard palate	• Epicenter at incisive canal •

2.2.1 Dentigerous Cysts

It is hypothesized that dentigerous cysts originate from an aggregation of fluid situated between the coronal portion of an impacted tooth. It is hypothesized that the epithelial source is the decreased coating epithelium of the dental sac. The typical age range for the prevalence of dentigerous cysts is the twenties and thirties. In radiographic examination, dentigerous cyst are found to be attached with the coronal part of an impacted tooth and are characterized by a radiolucent appearance. These lesions exhibit considerable variation in their dimensions and are devoid of ossified formation (11).

Dentigerous cysts, also known as follicular cysts, derive their name from the Latin term dentigerous, which translates to "tooth-bearing". The term 'dentigerous cyst' was initially introduced by Paget in 1853. In this particular type, the crown of an impacted tooth is surrounded by a cyst, which has formed as a result of the enlargement of its follicle and is bounded to the cemento enamel (CE) connection. This lesion is invariably associated with the coronal part of an unerupted teeth (14).

The specific type of cystic degradation present and its closeness to the coronal part of an impacted teeth will determine the classification of the lesion. The most common forms are central, lateral, peripheral. In the case of the first form mentioned above, the crown of the tooth may initially appear to be surrounded by the lesion in a symmetrical manner. As the enlargement progresses, however, the coronal part of the wisdom tooth may shift to the basal part of the lower jaw. The same phenomenon may also occur with the maxillary canine or upper wisdom tooth, which can be observed at the orbit region or at a position in the antrum. The peripheral form is characterized by enlargement of the lesion on a single side of the coronal part, and it is observed in circumstances of premature eruption of wisdom tooth in mandible. In the peripheral form, the X-ray will demonstrate a darker radiographic part that encompasses the complete perimeter of the tooth (13.30) (Figure 2.4).

Dentigerous cysts encompass the coronal part of the impacted tooth via the enlargement of the sac that houses it. The prevalence of this condition is higher in males than in females. While it can manifest at any age, it is most frequently observed in individuals in their thirties. The prevalence of these cysts varies between 18 and 24 percent of in published articles. In clinical practice, these lesions are frequently observed in association with commonly unerupted teeth. They are typically identified fortuitously on radiographic images obtained for the purpose of investigating an impacted tooth (32).

Such lesions are characterized by clear radiopaque borders and are unilocular radiolucencies with well-defined margins, situated attached to the coronal part of the impacted tooth. Sometimes, formation of trabeculae can be seen, and this may lead to the erroneous assumption that the lesion to be considered multilocular (32)

It is common for dentigerous cysts to lead the resorption of the roots of neighboring teeth. In addition, the displacement of nearby tissues may be observed (33). The precise etiology of dentigerous cystogenesis remains unclear. However, the prevailing hypothesis suggests that these cysts originate from fluid aggregation between the enamel of the tooth and the remnant enamel epithelium (34). The enlargement of the lesion is comparable to that observed in a radicular cyst, in which it is known that osseous degradation and fluid accumulation pressure play a pivotal role.

The histology of the lining demonstrates a narrow, uniform formation of non-keratinized stratified squamous epithelium, comprising 2–5 cells, which resembles the reduced enamel epithelium. The contents of the lesion are characterized by the presence of yellowish fluid and the formation of cholesterin crystals, accompanied by a resolvable protein concentration (31).

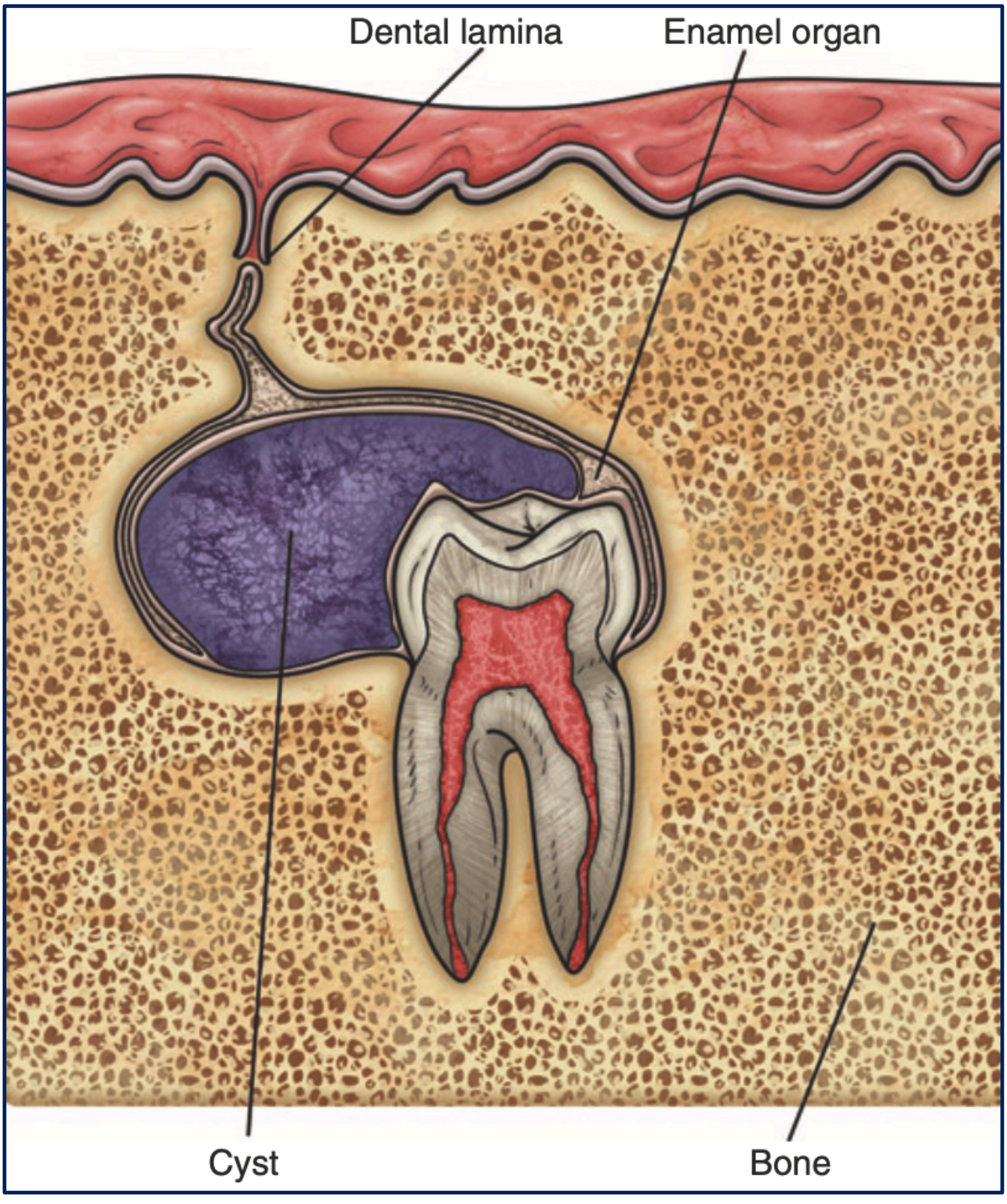


Figure 2.4. Formation of a Dentigerous cyst (13)

2.2.2 Keratocysts

In 2005, WHO defined the odontogenic keratocyst (OKC) as a keratinizing odontogenic tumour (KOT). The current classification maintains the separation between the OKC and the orthokeratinized odontogenic cyst, while retaining the previously defined pathohistological criteria. These include a parakeratinized epithelial lining comprising five to eight layers, and the potential for areas of scale like cell conversion to emerge in the presence of intra-capsular inflammation (11).

The significant cause of this is its invasive nature, which bear greater similarity to those of a malignant tumour, and its high tendency to recur in comparison to those of a benign cyst. In 2017, the KCOT was recategorized by the WHO as an odontogenic developmental cyst, adopting the original term 'OKC'. The incidence of these lesions can be seen across a broad age spectrum, with the highest prevalence in the twenties and thirties. The histological characteristics of the basement membrane include compressed and creased, along with the presence of para-keratin and basal covering of epithelial cells. It is possible to observe a considerable quantity of keratin within the inner cavity. Radiographic presentation of these lesions can manifest as unilocular or multilocular radiolucent lesions. Additionally, these lesions have the potential to manifest in a range of sizes and expansiveness. The propensity for OKCs to recur is estimated to be in the range of 25 and 30 percent. It is not uncommon for patients with nevoid basal cell syndrome to present with multiple OKCs (11).

The name this lesion was derived from the observation of keratin deposited in cells of cystic lining. The lumen is observed to contain a viscous substance with a composition similar to that of keratin particles and fluid of a transparent nature. The cyst is characterized by a distinctive developmental, odontogenic, and intraosseous origin, with epithelial features. It is notable for its rapid invasive progression and nature, high recurrent potential, and distinct features (35, 36). More than a half century, numerous studies have directed their attention to this subject. The evolution of this terminology is an intriguing phenomenon.

Reichart and Philipsen proposed a revised categorization system for odontogenic tumours. The lesion was classified as a malignancy of dental epithelioid with evolved fibroid stroma, given its proclivity for regional aggressive nature and cellular characteristics., and increased relapse and nuclear division observed in the above basal parts (37). ***Shear*** had reiterated that this lesion displays heightened cellular proliferation and a proclivity for relapse and had underscored the correlation between OKC and NBCCS (38).

The alteration in tumour classification prompted the implementation of a revised treatment strategy for this lesion, which initially encountered considerable opposition, and the idea was not truly embraced, predominantly due to the observation that not all OKCs manifest a recognizable PTCH alteration. It was unclear whether the new classification should be applied to all OKCs or only to a subset comprising a particular type of the lesion. To date, the full range of applicable data on this lesion has yet to be published and is still under investigation. It has been proposed that marsupialization may facilitate the conversion of the brittle epithelial tissue to healthy oral tissue or from para-keratin to ortho-keratin type (39, 40).

A lengthy and contentious debate ensued regarding the malignant characteristics of the lesion. In 2017, a group of experts convened by WHO reached the conclusion that there was insufficient evidence to justify labeling the odontogenic keratocyst as form of neoplasia. Consequently, the OKC was re-classified as a cyst and the designation KCOT was removed from the new categorization scheme (13).

OKC's exhibit a developmental characteristic; nevertheless, contemporary researches have revealed that the PTCH gene plays a role in the etiology of these lesions. There is consensus that the lesions arise from dental epithelium, and two origins of epithelium have been put forth for consideration: the odontogenic lamina and its residuals, or proliferations of basal cells from the attached epithelium (41).

From a clinical perspective, OKC's are typically characterized by localized harmful properties. As they have the potential to expand to a considerable size without being identified and are frequently located in the angle of the mandible, the significant sign may be paresthesia of the inferior alveolar nerve (42).

Recurrence rates have been documented to be as high as fifty to sixty percent, with multiple potential causes proposed, like satellite cysts. The delicate and thin tissue lining of these cysts often makes complete enucleation challenging (42).

From an imaging perspective, such lesions may manifest as small, circular, unilocular radiolucencies, or they may be expansive with edges that are indented. These cysts are clearly delineated by well-defined radiopaque borders, although in some instances, they may also manifest as diffuse lesions. Furthermore, the occurrence of lesions presenting with multiple cavities has been documented. It is not uncommon for neighboring teeth to be displaced as a result of the disease process; however, apical resorption is an uncommon occurrence. It is possible to observe a perforation of the cortical bone. Such lesions may be present in several locations or as a single occurrence (46).

A histological analysis of the cyst reveals a lining comprising keratinized, stratified squamous epithelium with five to eight cell layers. No rete ridges are present. The basal layer is clearly delineated and composed of columnar or cube-shaped cells that exhibit intense basophilic staining, which serves as a crucial significant property. Mitotic activities are frequently observed above basal layers, and some linings exhibit characteristics of epithelial abnormality (see Figures 2.5 and 2.6). Such lesions may be unilocular and exhibit less invasive features, or alternatively, they may be multilocular (46).

The recommended approach to treat OKC's is no longer excision with curettage, but en bloc resection, which includes the surrounding tissue if the lesion is small enough to leave a part of osseous tissue bone. In the event, that the lesion is of a considerable size, bone resection and the implementation of a composite free graft are necessary (46).

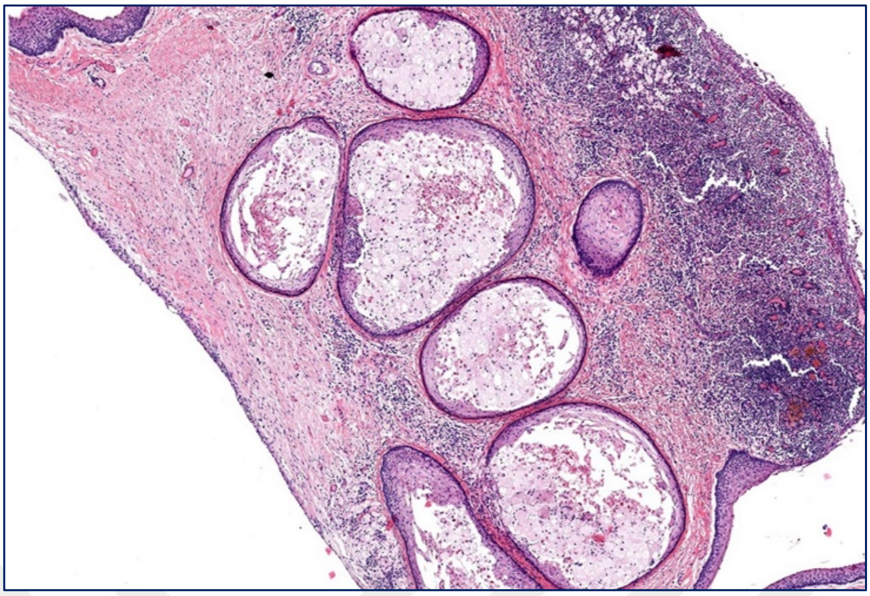


Figure 2.5. Histological section of an OCK wall. Daughter cysts can lead to recurrences (47).

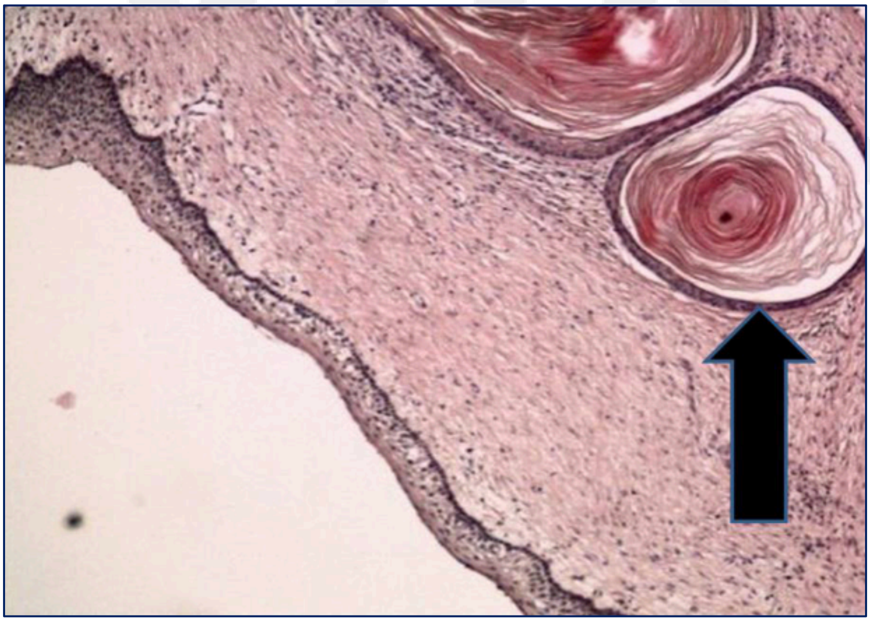


Figure 2.6. Histological section of an OKC Wall. (Black arrow: satellite cyst) (48)

2.3 Treatment Modalities of Cysts

The determination of the optimal management modalities is contingent upon the application of multiple considerations. The following criteria were considered and used to dictate the management decision indicated in each case: lesion dimension and location, age, presence of unerupted tooth, surrounding anatomy, and biopsy result (49).

The measurement of **lesion dimensions** is a crucial element in the development of a comprehensive management strategy. In cases where the cysts are relatively smaller in size, they may be excised and sent for a histologic evaluation, which can be done via excisional biopsy. This procedure can be performed while preserving the tooth attached to the lesion (49).

Age and Surrounding Anatomy. In addition to the aforementioned factors, the age and the distance to surrounding anatomy must also be taken into account. In pediatric patients presenting with large lesions, there is a potential risk of damage to the tooth buds and subsequent devitalization of the tooth through enucleation. Therefore, a preliminary decompression of the cyst to reduce the extent of the bone damage may be recommended, with surgical enucleation conducted at a future stage (49).

Presence of Unerupted Tooth. Prior to surgical intervention, consideration should be given to the importance of the affected tooth in question. To illustrate, an upper or lower canine tooth possesses the requisite aesthetic and occlusal value for its retention, therefore lesion elimination with the tooth saved represents the optimal course of action. An additional consideration is an unerupted wisdom teeth, which frequently necessitates removal and cyst excision (49).

Biopsy Result. The histopathological characteristics of the epithelium encasing the lesion are pivotal in discriminating between cystic lesions, forecasting relapse rates and gauging the potential for neoplastic development, and are similarly the most crucial element in establishing the optimal management plan (25, 50).

Box 2.1. A range of operative treatment approaches for Cysts (13)

Conservative Surgical Treatment

Decompression alone with the use of drainage material

Decompression followed by Enucleation

Marsupialization alone

Marsupialization followed by Enucleation

Enucleation with or without packing or with reconstruction surgery

Enucleation with excision of surrounding tissue

Enucleation along with adjuvant treatments

Peripheral ostectomy

Chemical cauterization with Carnoy solution

Electrocauterization

Cryotherapy

Invasive Surgical Treatment

Resection without creating defect

Resection with a defect (segmental resection)

Resection with excision of the condyle

The goal of selecting a specific surgical procedure is to eradicate the underlying pathology, reduce discomfort, diminish the likelihood of relapse, and enhance the patient's overall well-being. To this end, it is essential to minimize the trauma to surrounding structures that are vital to the patient's well-being, including the sinus, nasal floor, teeth, nerves and other important anatomical features. The objective is to achieve a restoration and preservation of these structures, ensuring their continued functionality and aesthetic integrity. Operative procedures for the treatment of cysts are frequently categorized as either conservative or aggressive (13).

The operative procedures most commonly employed are enucleation and curettage. In the case of cysts with a diameter of less than five centimeters, enucleation is typically the chosen method of treatment. Nevertheless, there are various methodologies for the management of cysts exceeding five centimeters in diameter. In addition to the dimension of the lesion, the biopsy result is also a key factor in determining the most appropriate treatment strategy. To illustrate, while more invasive surgical procedures are advised for parakeratinizing group of odontogenic keratocysts, less aggressive treatment modalities are typically favored for orthokeratinizing groups (25, 51, 52) (Box 2.1).

2.3.1 Enucleation

Enucleation with or without adjunctive techniques, have been demonstrated to be the most effective operative approaches for the majority of the cysts of Oral and Maxillofacial area, with the specific combination of additional options selected on a case-by-case basis (13).

Enucleation is defined as the complete excision of a structure from its envelope without compromising the integrity. In this procedure, no osseous tissue is excised other than that which is necessary for direct surgical entry to the cyst (13).

It is the most widely applicable treatment approach. Indeed, numerous authors have indicated that surgical excision of a cyst without rupture has been illustrated to diminish the likelihood of relapse (13).

The feasibility of this operation is contingent upon the fibrotic connecting tissue situated between the epithelioid layer of a lesion and the osseous part of the cystic cavity. The presence of this layer serves as a dividing point, facilitating the dissection of the cystic lining from the osseous tissue and enabling the operation to be held with minimal invasiveness (13).

To minimize the risk of relapse in these lesions that cannot be excised intact and to eradicate any residual viable cells, additional approaches that facilitate localized cauterization following enucleation represent an optimal therapeutic strategy for certain invasive cystic lesions and tumours (13).

2.3.1.1 Enucleation with Peripheral Ostectomy

2.3.1.2 Enucleation & Utilizing Carnoy’s Solution

On numerous occasions, the narrow and fragile nature of the wall, coupled with the presence of numerous minor satellite cysts, has presented a challenge in enucleating the cyst without rupture. Therefore, the objective of the operative technique is to diminish all remnants of the epithelial tissue. The objective is to achieve this by utilizing a penetrating and cauterizing solvent such as Carnoy's solution. The mean bone infiltration depth is 1.54 mm, with a 5-minute exposure time. The composition of Carnoy's solution is as follows: 3 ml of chloroform, 6 ml of absolute ethanol, 1 ml of glacial acetic acid, and 1 g of ferric chloride. This allows for adequate thermal coagulation of the remains of the pathological fragments. The literature indicates that a variant form of Carnoy's solution, excluding chloroform, has been employed due to the carcinogenic properties of the latter (13).

The application of the enucleation protocol in conjunction with Carnoy's solution has been demonstrated to reduce the relapse and morbidity in the management of invasive lesions, such as OKCs. In order to protect the IAN during the administration of Carnoy's solution, the operator may choose to employ the use of one of the following techniques: the application of bone wax or paraffin gauze (13).

In a study conducted by ***Dashow et al.***, the efficacy of Carnoy's solution and a modified version of it was evaluated in the treatment of OKCs. The findings indicated that both approaches resulted in a significant reduction in relapse and produced outcomes comparable to those achieved through surgical resection, without the need for invasive and potentially hazardous surgical procedures (13,53,54).

2.3.1.3 Enucleation with Cryotherapy

2.3.1.4 Enucleation Followed by Bone Grafting

In order to prevent osseous fracture,

In order to circumvent aesthetic and physiological issues in an extensive cystic cavity exceeding 4 cm. (55, 56).

2.3.2 Resection

The surgical procedure of resection of a jawbone may be undertaken in one of two ways: as partial or segmental resection. In the case of a partial resection procedure, the lesion in question is typically minor in size. As a result, the entire lesion is excised without affecting the surrounding bone. This approach allows for the preservation of bone integrity within the jawbone, a critical aspect in maintaining optimal dental functionality. In the event, that the lesion in question is extensive, it may become necessary to undertake a complete resection of either osseous part of the jaws. As a consequence of this procedure, patients frequently suffer from significant defect; thus, there is a clear necessity for reconstruction, both functionally and aesthetically, through the application of reconstructive measures. Indeed, numerous authors have concluded that the treatment of cystic lesions does not necessitate the use of aggressive therapies. Instead, these lesions can be successfully managed through non-aggressive techniques (13).

In a systematic review, ***Blanas et al.*** found that after resection, they didn't observe any relapse. However, this procedure is always associated with a high morbidity. The findings of the study indicated that enucleation in conjunction with Carnoy's solution yields comparable minimal relapse to resection, while circumventing the necessity for radical intervention. The complete excision of the jaw bones is regarded as an excessively traumatic procedure for the treatment of large, locally invasive lesions. The principal fallback of a non-invasive approach is the prolonged treatment duration (13, 35, 36).

Some researchers argue that resection is too radical in the management of cystic areas in the jaws, including odontogenic cysts, and should not be used unless there is a possibility of malignancy. In addition, resection has not gained much popularity because it creates facial deformity due to tissue destruction, causes occlusion problems, reduces the refractive function, and can lead to a decreased quality of life after the surgery (25, 58).

2.3.3 Marsupialization

The surgical procedure entails the modification or peeling away of a cystic cavity, thereby transforming it into a sac. This process serves to diminish the intra-cystic fluid pressure. In essence, the procedure entails the creation of a pouch in the outer layer of the cystic cavity, thereby exposing the cystic contents externally (see Figure 2.7). The excised tissue is submitted for biopsy. Subsequently, the edges of the epithel wall are attached to the overlying oral tissues via suturing, thereby transforming an enclosed cavity into an open structure. This procedure introduces the epithelium to the oral region. The procedure results in a shrinkage in the cyst volume and dimension, while also facilitating the regeneration of new osseous tissue. This technique may be employed as a standalone management for a lesion or as a preliminary approach before the enucleation (13,59).

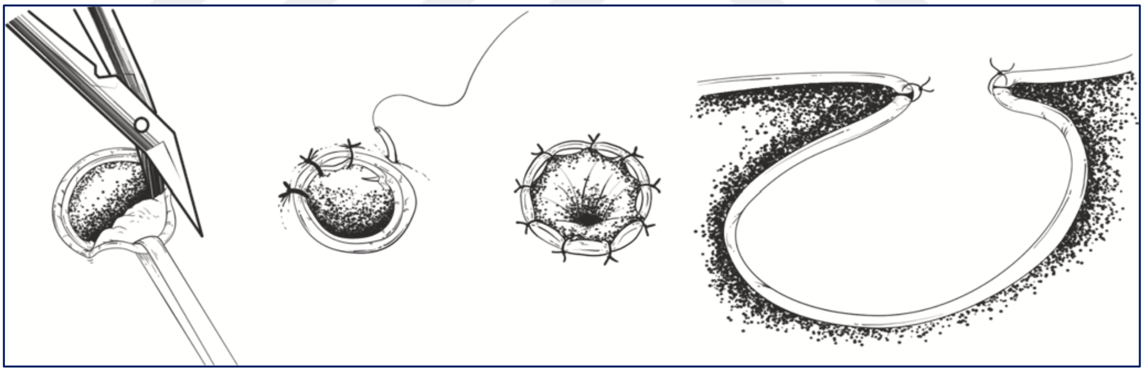


Figure 2.7. Marsupialization procedure (13)

2.3.4 Decompression

The surgical decompression of a cyst involves the performance of a minor operation which serves to reduce the intra-cystic pressure, which is identified as being the causal factor in lesion enlargement. In addition, this technique permits the reconstruction and the formation of osseous tissue (13).

This approach is achieved via the creation of a tiny puncture in the cyst wall, which is then maintained patent via the utilization of a dedicated a drain of choice, with the openings fixed in place using sutures or wiring. The openings are washed daily with saline or antimicrobial solution (13) (see Figures 2.8, 2.9 and 2.10).

In the case of lesion located in mandible, the normal method of drainage is through an opening into the oral cavity. With respect to maxillary cysts, there are three potential routes for draining: into the intraoral region, the antrum, or the nasal region.

Decompression is a conservative approach with a high level of patient acceptance. In accordance with observations made in clinics, prognosis for patients with limited qualifications attainment who receive care for the drain and irrigation of lesions are favorable (60).

The shrinkage of the cysts that is achieved through the release of intracystic pressure is a result of this procedure. This outcome can be achieved through the creation of an epithelial incision along the tiny puncture of the cystic wall, thereby facilitating an opening to the oral region (60).

The decline in intra-cystic pressure and alterations in the inflammatory milieu constitute the two principal mechanisms underpinning the efficacy of this technique (60).

This technique has been shown to promote the development of new osseous tissue from the margins, and it also has low complication rate than enucleation, curettage and resection. Nevertheless, patients undergoing this approach require more frequent observation and monitoring than those treated with alternative methods (59,60).

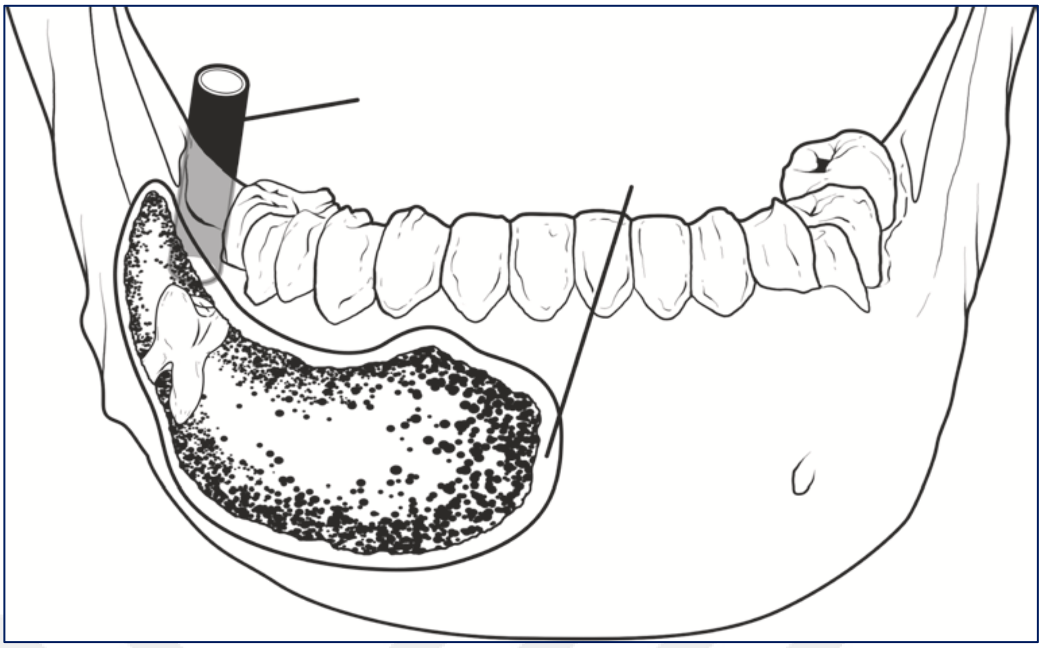


Figure 2.8. Decompression of a cystic lesion through oral cavity (13)

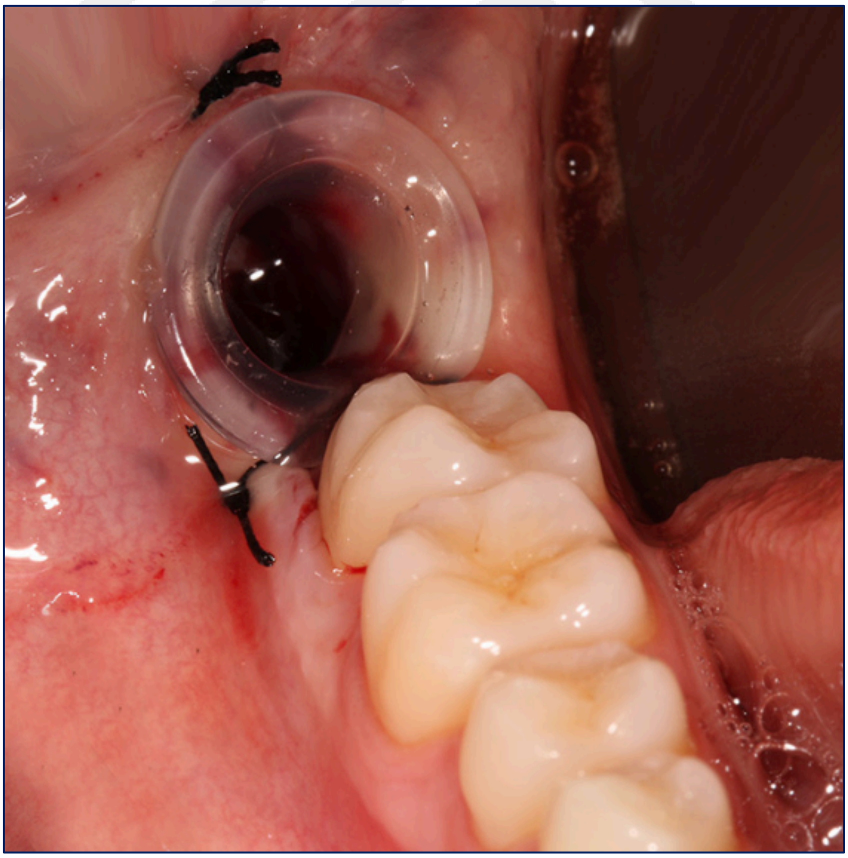


Figure 2.9. Decompression material (tube) (47)

Figure 2.10. Decompression (individual resin) (47)

2.4 Computed Tomography

In any case, CT scans involve the application of a considerable quantity of high energy radiation to patients. The introduction of CBCT marked a significant breakthrough in radiographic imaging for the dental sector, offering a substantially reduced radiation dose (61).

In conclusion, the radiographic doses associated with CBCT in dentistry are typically superior to those of standard intraoral scans, but inferior to those of MSCT scans of the same region (61).

The ability to obtain multiplanar resolution images and representations, along with 3-dimensional visualizations of anatomical structures, in a relatively low scanning time, and with a low radiation exposure to the patient, have contributed to the increasing use of CBCT in dental region, including in pediatric cases. It has been recently established that this modality represents an optimal first-line technique in a number of clinical scenarios (62).

The utilization of multisectional CBCT sections and 3D reconstructions facilitates the accurate identification of a lesion's localization, source and provides precise measurements of its diameter, encompassing all dimensions (Figure 2.12.). CBCT scans offer greater reliability than conventional X-rays for the determination of lesion size. Unlike conventional X-rays, CBCT scans are free from magnification errors. Furthermore, CBCT images facilitate an accurate assessment of lesion osseous margins, interior structure, presence of bone loss, the calcification of surrounding bone and evaluation of the closeness to adjacent anatomical structures, thus enabling more optimal preoperative evaluation. Moreover, CBCT is a valuable tool in the postoperative follow-up of lesions with a high relapse possibility (62).

Although CBCT is regarded as the optimal method for visualizing intricate details with high resolution, it is not suitable for instances that require the differentiation of soft tissues. In such cases, MSCT or magnetic resonance imaging (MRI) with or without resolution is recommended (63).

One of the primary benefits of CBCT lies in its capacity to enable 3D visualization and analysis of bone, anatomical structures, effectively circumventing the limitations associated with conventional X-rays, which often result from magnified or superposed structures. It is crucial to acknowledge that the current CBCT imaging has limitations in visualizing soft tissue, including muscles, glands, vasculature, and soft tissue tumors. While it can visualize the bone and calcified structures, as well as airway spaces, the complete assessment of soft tissue is not possible. CBCT imaging provides an accurate three-dimensional image of the bones of the Oral and Maxillofacial area (64-66) (Figure 2.13, 2.14).

It would be beneficial to ascertain the quantity of radiation that the patient is subjected to during the CBCT process. The exposure of radiation by CBCT is greater than conventional X-rays; nevertheless, it is relatively 10 times lower compared to a medical MSCT according to a CBCT study. It should be noted that the quantity of radiation exposure will vary according to the specific company or CBCT unit. In certain cases, CBCT machines produces a non-stop radiation. It is important to note that during the entire process, the machine will maintain a continuous emission of ionizing radiation. On the other hand, it should be noted that other CBCT units employ pulsed or intermittent radiation, which results in a reduction in the total exposure (63, 67).

2.4.1 Usage of CBCT Units

CBCT units can be classified into four principal categories on the basis of the dimensions of the line of vision, both in the vertical and horizontal planes. For the Maxillofacial area, the craniofacial region is typically covered, from the chin bone to the nasion. In most cases, the measurement exceeds 15 cm. In most cases in the Dentoalveolar region. the diameter and height of these structures exceed 8 cm. The device can be utilized to cover either a single, full jaw or both temporomandibular joints (TMJ's). The diameter is considerable, measuring at least 10 cm or 14 cm in the case of its use in the TMJ's. For the localized lesions which are typically small, measuring no more than 3 cm in any dimension, such as 2–4 teeth and the adjacent alveolus or a single TMJ (62) (Figure 2.11).

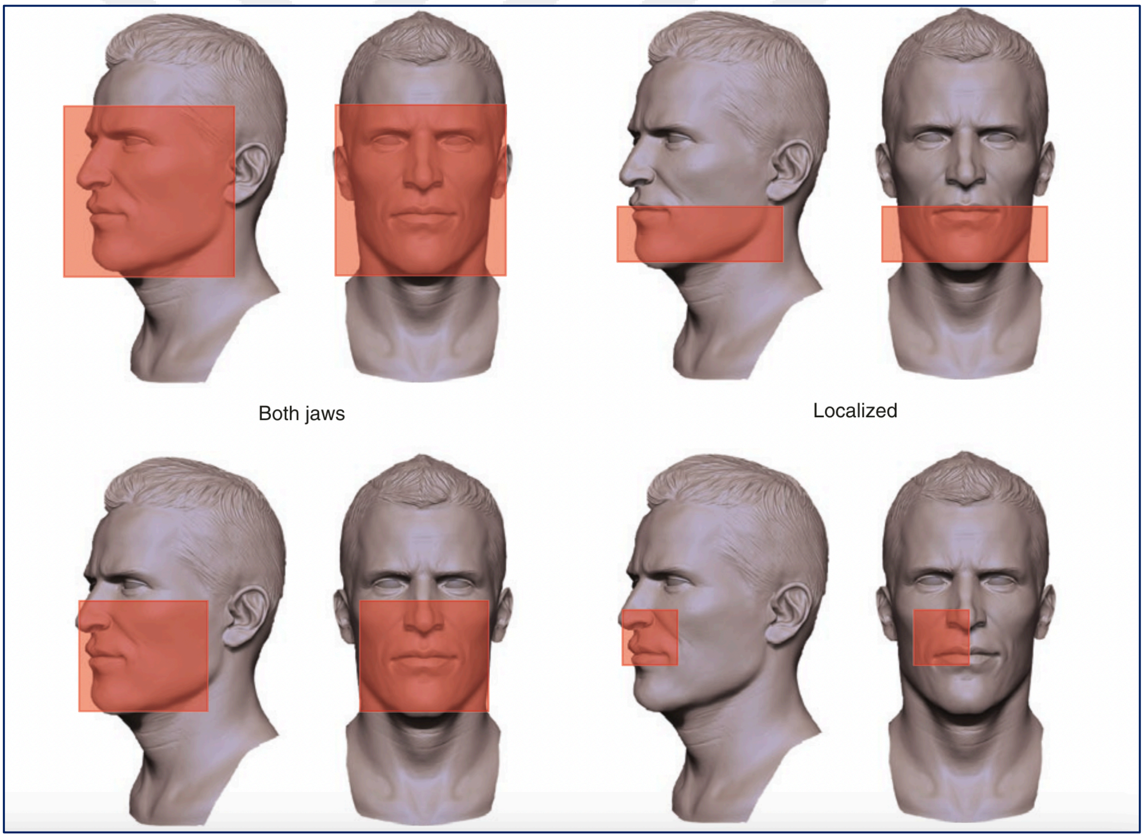


Figure 2.11. Three-dimensional images of models of different line of vision sizes presented in Oral and Maxillofacial CBCT (61).

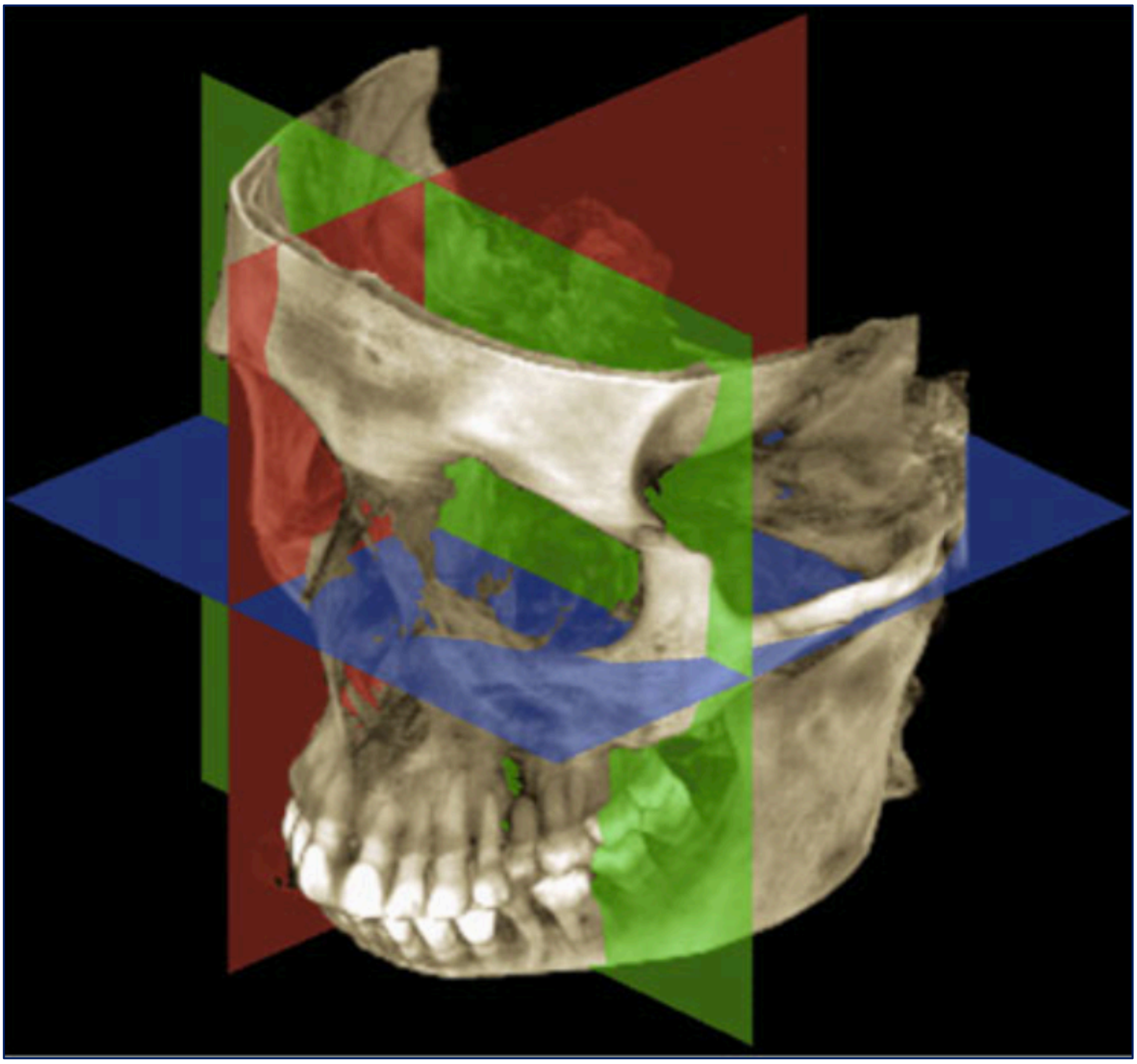


Figure 2.12. Multiplanar visualization of CBCT images; green coronal; blue axial; red sagittal (70)

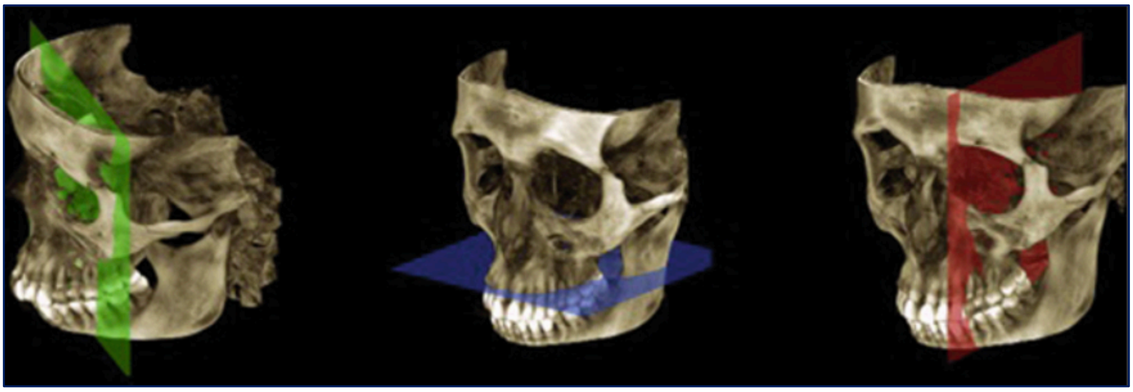


Figure 2.13. Anatomical planes of 3D models (71)

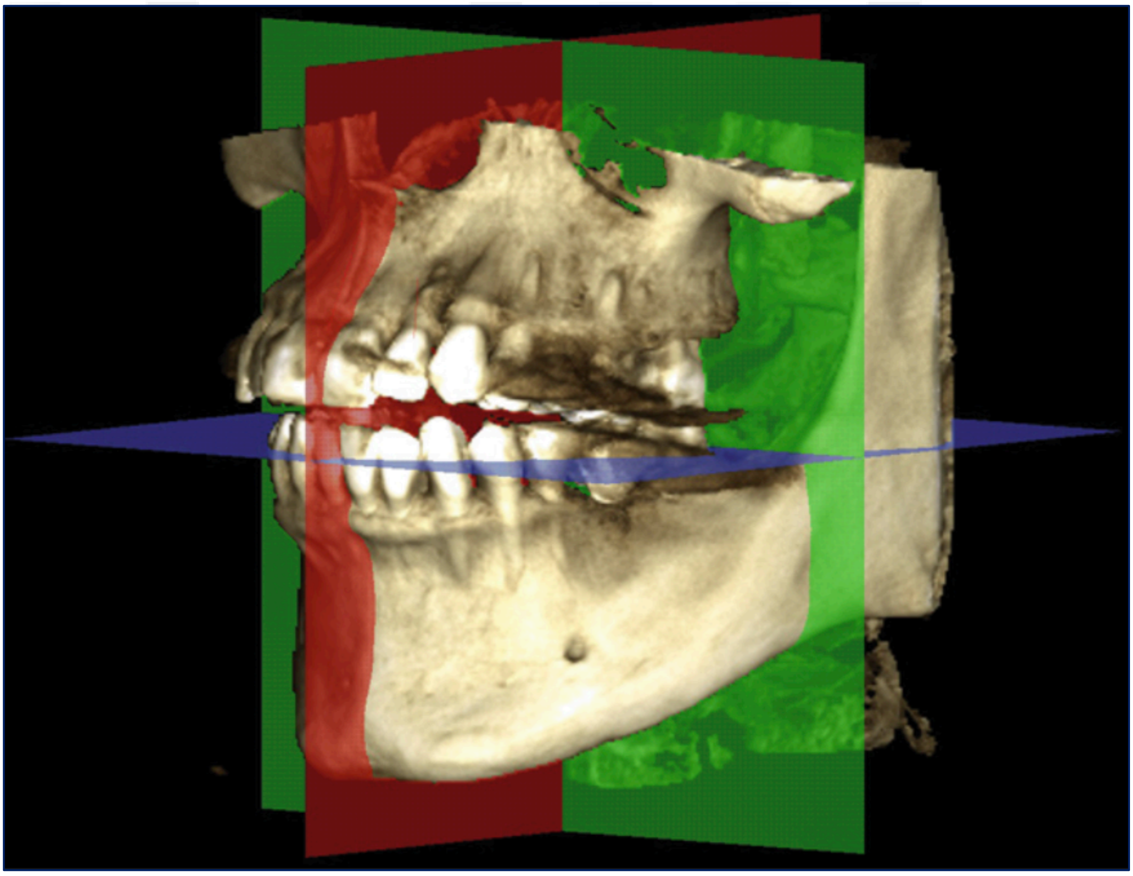


Figure 2.14. Anatomical planes of 3D models (72)

In 1972, ***Hounsfield*** devised a new form of medical imaging called CT. In the early 80s, ***Robb et al.*** conducted a study about the fundamental principles of CBCT. In the early 80s, ***Toyofuku et al.*** stated the efficacy of CBCT in 3D evaluation for Maxillofacial disorders (68).

In 1997, ***Mozzo et al.*** developed a dental CBCT device that is particularly suited to use in the head and neck, as well as the Maxillofacial region. The apparatus enables the Maxillofacial area to be visualized in a single scan, while the patient is lying down (68).

The technology has been employed in the management of traumatic injuries, including preoperative evaluation, surgical planning and treatment of fractures. In the late 90s, ***Arai et al.*** designed a CBCT mechanism that minimized the region which the surgeon wants to assess. This methodology has been demonstrated to yield superior imaging with minimal radiation dosage and has since gained considerable traction in clinical settings, as evidenced by its extensive utilization (68, 69).

Dental CBCT is utilized for the inspection of teeth and associated osseous tissues with high X-ray absorptive capacity, thereby facilitating precise observation and imaging of intricate details within these structures. The presence of sound and ionizing radiation has a considerable impact on the resolution achievable with dental CBCT, particularly in the case of low-density structures. It is therefore not an optimal modality for the assessment of soft tissues, which are better evaluated through the use of specific imaging techniques. In the event, that evaluation regarding the soft tissue is required, MRI should be employed (68, 69) (see Box 2.2).

Dental CBCT is preffered;

Box 2.2. The situations where Dental CBCT is used (70)

❖ In cases where conventional X-rays are insufficient in periodontal and endodontic treatments,
❖ Before surgery of impacted mandibular third molars,
❖ Before surgery of impacted and supernumerary teeth, before implant surgery,
❖ In the evaluation of the alveolar area, sinus diseases, facial and trauma cases,
❖ In the examination of pathological lesions of the jaw bones and TMJ disorders.

2.5 Relevant Background Literature Review

Zhao et al. conducted a retrospective analysis of 53 patients in lower jaw with odontogenic keratocysts who had undergone marsupialization. Bone density at the site of the cyst was quantified using conventional X-rays. A negative association was observed between the increase in bone density and the decrease in cyst volume (73).

Enislidis et al. identified 13 excellent, 5 moderate, and 2 poor results according to the rating system proposed by Nakamura et al. for the prospective evaluation of decompression as a primary treatment for large mandibular cysts, regardless of their type, through radiological examinations. The mean reduction in size of the lesions was 81% (74).

In a retrospective study, ***Ulu et al.*** sought to analyze the association between decompression period and CBCT volume of initial lesions. The study yielded a positive association between the volume of the cystic lesions and decompression period (75).

The objective of the research conducted by ***Xiong et al.*** was to assess the association between intracapsular pressure and the shrinkage rate of cystic lesion volume at various time following decompression. The rate of shrinkage of the cystic cavity volume at various time was calculated. The researchers identified intracapsular pressure and the preoperative volume as the factors influencing the rate of shrinkage (RS) during the initial three-month postoperative period (76).

Shudou et al. conducted a study including 15 subjects with the diagnosis odontogenic keratocyst of the lower jaw. Dimensions and volumetric measurements were calculated and changes after marsupialization were analyzed using CBCT. In conclusion, the authors point out that marsupialized keratocysts in the lower jaw can forecast the future shape of the lesion with high precision (77).

In a study involving 41 patients, ***Wongrattanakarn et al.*** investigated the impact of various parameters on the reduction rate and percentage of volume reduction of cystic lesions. All subjects completed decompression treatment. The researchers stated that information of the rate of reduction of odontogenic cysts is significant for operators in order to assess the time of decompression prior to enucleation and in order to determine an optimal management strategy. They also stated that there were important effects of gender and first volume on the reduction rate (78).

The objective of the study conducted by ***Shi et al.*** was to evaluate the 3D image alterations of bone remodeling after decompression over an extended follow-up period, with a particular focus on the progression of unossified lesions after one year of treatment. The researchers analyzed CBCT scans of 17 patients, and among those who had regular imaging follow-ups, 14 cases demonstrated that the unossified part proceed ossification after one year of decompression (79).

3. MATERIALS AND METHODS

3.1 Study Design & Sample

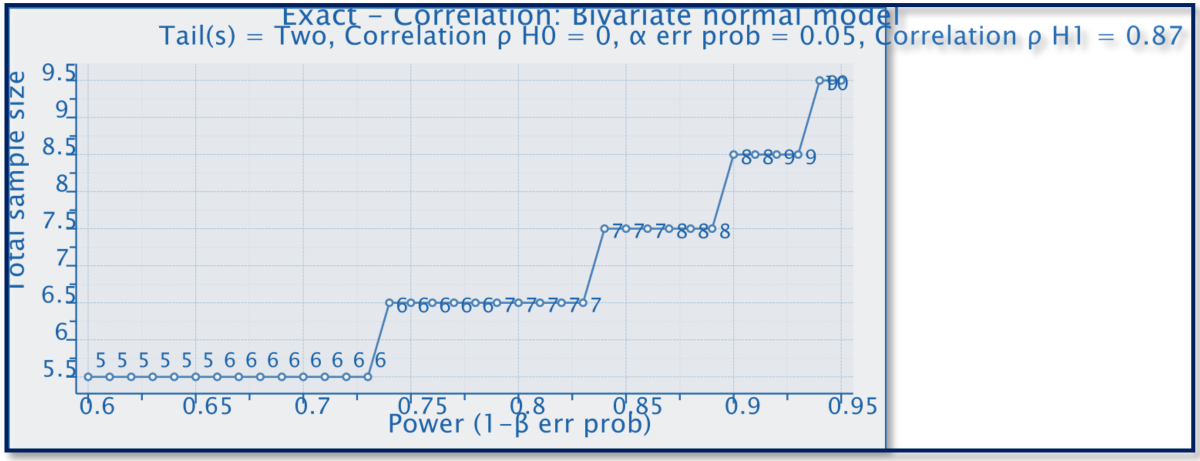
This study complied with the ethic norms of the institution in charge for human research (institutional and national) and the Helsinki Declaration of 1975 as revised in 2008 and was licensed by the Ethical Committee of Non-Invasive Clinical Research of Yeditepe University (acceptance date: 08/12/2023, acceptance number: 521).

In order to fulfill the objectives of this project, a retrospective cohort study was designed. This research was carried out in a retrospective manner of subjects who had undergone decompression therapy on the jawbone at the Department of Oral and Maxillofacial Surgery of Yeditepe University, Dentistry Faculty from 2011 to 2024 and had met the inclusion criteria. All patients must have received their treatments at Oral and Maxillofacial Surgery Department of Dentistry Faculty. Inclusion criterias are patients who volunteered to participate in the study in voluntary basis, lesions in the posterior mandible or ramus, patients who had before and after CBCT records at Yeditepe University, Dentistry Faculty, patients who had the biopsy report, patients who received their treatment via decompression therapy. Exclusion criterias are lesions in areas other than posterior mandible, patients whose biopsy records couldn’t have reached, patients who received other treatments, patients who didn’t accept treatment, patients who had biopsy report results other than cyst.

G*Power (v3.1.9) software was used to calculate statistical power to find out the appropriate size for the study. The correlation between the volume reduction and initial volume was grounded upon the research conducted by ***‘U. Consolo’*** **et al.** in 2020 and it was determined that 12 patients should be included in the study considering 95% confidence level, power and bivariate normal model (Table 3.1.).

Table 3.1. G* Power analysis

Exact Correlation:	Options:	Analysis:	Input:	Output:
Bivariate normal model	Exact Distribution	A priori: Computed required sample size	Tail(s) = Two	Lower critical r = -0.6318969
			Correlation ρ H1 = 0.87	Upper critical r = 0.6318969
			Aerrprob = 0.05	Total sample size = 10
			Power (1-β err prob) = 0.95	Actual power = 0.9610443
			Correlation ρH0 = 0	



For the sampling, in order to access the patient's data with cyst diagnosis, we obtained the necessary permission from the medical coordinator department in the Dentistry Faculty, then with the permission paper, we applied to the Information Technology (IT) Department for the patient's data. Three hundred and sixty-five patients with cyst diagnosis were reviewed initially. In the second stage, CBCT images of patients with the diagnosis with cyst between the years 2011 and 2024 were retrieved from the archives of the Department of Dentomaxillofacial Radiology at Yeditepe University, Faculty of Dentistry. The images were the diagnostic records collected for intraoral cystic lesions. CBCT scans were not performed for the purpose of this study.

All scans were taken using the same imaging device (i-CAT Imaging Science International, Inc. Hatfield, PA, USA). A single volume contains 327 units of measurement. The figures were displayed utilizing the i-CAT Vision program on the same computer and monitor (Figure 3.1.).

Figure 3.1. Cone Beam CT machine (i-CAT Imaging Science International, Inc. Hatfield, PA, USA)

3.2 Eligibility Process

All patient's data were reviewed and those who have CBCTs before decompression and before enucleation and those who had the cyst in the mandibular posterior or ramus region were incorporated in the research sampling. Then an of 12 patients were considered eligible for this study (Figure 3.2.).

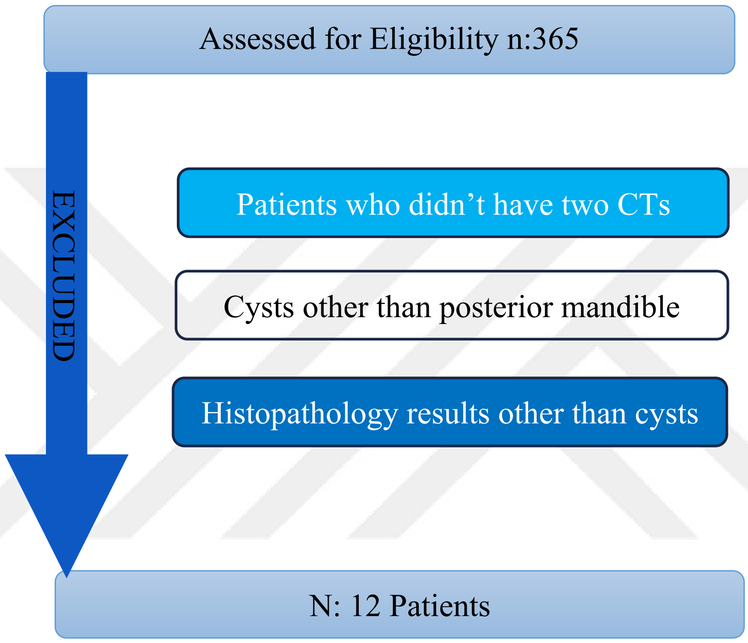


Figure 3.2. Eligibility criteria process of study sample

3.3 Surgical Procedures for Decompression

All operative treatments were conducted in accordance with the established guidelines. Decompression was carried out via infiltrative injections with articaine, including 0.006 mg epinephrine (Sanofi Aventis İlaçları, İstanbul, Turkey). A tiny cut was made around the lesion via 15 blade. If the compact osseous part of the cut was bony, an opening was created via a surgical motor and a bur chosen by the operator. After approaching the lesion, a part of the cyst tissue was cut and stabilized within formalin solution and sent for the histopathological examination. After applying the tube (Bıçakçılar Turkey) (Figure 3.3.) or impression material (Zeta Plus) (Figure 3.4.) or acrylic stent (Figure 3.5.) into the cyst, the flap was sutured back to its original position using the 3-0 silk suture (Doğsan, Trabzon, Turkey). Irrigating the area was done via saline solution. Subsequently, prescriptions were given. Amoxicillin + Clavulanic acid 1 gr. (Twice a day), Naproxen Sodium 550 mg. (Twice a day) and a 0.2% chlorhexidine irrigation was topically rinsed (for 1 min, thrice a day) for 7 days. A training program was implemented whereby patients were instructed in the technique of self-irrigation with saline solution. Following decompression protocol, the operator conducted a monthly assessment of the condition of the drainage equipment. In the event of contamination, a new one was introduced in its place. Subsequent to decompression, the procedure designated as excision and debridement entailed the enucleation of the lesion. The flap was opened, and the remaining cyst was enucleated and treated by curettage to the surrounding normal osseous tissue. The depth of curettage was typically between one and two millimeters, performed with a high-speed round bur. The objective of this protocol was to ensure the complete elimination of any residual epithelioid tissue.

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Figure 3.3. Impression material

Figure 3.4. Tube

Figure 3.5. Acrylic stent in a CBCT view

3.4 CBCT Data Progress

Three-dimensional computed tomography data were obtained utilizing a cone beam CT device (i-CAT, Imaging Science International, Inc., Hatfield, PA, USA) (Figure 3.1). A minimum of a 1 mm slice was acquired from each CT scan. All patients were subjected to computed tomography prior to undergoing decompression and enucleation between six months and 18 months. The CBCT scans were conducted at varying time points for every patient. In instances where two or more postoperative CBCT images were acquired, the final image conducted prior to the enucleation was utilized for the purpose of performing the requisite volume reduction measurement. A second CBCT was taken with the aim of obtaining information regarding the status of the healing progress to establish the optimal time for cyst enucleation. Special consideration was paid to the development of new osseous development on the mandible, as well as the position of the inferior alveolar canal within relation to the lesion.

3.5 3D Volume Measurements

The volume of the lesions was calculated using Mimics 20.0, a software program developed by Materialise Medical, Leuven, Belgium. Subsequently, the CT digital imaging and communications in medicine (DICOM) datasets were loaded to the software, and slicing was conducted in the axial, coronal, and sagittal planes. A manual threshold definition was employed in order to encompass the entirety of the cyst, whilst simultaneously eliminating any artefact. In establishing the margin of the cysts, the Hounsfield unit (HU) values of the three-dimensional voxel were set in each slice. It was hypothesized that the cystic cavity would be represented by values within the lower threshold range of −1000 to −500 Hounsfield units (HU) and the upper threshold range of 500 to 1000 HU in the CT slice. Following the manual editing of the masks for hard and soft tissues. A method of demarcation was employed around the area which was deemed to contain desired region. In the event of any discrepancy, the 3D imaging was subject to manual correction. The lesion cross-section was delineated on computed tomography slices, with the delineated images then integrated to reconstruct the lesion's 3D structure for subsequent volumetric measurement. The volumetric measurement was done in cubic millimeters (mm^3) based on the three-dimensional imaging data obtained from the software. This was then calculated in order to find out the volume reduction and the percentage of volume reduction. The resulting data were subsequently analyzed using

Microsoft Excel version 2021 (Microsoft Corp., Redmond, WA, USA). In a room with minimal illumination, one observer conducted the volumetric measurement. To ensure consistency and accuracy, all measurements were conducted by the same observer. In order to minimize potential intra-observer discrepancies, the volume of each lesion was measured on two occasions, with the mean value used for subsequent analysis (see Figure 3.6-3.23).

The reduction in volume of the cysts was calculated as follows, subtracting the postoperative volume for each patient from the preoperative volume. The program automatically excluded involving tooth from the cyst area and we manually excluded the inferior alveolar nerve (IAN) from the cyst by erase its borders manually (Video 3.1.). The Percentage Reduction in the Volume (PRV) of cystic lesions in the jaw was calculated as follows: First, subtracting the cystic volume after decompression from cystic volume before decompression, then divide the result with cystic volume before decompression and finally multiple the result with the value one hundred.

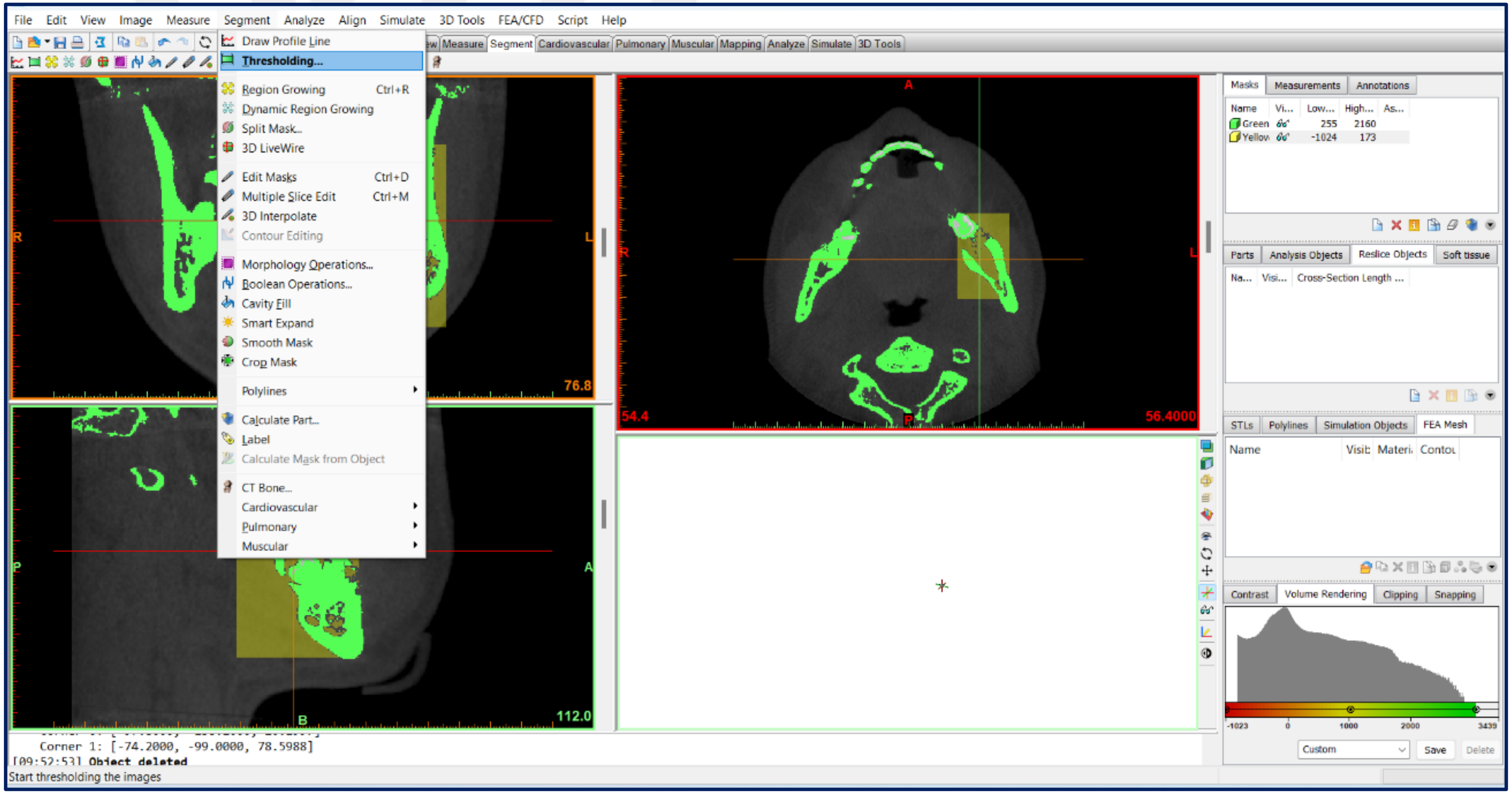


Figure 3.6. Thresholding option

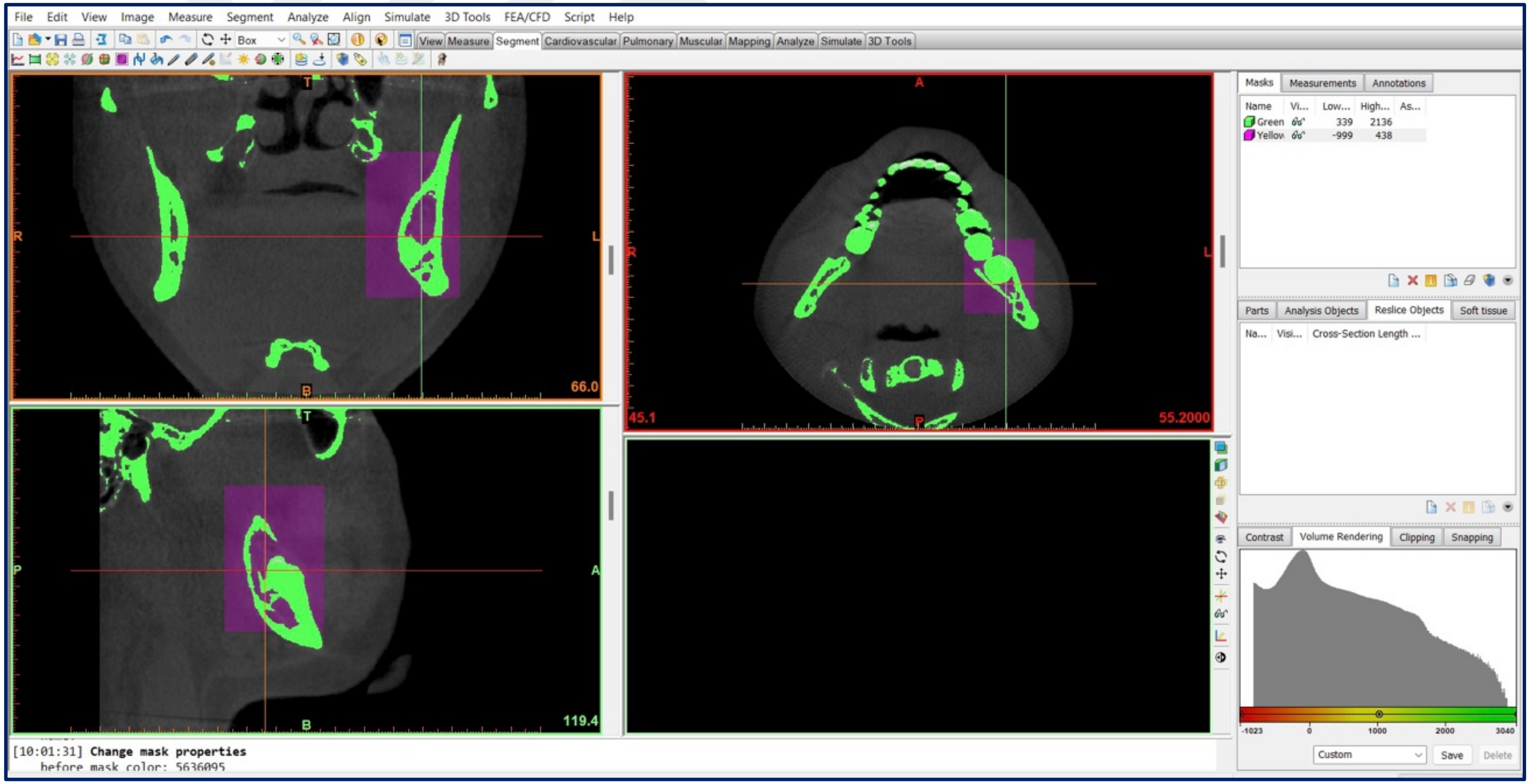


Figure 3.7. Coronal, sagittal and axial view of the cropped areas

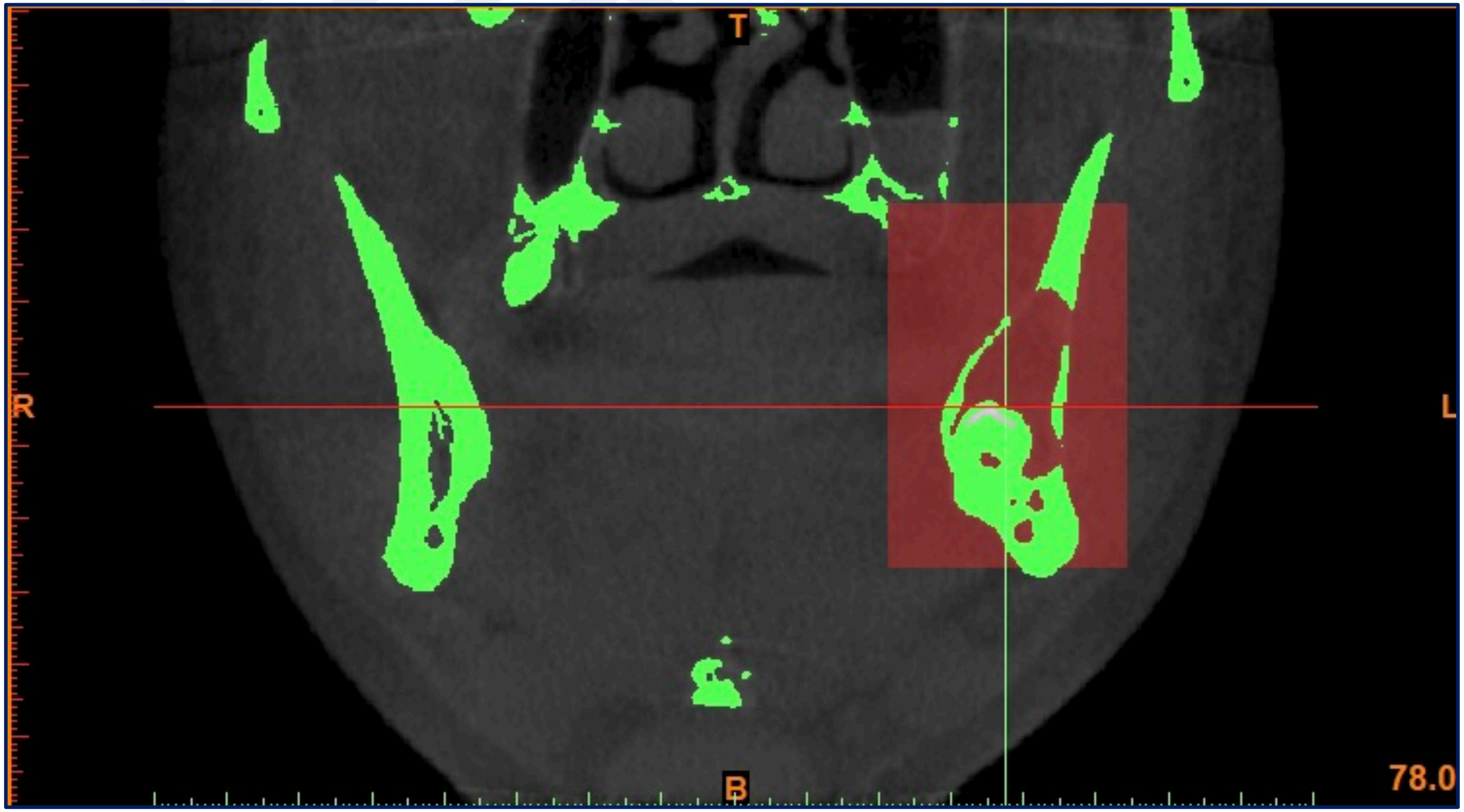


Figure 3.8. Coronal plane cropped interested area

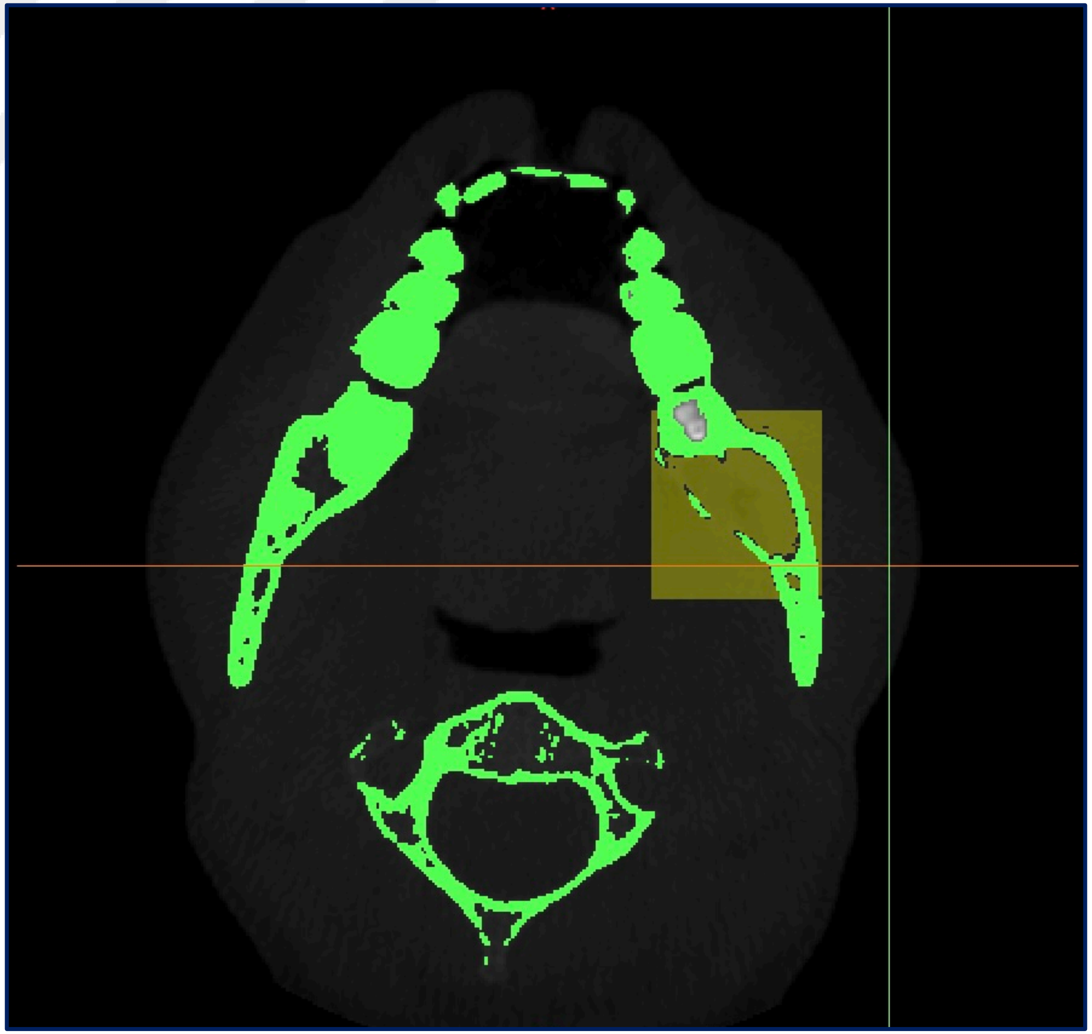


Figure 3.9. Mimics program crop feature of the interested area in the axial plane

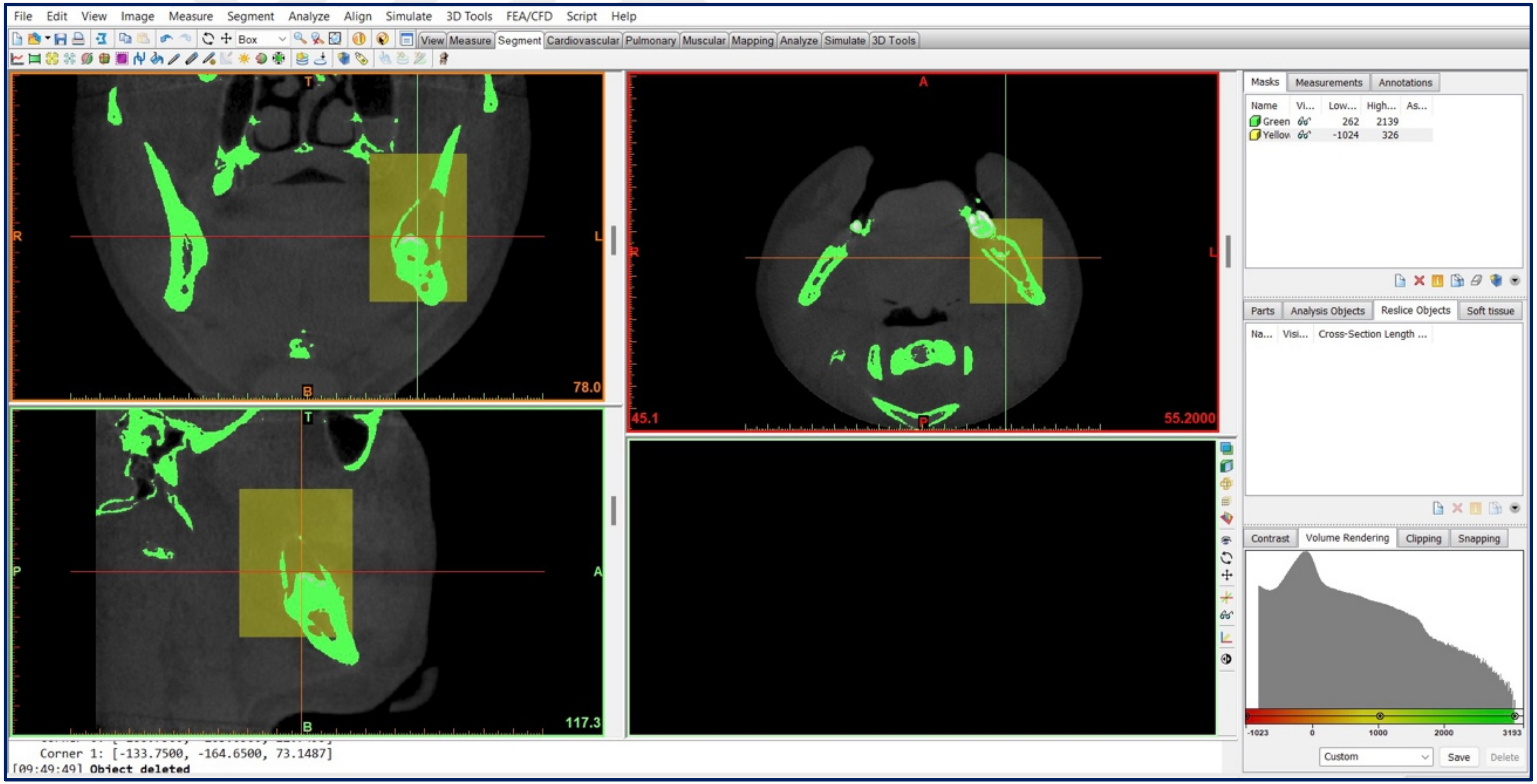


Figure 3.10. Coronal, sagittal and axial planes cropped interested area

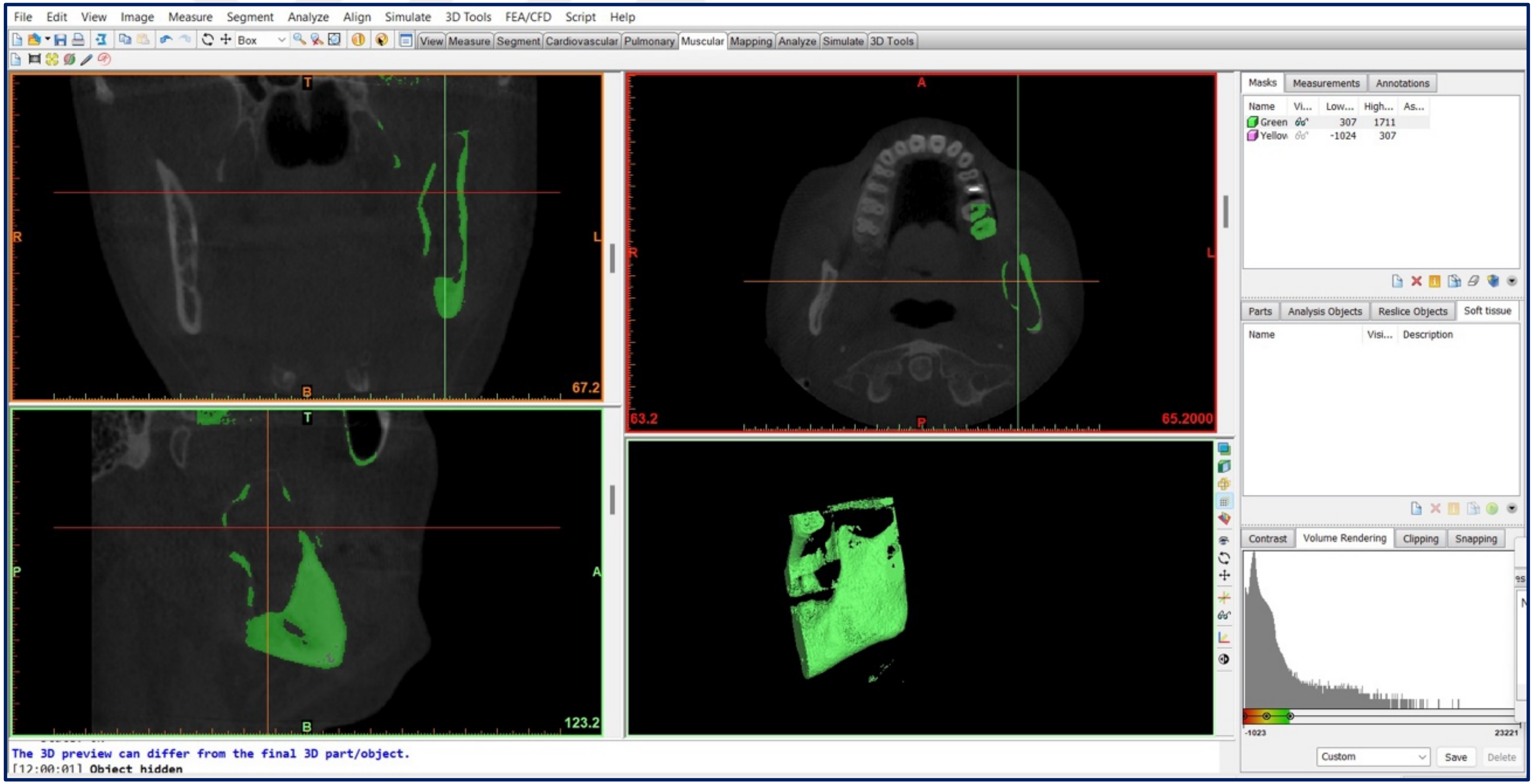


Figure 3.11. Coronal, sagittal, axial planes and 3D bone cropped area view

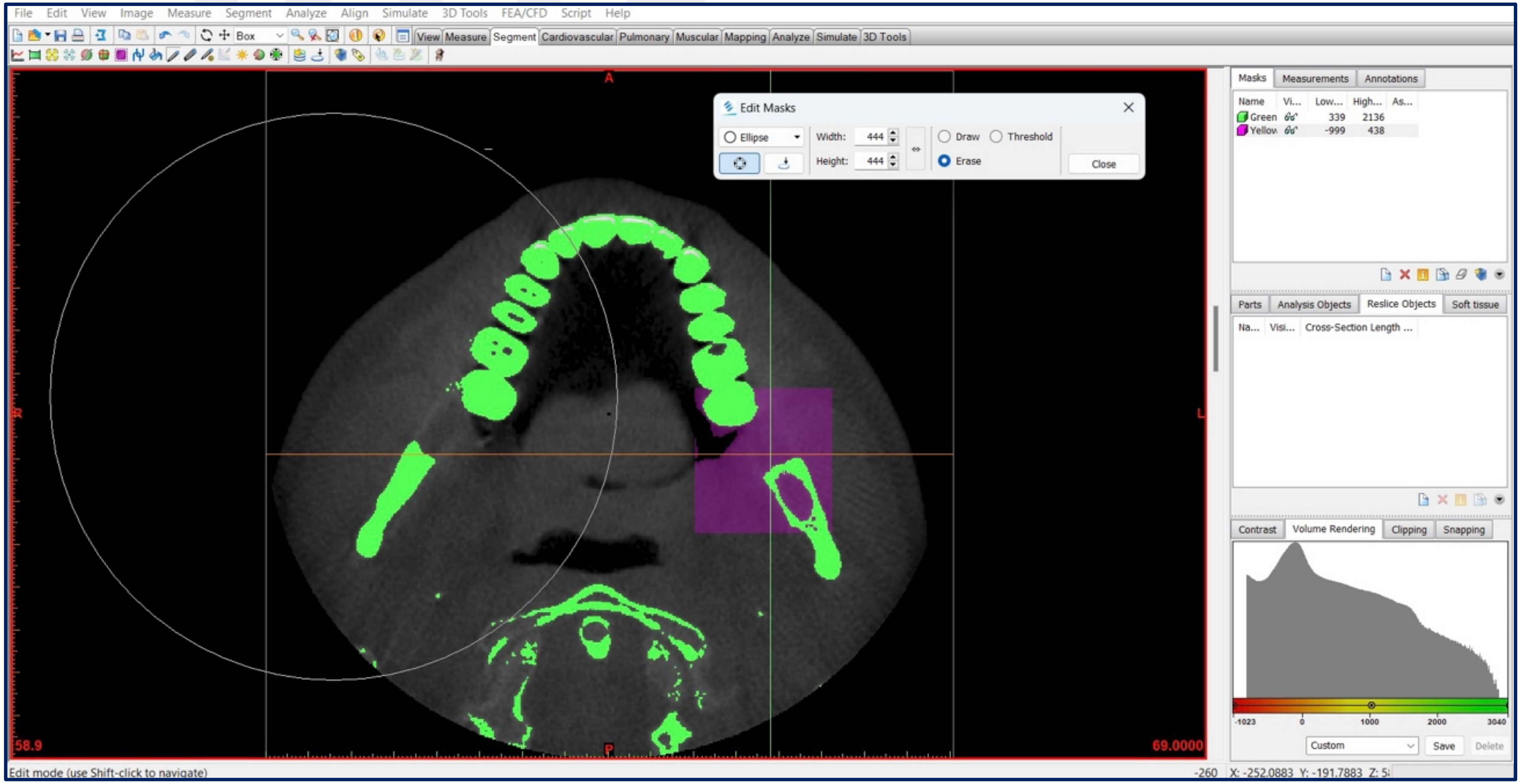


Figure 3.12. Erasing the unnecessary part to estimate the interested area

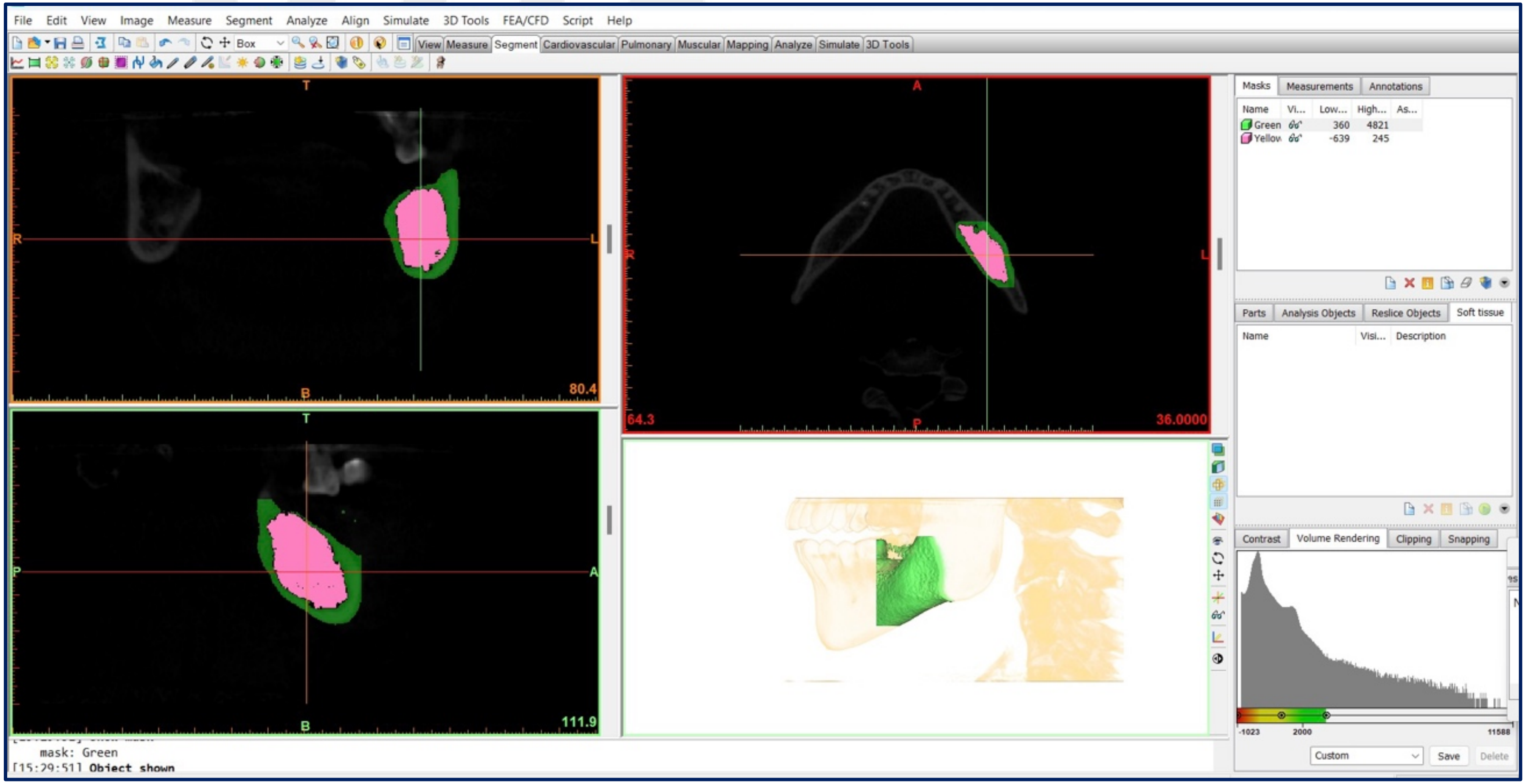


Figure 3.13. Coronal, sagittal, axial and 3D bone views

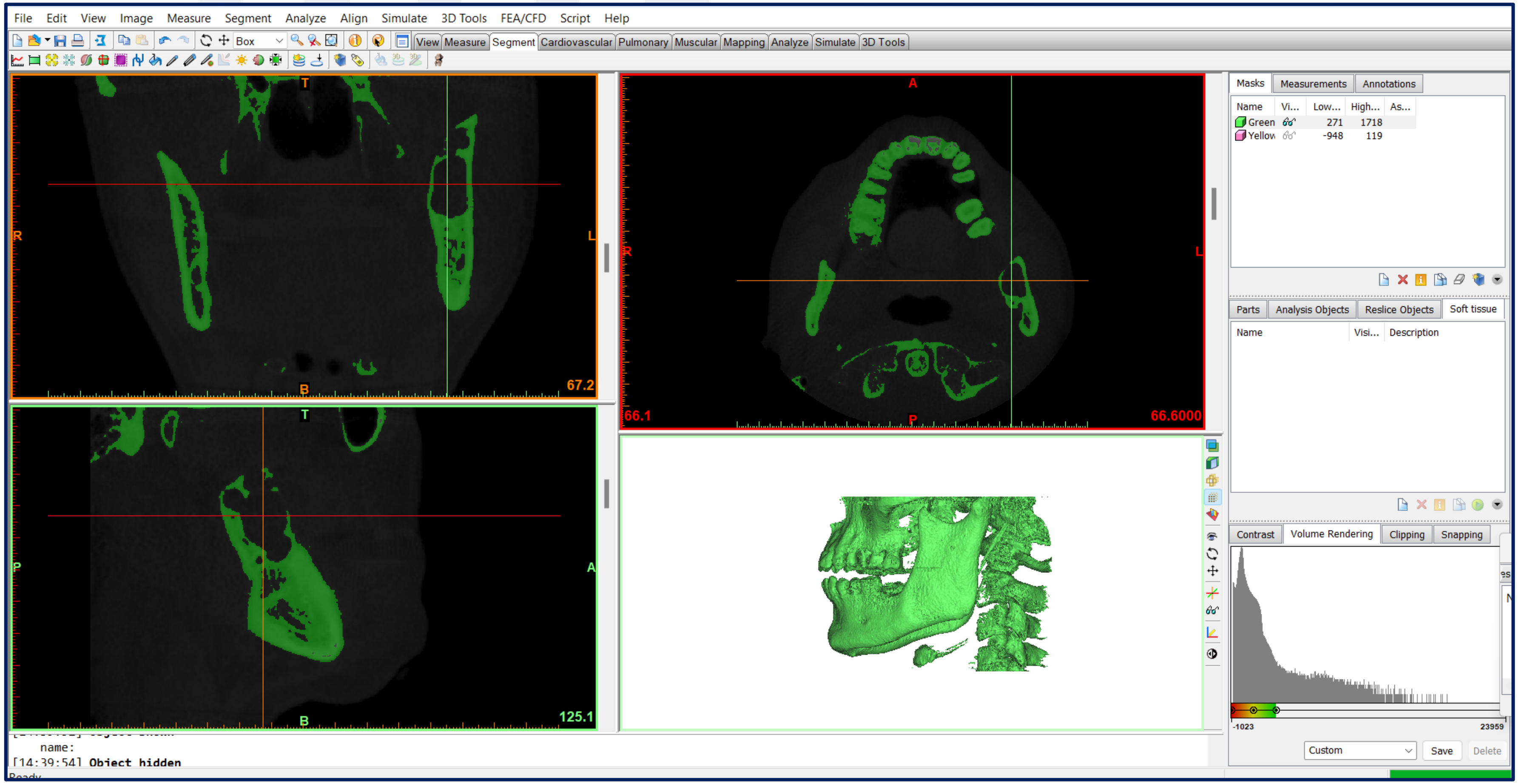


Figure 3.14. Coronal, sagittal, axial planes and 3D bone view

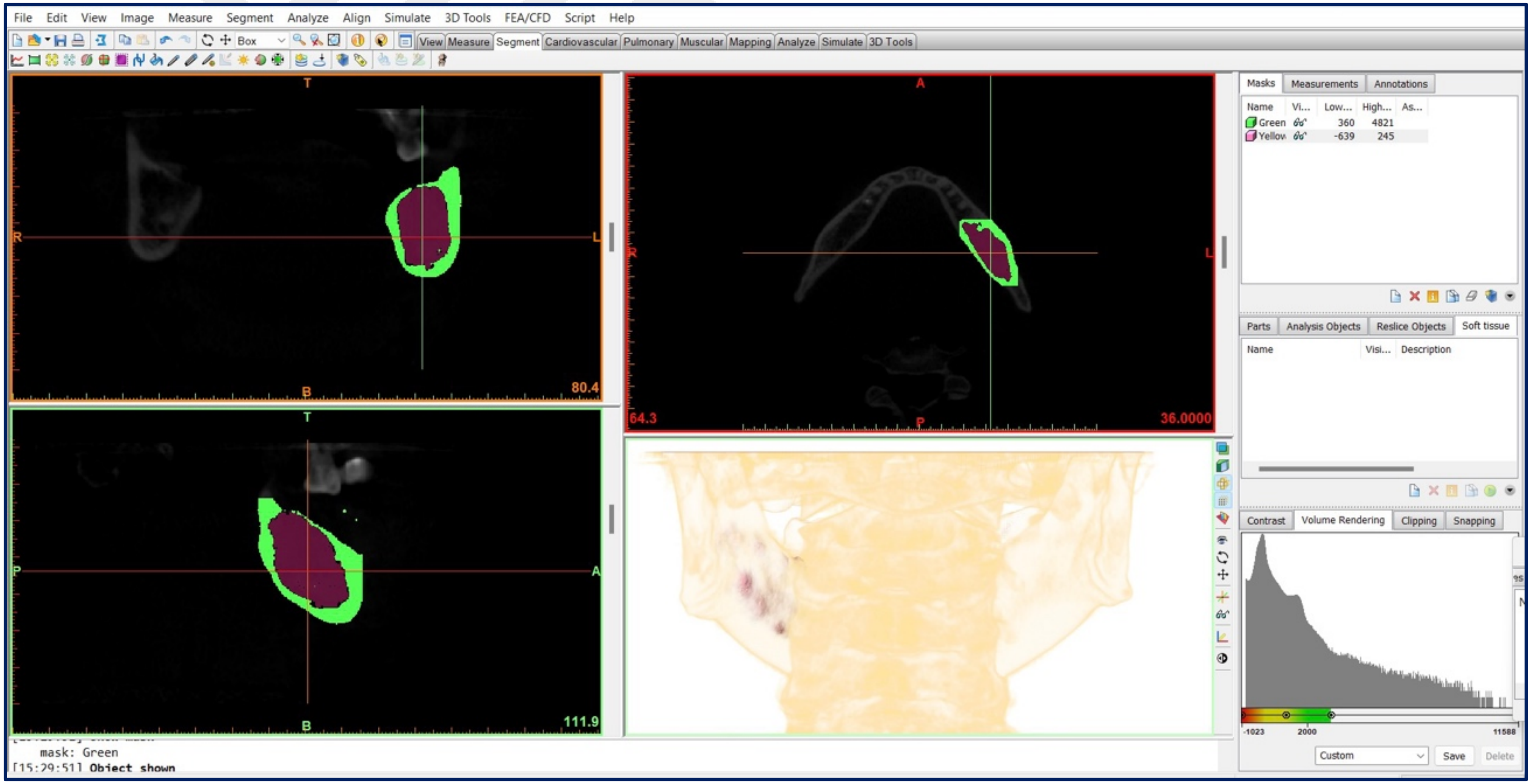


Figure 3.15. Coronal, sagittal, axial planes and 3D rendering

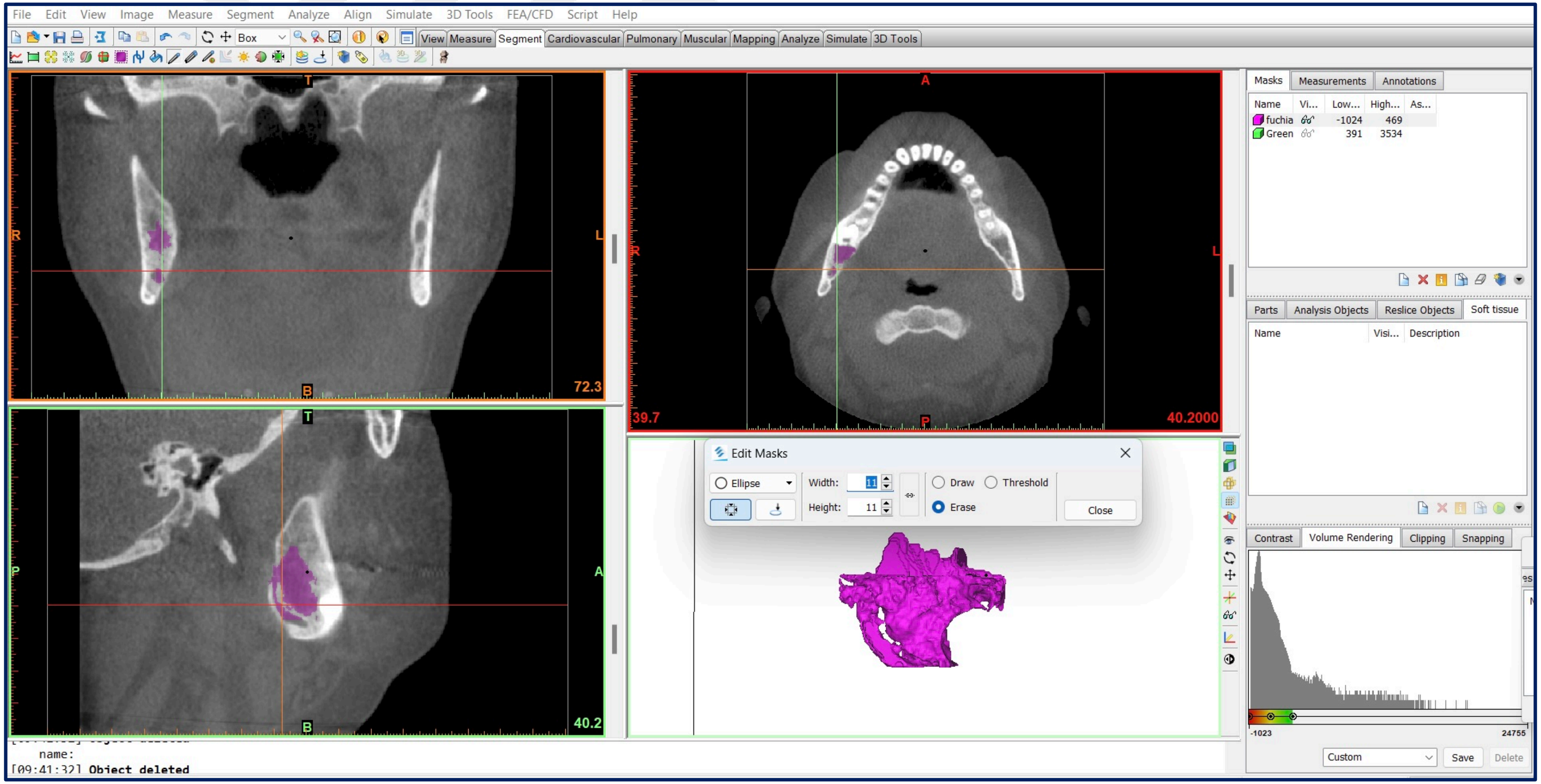


Figure 3.16. Coronal, sagittal, axial planes and 3D image of the cyst before erasing the inferior alveolar nerve manually

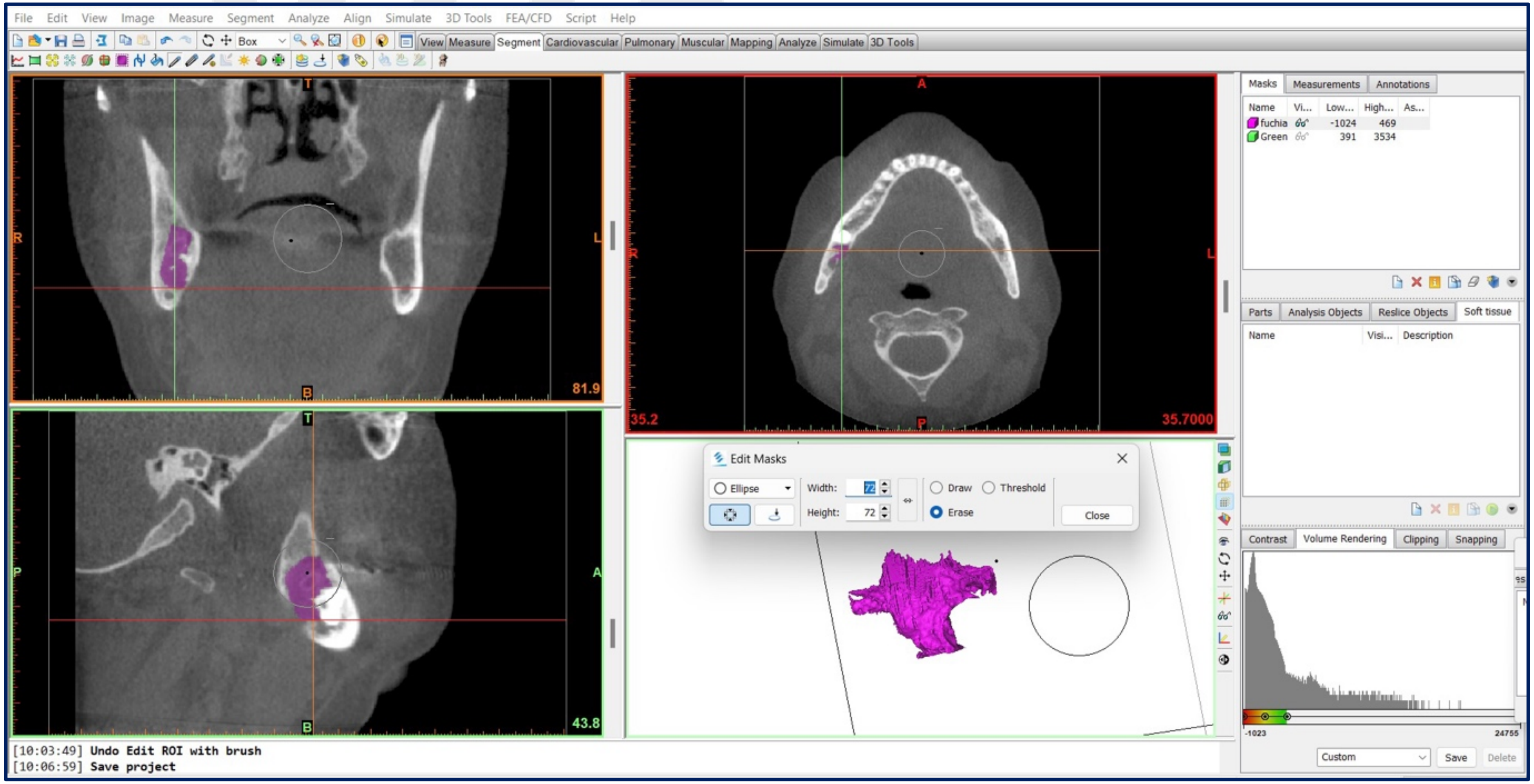


Figure 3.17. Coronal, sagittal, axial planes and 3D image of the cyst after erasing the inferior alveolar nerve manually

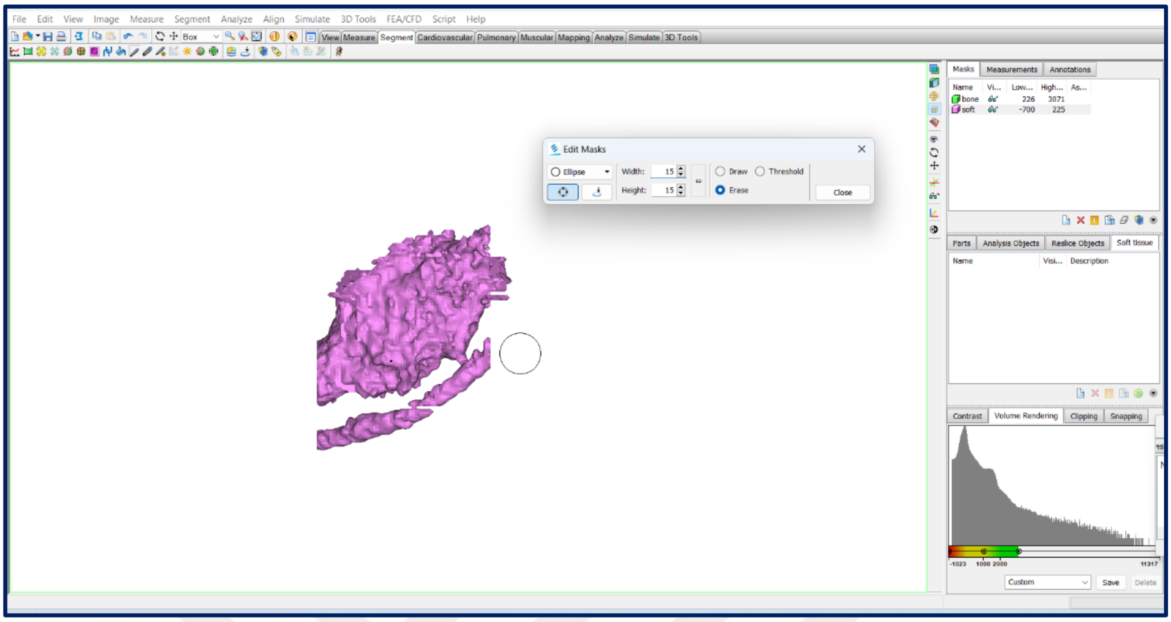
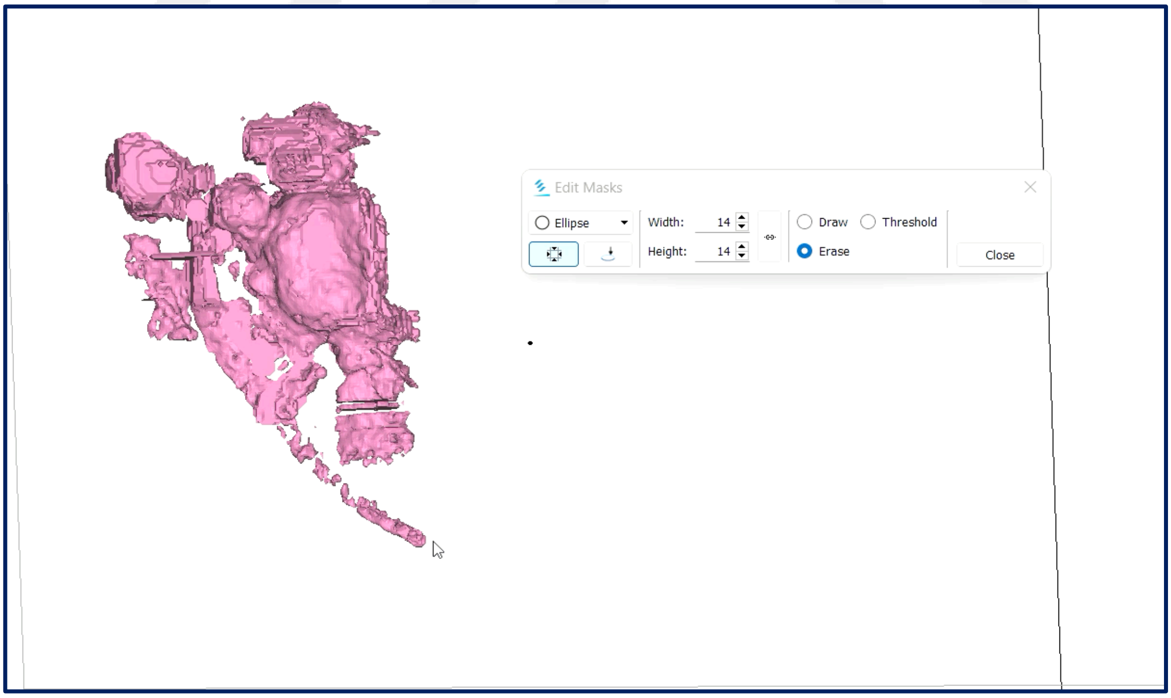


Figure 3.18. Before erasing inferior alveolar verve manually



Video 3.1. Demonstration of erasing the inferior alveolar nerve

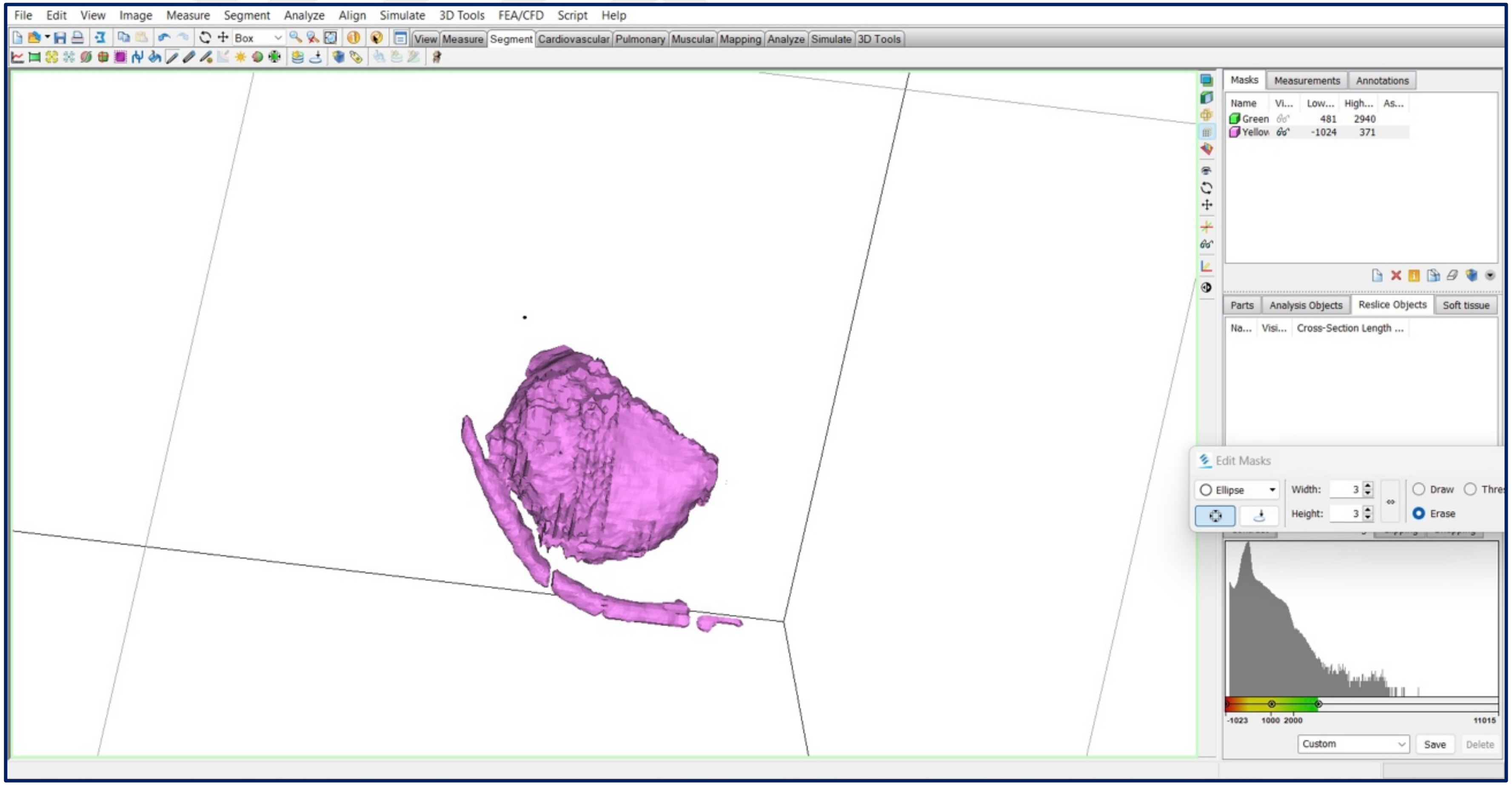


Figure 3.19. Before erasing inferior alveolar nerve manually

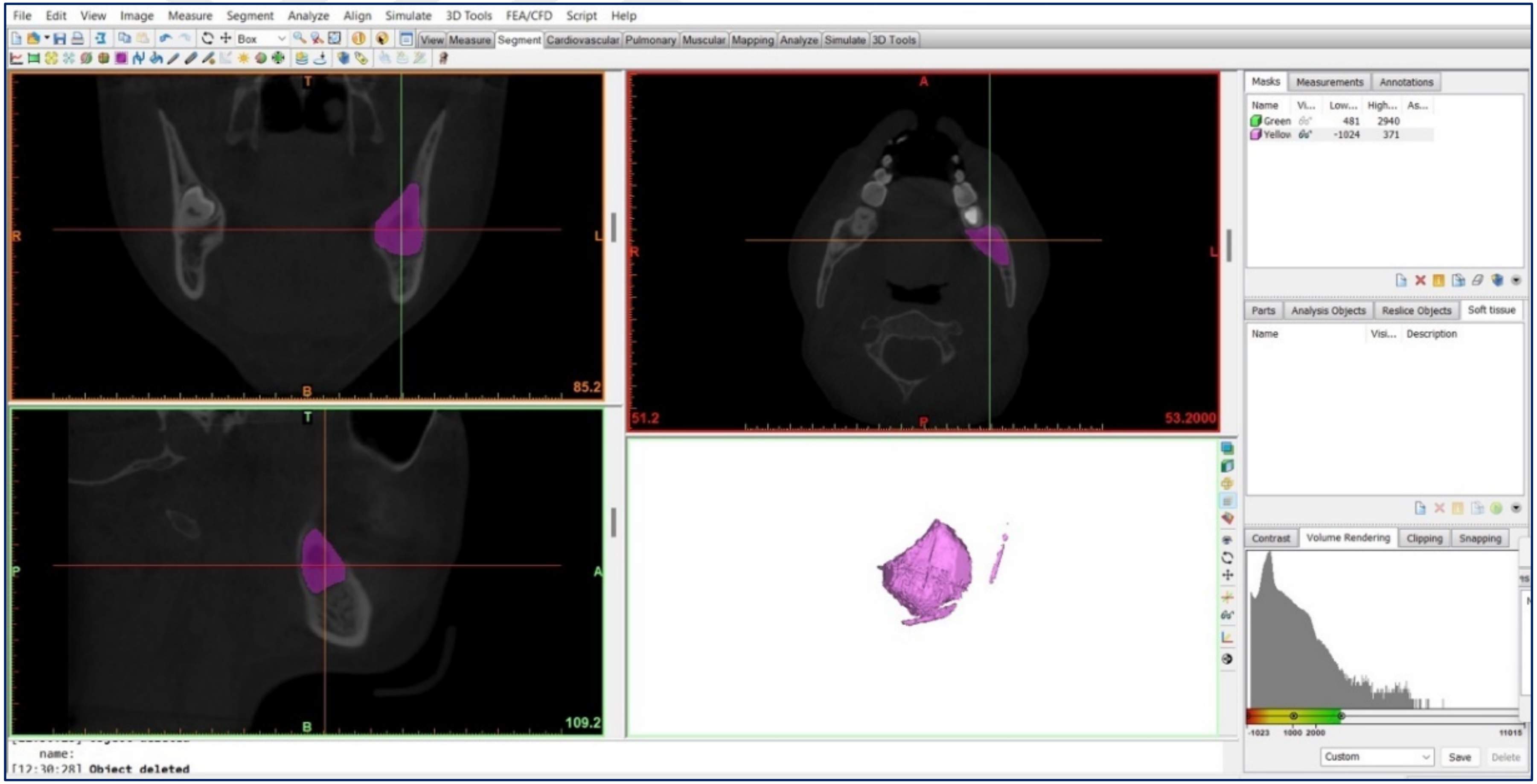


Figure 3.20. Coronal, sagittal, axial planes and 3D images of the cyst with inferior alveolar nerve

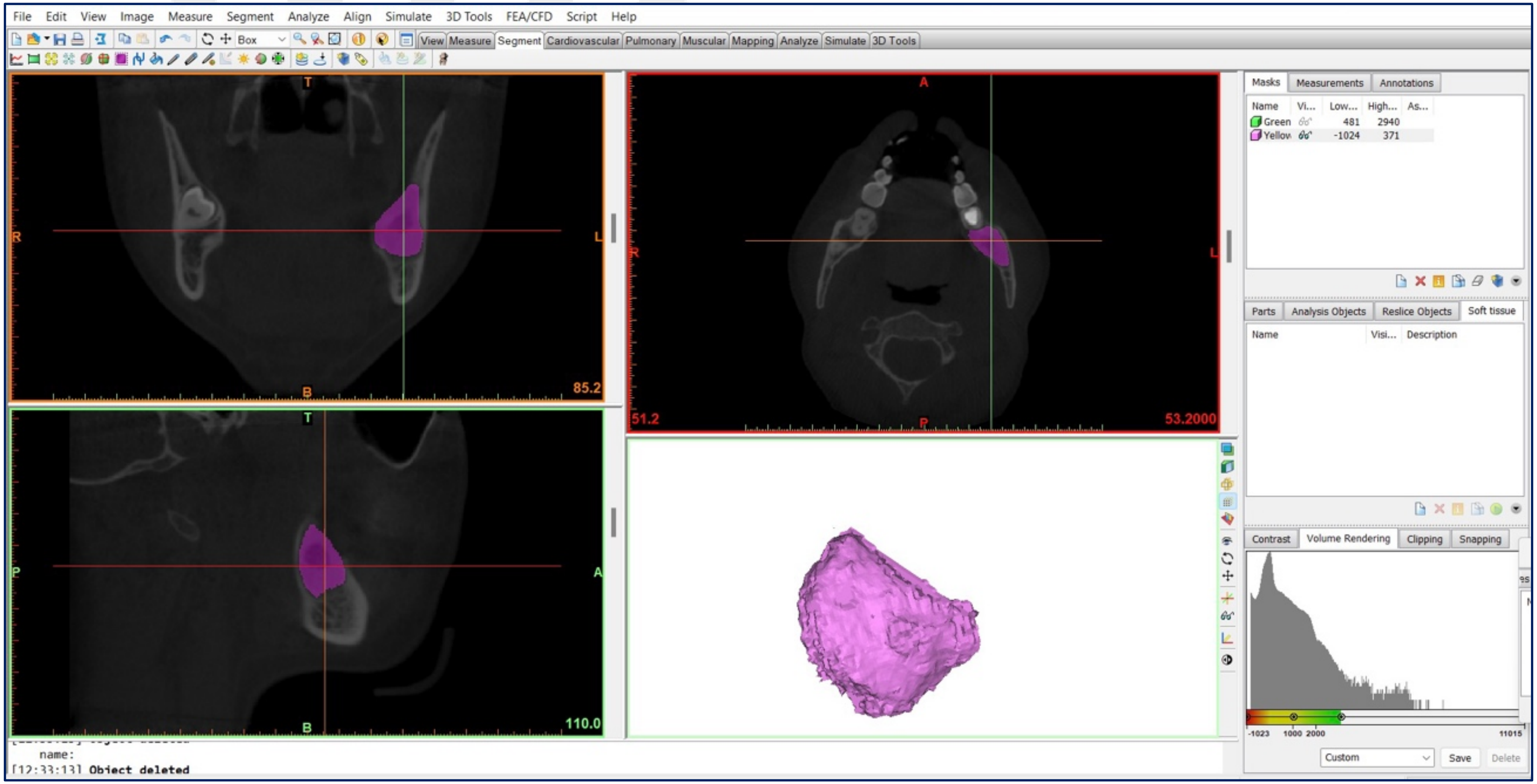


Figure 3.21. After erasing inferior alveolar nerve manually

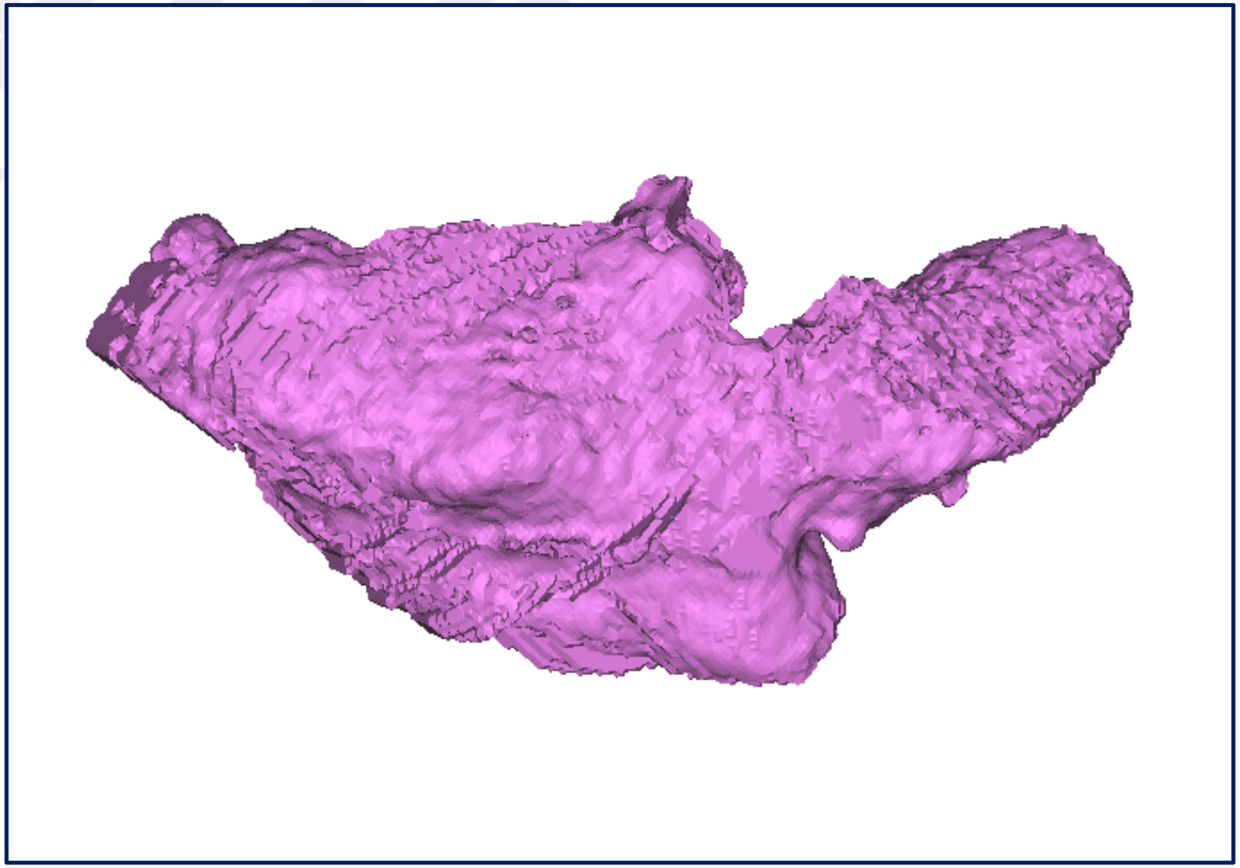


Figure 3.22. 3D view of cyst before decompression

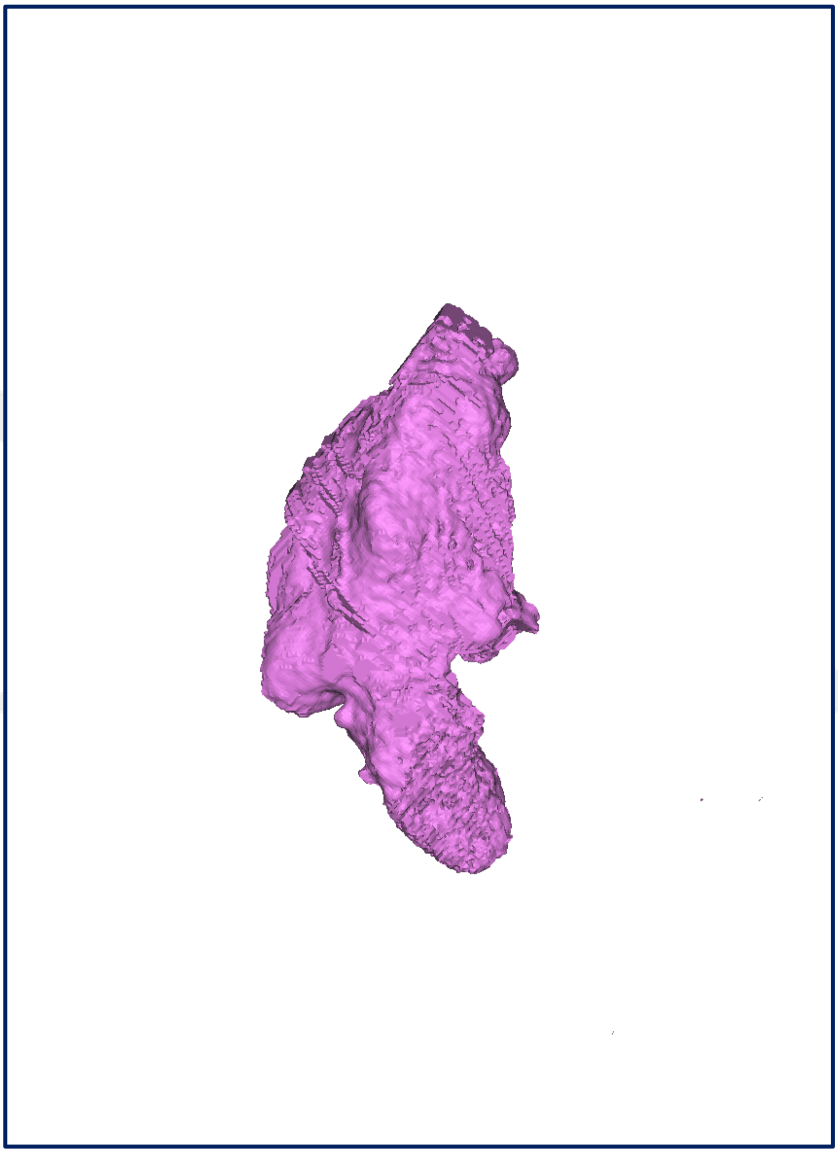


Figure 3.23. 3D view of cyst before decompression

3.6 Study Variables

We identified that the specific factors could impact the effect of decompression: age, gender, duration of decompression, initial volume, smoking, cortical bone expansion, cortical bone perforation, impacted tooth presence, drain localization, drain type, extraction, lesion type. These parameters were considered as predictor variables, whereas total and percentage of volume reduction were considered as the outcome variables (Table 3.2.,3.3.).

Table 3.2. Variables of the study

Patient	Age	Gender	Duration	Initial volume	Impacted tooth
1	16	Male	7 Months	26476,5254 mm^3	Yes
2	58	Female	9 Months	7577,5425 mm^3	Yes
3	23	Female	15 Months	15583,0596 mm^3	Yes
4	45	Female	6 Months	2587,6726 mm^3	No
5	48	Male	12 Months	5725,1611 mm^3	No
6	53	Male	6 Months	5237,8394 mm^3	No
7	26	Male	16 Months	6431,1670 mm^3	Yes
8	49	Male	12 Months	12872,0537 mm^3	Yes
9	49	Male	18 Months	9903,0801 mm^3	Yes
10	44	Male	8 Months	8116,0767 mm^3	No
11	27	Male	8 Months	3980,6575 mm^3	Yes
12	21	Male	6 Months	7354,2021 mm^3	Yes

Table 3.3. Variables of the study

Patient	Cortical expansion	Cortical perforation	Smoking	Drain localization	Lesion type	Drain type	Extraction
1	Yes	Yes	No	Occlusal	Keratocyst	Acrylic Stent	No
2	Yes	Yes	No	Buccal	Dentigerous	Tube	No
3	Yes	Yes	No	Buccal	Keratocyst	Tube	No
4	Yes	Yes	Yes	Buccal	Keratocyst	Tube	No
5	Yes	No	No	Occlusal	Keratocyst	Zeta Plus	Yes
6	No	No	Yes	Occlusal	Keratocyst	Tube	No
7	Yes	Yes	No	Buccal	Dentigerous	Tube	Yes
8	No	Yes	No	Occlusal	Dentigerous	Acrylic stent	No
9	Yes	Yes	No	Buccal	Keratocyst	Zeta Plus	Yes
10	No	Yes	No	Buccal	Keratocyst	Tube	No
11	Yes	No	No	Buccal	Dentigerous	Tube	No
12	Yes	Yes	No	Buccal	Keratocyst	Tube	No

3.7 Statistical Analysis

All statistical analyzes were performed with International Business Machines (IBM) Statistical Package for the Social Sciences (SPSS) 25.0 program. In the research, first of all, it was determined whether the data collection tools complied with the normal distribution hypothesis by looking at the skewness and kurtosis coefficients, and non-parametric test methods were preferred. Descriptive statistics are then given. Finally, the hypothesis evaluation was made. Three methods were chosen when evaluating the hypothesis. These:

1. Since it does not provide the assumption of normal distribution in determining whether the change rates between the cyst volumes before decompression treatment and the cyst volumes after treatment of the patients included in the study differ according to gender, smoking, impacted tooth, cortical expansion, drainage localization, cortical localization, lesion types and removal situations. It was evaluated with the “Mann-Whitney U test”.

2. The change rates between the cyst volumes before decompression treatment and the cyst volumes after treatment of the patients included in the study were evaluated with the "Kruskall Wallis H Test" as it did not meet the assumption of normal distribution in determining whether there were differences according to drainage types.

3. The "Wilcoxon test" was used to determine whether the difference between the cyst volumes before decompression treatment and the cyst volumes after treatment was significant, as it did not meet the assumption of normal distribution.

4. The patients included in the study were evaluated with "Shearson Correlation Analysis" as it did not meet the assumption of normal distribution in determining whether there was a significant relationship between the change rates between cyst volumes before decompression treatment and cyst volumes after treatment, their ages and post-treatment measurement times.

Statistical significance in all results was evaluated at the **$p<0.05$** level.

4.RESULTS

4.1. Patient Distributions

After applying the exclusion criteria, the total number of samples was 12 (3 female and 9 male) with an average age of 38,25 years (range, 16-58 years). All the patients completed the decompression period uneventfully and followed up regularly. The histological diagnosis at the time of surgical decompression was confirmed in all cases by the second histological analysis after enucleation. The lesions comprised 8 keratocytes and 4 dentigerous cysts. Impacted teeth existed in 8 patients out of 12 patients. The number of patients with both cortical expansions and cortical perforations were 9. Drain localizations were in the buccal region in 4 patients whereas in occlusal region in 8 patients. 2 patients were smokers. The number of cases involving tooth extraction were 3 respectively (Table 4.1.). Subjects were categorized in accordance with to gender, age, initial volume of the lesion, duration, presence of involved teeth, cortical bone expansion, cortical bone perforation, smoking, drain localization, drain type, extraction and pathological diagnosis.

Developing the normal distribution analysis results should be close to the mean-median coverage and the kurtosis and collision should be between ±1; It is seen that these values do not comply with the normal distribution according to the variables. Non-parametric tests that are not suitable for normal distribution were used for the study (Table 4.2.).

Table 4.1. Demographic information of the subjects

Demographic info		***n***	***%***
Gender	Female	3	25,00%
	Male	9	75,00%
Impacted tooth	Yes	8	66,70%
	No	4	33,30%
Cortical expansion	Yes	9	75,00%
	No	3	25,00%
Cortical perforation	Yes	9	75,00%
	No	3	25,00%
Smoking	Yes	2	16,70%
	No	10	83,30%
Drain localization	Buccal	4	33,30%
	Occlusal	8	66,70%
Lesion type	Keratocyst	8	66,70%
	Dentigerous	4	33,30%
Drain type	Acrylic stent	2	16,70%
	Tube	8	66,70%
	Zeta plus	2	16,70%
Extraction	Yes	3	25,00%
	No	9	75,00%

Table 4.2. Result of Normality Tests for the Distribution of Data

Variables	*Statistics*	*df*	*p*	*Mean*	*Median*	*Min.*	*Max*	*Skew.*	*Kurtos.*
Initial volume	0,819	12	0,016	9320,42	7465,87	2587,67	26476,53	1,87	3,99
Last Volume	0,936	12	0,443	2327,71	2070,53	0	4625,19	0,39	-0,57
Volume difference	0,783	12	0,006	6992,54	5581,88	1466,96	21849,33	1,91	3,69
Percentage Volume Reduction	0,876	12	0,077	71,175	66,5	56,9	100	1,08	0,16

Analysis Results of the Differences Between Pre-treatment Cyst Volumes and Post-Treatment Cyst Volumes of the Patients within the Scope of the Study

Wilcoxon test was performed to determine whether the cyst volumes of the patients included in the study differed according to the pre-test and post-test groups. According to the results of the Wilcoxon test, the difference in cyst volumes of the individuals according to the test group was determined to be statistically significant at a 95% confidence level ($z=-3.06$, $p<.05$). According to the pre-test group, it was determined that all of the patients ($n=12$) became negative and remained in a negative state (mean rank = 6.5). It was determined that all patients had a decrease in cyst volumes after treatment (Table 4.3.).

Table 4.3. Statistical analysis of the differences between last and initial volume

	Test	*n*	*mean rank*	*z*	*p*
Last-initial volume	Negative Ranks	12	6,5	-3,059	0,002
	Positive Ranks	0	0		
	Ties	0			

Analysis Results of the Differences in the Rate of Change in Cyst Volumes of the Patients within the Scope of the Study, According to Their Gender

Mann Whitney U test was performed to determine whether the rate of change in cyst volumes of the patients included in the study differed according to gender. According to the Mann Whitney U test results, it was determined that the difference in the rate of change in cyst volumes according to gender was not statistically significant at the 95% confidence level (Table 4.4.).

Table 4.4. Correlation between Percentage Volume Reduction and Gender

	Gender	*n*	*mean rank*	*u*	*p*
Percentage Volume Reduction	Female	3	7	12	0,782
	Male	9	6,33		

Analysis Results of the Relationship Between the Rate of Change in Cyst Volumes and Their Ages of the Patients within the Scope of the Study

Spearson correlation coefficient was examined to determine whether there was a significant relationship between the rate of change in cyst volumes and the ages of the patients included in the study. According to the results of the correlation analysis, it was determined that there was no statistically significant relationship between the rate of change in cyst volumes and patient's ages (Table 4.5.).

Table 4.5. Correlation between Percentage Volume Reduction and Age

		Percentage Volume Reduction
Age	r	-0,357
	p	0,254
	N	12

Analysis Results of the Relationship Between the Rate of Change in Cyst Volumes of the Patients in the Scope of the Study and Initial Volume

Pearson correlation coefficient was examined to determine whether there was a significant relationship between the rate of change in cyst volumes and initial volumes of the cysts of the patients included in the study. According to the results of the correlation analysis, it was determined that there was statistically significant relationship between the rate of change in cyst volumes and initial cyst volumes (Table 4.6).

Table 4.6. Correlation between Volume Reduction and Initial Volume

	Mean	*Min.*	*Max.*	*r*	*p*
Initial Volume	9320,42	2587,67	26746,53	0,98	0,22
Volume Reduction	6992,54	5581,88	21849,33		

Analysis Results of the Relationship Between the Rate of Change in Cyst Volumes of the Patients in the Scope of the Study and Duration

Spearson correlation coefficient was examined to determine whether there was a significant relationship between the rate of change in cyst volumes of the patients included in the study and the measurement times after treatment. According to the results of the correlation analysis, it was determined that there was no statistically significant relationship at the 95% confidence level between the rate of change between cyst volumes and the duration (Table 4.7).

Table 4.7. Correlation between Percentage Volume Reduction and Duration

		Percentage Volume Reduction
Duration	r	0,145
	p	0,653
	N	12

Analysis Results of the Differences in the Ratio of Change in Cyst Volumes of the Patients within the Scope of the Study, According to Their Smoking Status

Mann Whitney U test was performed to determine whether the rate of change in cyst volumes of the patients included in the study differed according to their smoking status. According to the results of the Mann Whitney U test, it was determined that the difference in the rate of change in patient's cyst volumes according to their smoking status was not statistically significant at a 95% confidence level. Patient's smoking does not affect the change in cyst volumes (Table 4.8.).

Table 4.8. Correlation between Percentage Volume Reduction and Smoking

	Smoking	***n***	***mean rank***	***u***	***p***
Percentage Volume Reduction	Yes	2	4,5	6	0,39
	No	10	6,9		

Analysis Results of the Differences in the Ratio of Changes in Cyst Volumes of the Patients in the Scope of the Study, Depending on Whether They Have Impacted Tooth or Not

Mann Whitney U test was performed to determine whether the rate of change in cyst volumes of the patients in the study differed depending on whether they had impacted tooth or not. According to the results of the Mann Whitney U test, it was determined that the difference in the change rate between patient's cyst volumes according to their impacted tooth status was not statistically significant (Table 4.9.).

Table 4.9. Correlation between Percentage Volume Reduction and Impacted Tooth

	Impacted Tooth	*n*	*mean rank*	*u*	*p*
Percentage Volume Reduction	Yes	8	7,63	7	0,126
	No	4	4,25		

Analysis Results of the Differences in the Rate of Change Between Cyst Volumes of the Patients within the Scope of the Study, Depending on Whether or Not They Have Cortical Expansion

Mann Whitney U test was performed to determine whether the rate of change in cyst volumes of the patients in the study differed depending on whether there was cortical expansion or not. According to the results of the Mann Whitney U test, it was determined that the difference in the rate of change between cyst volumes of individuals according to their cortical expansion status was not statistically significant (Table 4.10.).

Table 4.10. Correlation between Percentage Volume Reduction and Cortical Expansion

	Cortical Expansion	*n*	*mean rank*	*u*	*p*
Percentage Volume Reduction	Yes	9	6,56	13	0,926
	No	3	6,33		

Analysis Results of the Differences in the Rate of Change Between Cyst Volumes of the Patients within the Scope of the Study, According to Drain Location

Mann Whitney U test was performed to determine whether the rate of change in cyst volumes of the patients included in the study differed according to the drain location. According to the results of the Mann Whitney U test, it was determined that the difference in the rate of change in cyst volumes of individuals according to the drain location was not statistically significant (Table 4.11.).

Table 4.11. Correlation between Percentage Volume Reduction and Drain Location

	Drain Location	*n*	*mean rank*	*u*	*p*
Percentage Volume Reduction	Buccal	4	6,25	15	0,865
	Occlusal	8	6,63		

Analysis Results of the Differences in the Rate of Change Between Cyst Volumes of the Patients within the Scope of the Study, According to Cortical Perforation Status

Mann Whitney U test was performed to determine whether the rate of change in cyst volumes of the patients in the study differed depending on whether there was cortical perforation or not. According to the results of the Mann Whitney U test, it was determined that the difference in the rate of change between patient's cyst volumes according to their perforation status was not statistically significant (Table 4.12.).

Table 4.12. Correlation between Percentage Volume Reduction and Cortical Perforation

	Cortical Perforation	***n***	***mean rank***	***u***	***p***
Percentage Volume Reduction	Yes	9	7,11	8	0,309
	No	3	4,67		

Analysis Results of the Differences in the Rate of Change Between Cyst Volumes of the Patients within the Scope of the Study, According to Lesion Types

Mann Whitney U test was performed to determine whether the rate of change in cyst volumes of the patients in the study differed according to lesion types. According to the results of the Mann Whitney U test, it was determined that the difference in the rate of change between patient's cyst volumes according to lesion types was not statistically significant (Table 4.13).

Table 4.13. Correlation between Percentage Volume Reduction and Lesion Types

	Lesion Types	*n*	*mean rank*	*u*	*p*
Percentage Volume Reduction	Keratocyst	8	6,25	6	0,497
	Dentigerous	4	7		

Analysis Results of the Differences in the Rate of Change Between Cyst Volumes of the Patients within the Scope of the Study, According to Drain Type

Kruskal Wallis H test was performed to determine whether the rate of change in cyst volumes of the patients included in the study differed according to drain type. According to the results of the Kruskal Wallis H test, it was determined that the difference in the rate of change in cyst volumes of individuals according to drain type was not statistically significant (Table 4.14).

Table 4.14. Correlation between Percentage Volume Reduction and Drain Type

	Drain Type	*n*	*mean rank*	*h*	*5*
Percentage Volume Reduction	Acrylic stent	2	7,5	2,962	0,227
	Tube	8	7,25		
	Zeta Plus	2	2,5		

Analysis Results of the Differences in the Change Rate Between Cyst Volumes of the Patients within the Scope of the Study, According to Extraction

Mann Whitney U test was performed to determine whether the rate of change in cyst volumes of the patients in the study differed according to extraction. According to the results of the Mann Whitney U test, it was determined that the difference in the rate of change between patient's cyst volumes according to their extraction status was not statistically significant (Table 4.15.).

Table 4.15. Correlation between Percentage Volume Reduction and Tooth Extraction

	Extraction	*n*	*mean rank*	*u*	*p*
Percentage Volume Reduction	Yes	3	5,67	11	0,644
	No	9	6,78		

As a result of the measurements made using the mimics program on the CBCTs taken before and after decompression, the first and last volume differences were found to be minimum 1466,9618 mm3 and the maximum 21849,334 mm3, while the percentage reduction of the cyst volume was found to be minimum 56.9% and maximum 100% (Table 4.16) (Figure 4.1. - 4.36.).

Table 4.16. Volume Difference and Percentage Volume Reduction of patients

Patient	Initial Volume	Last Volume	Volume difference	Percentage Volume Reduction
1	26476,5254 mm3	4625,1914 mm3	21849,334 mm3	82.5%
2	7577,5425 mm3	1753,5693 mm3	5823,9732 mm3	76.8%
3	15583,0596 mm3	1193,8379 mm3	14389,2217 mm3	92.3%
4	2587,6726 mm3	1120,7108 mm3	1466,9618 mm3	56.9%
5	5725,1611 mm3	2387,4836 mm3	3337,6775 mm3	58.2%
6	5237,8394 mm3	1601,8856 mm3	3635,9538 mm3	69.4%
7	6431,1670 mm3	0	6431,1670 mm3	%100
8	12872,0537 mm3	4554,2368 mm3	8317,8169 mm3	64.6%
9	9903,0801 mm3	3945,0720 mm3	5958,0081 mm3	60.1%
10	8116,0767 mm3	2776,2869 mm3	5339,7898 mm3	65.7%
11	3980,6575 mm3	1576,6949 mm3	2403,9626 mm3	60.3%
12	7354,2021 mm3	2397,5635 mm3	4956,6386 mm3	67.3%

60.1 %
18 Months

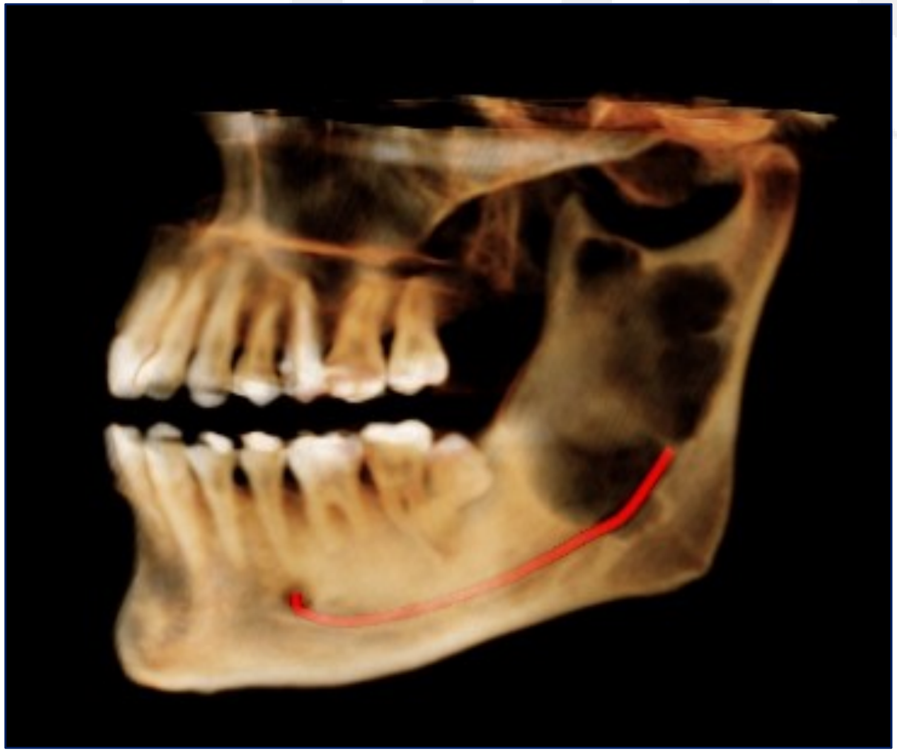


Figure 4.1. 3D view of the cyst before decompression

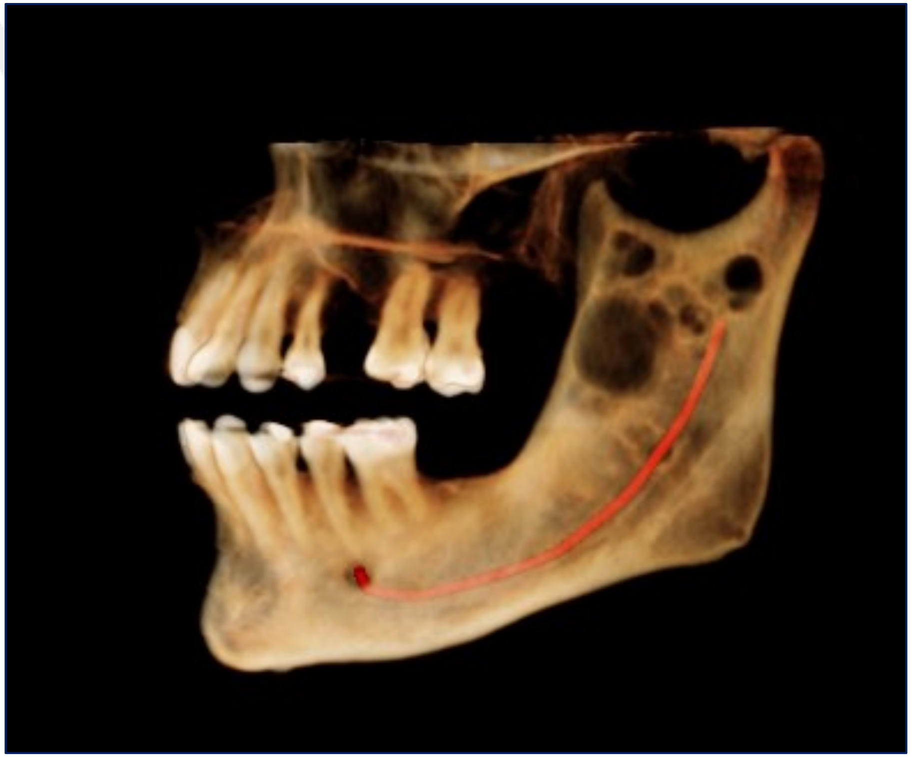


Figure 4.2. 3D view of the cyst before enucleation

65.7%
8 Months

Figure 4.3. 3D view of the cyst before decompression

Figure 4.4. 3D view of the cyst before enucleation

65.7%
8 Months

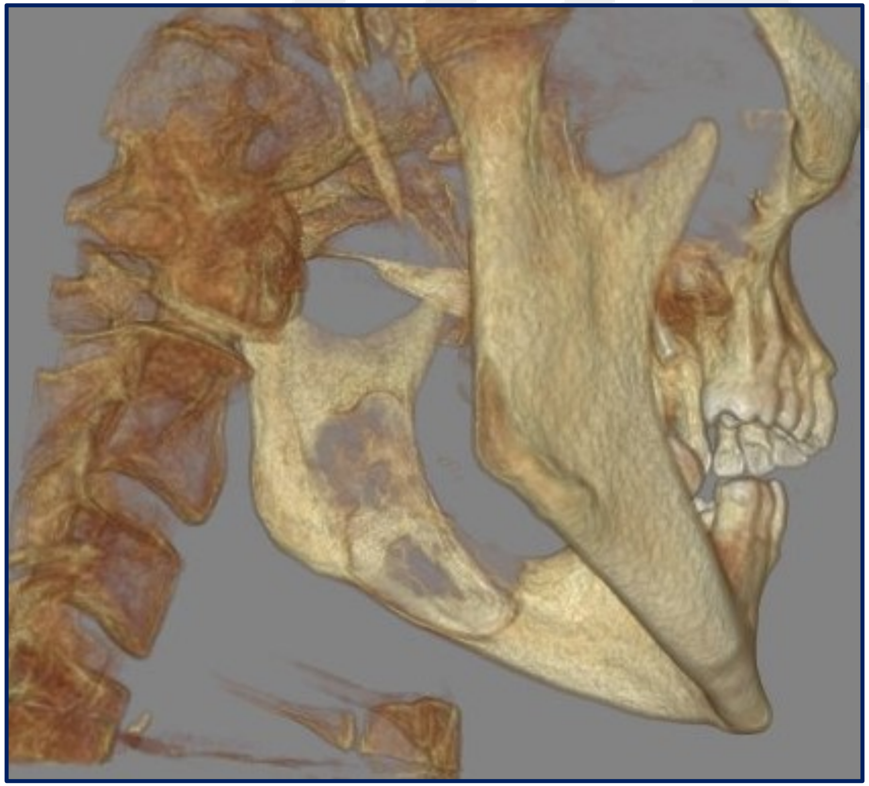


Figure 4.5. 3D lingual view of the cyst before decompression

Figure 4.6. 3D lingual view of the cyst before enucleation

82.5%
7 Months

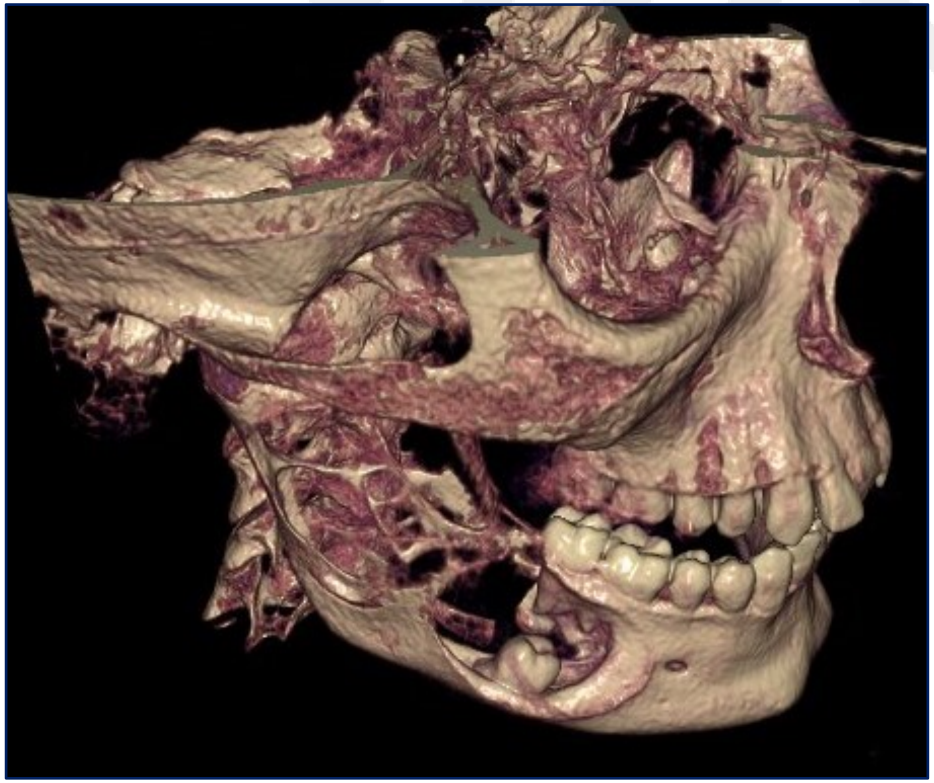


Figure 4.7. 3D view of the cyst before decompression

Figure 4.8. 3D view of the cyst before enucleation

76.8%
9 Months

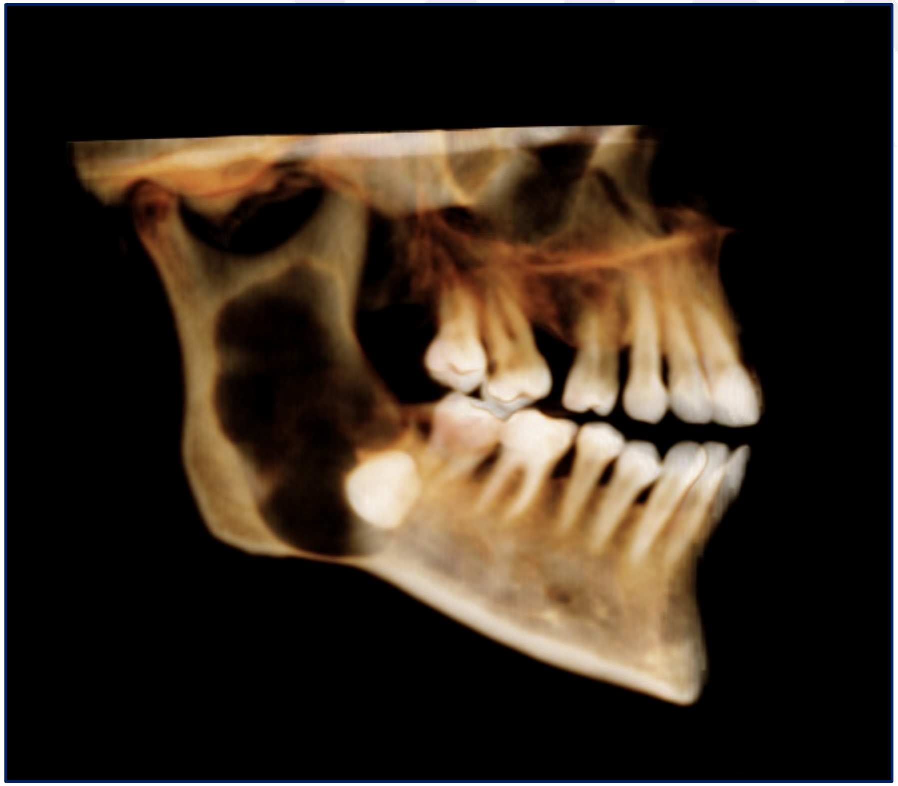


Figure 4.9. 3D view of the cyst before decompression

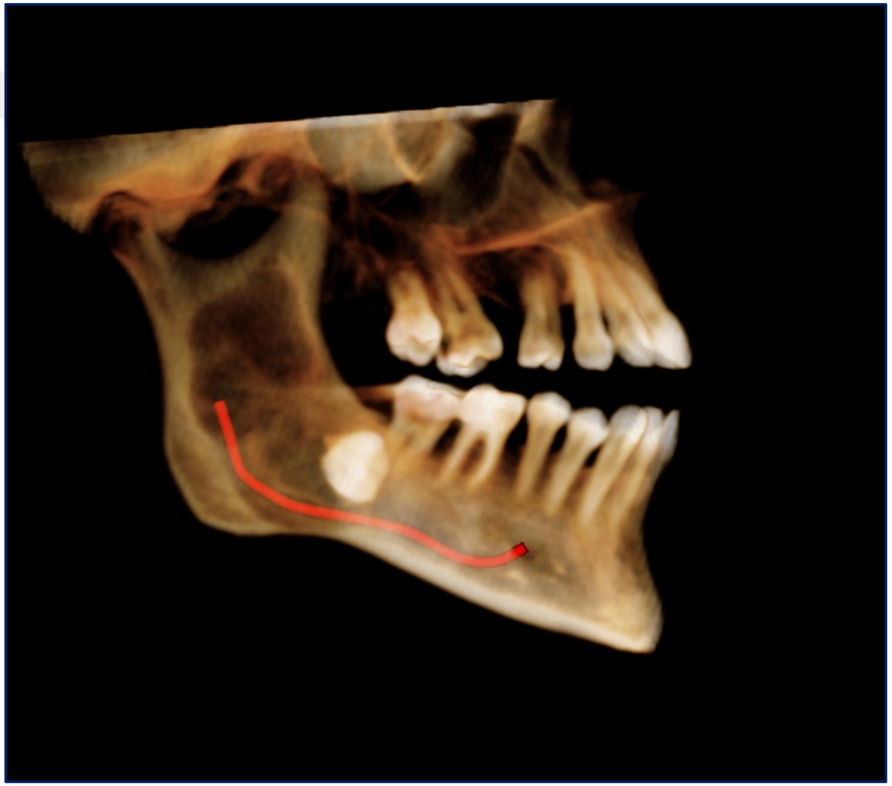


Figure 4.10. 3D view of the cyst before enucleation

67.3%
6 Months

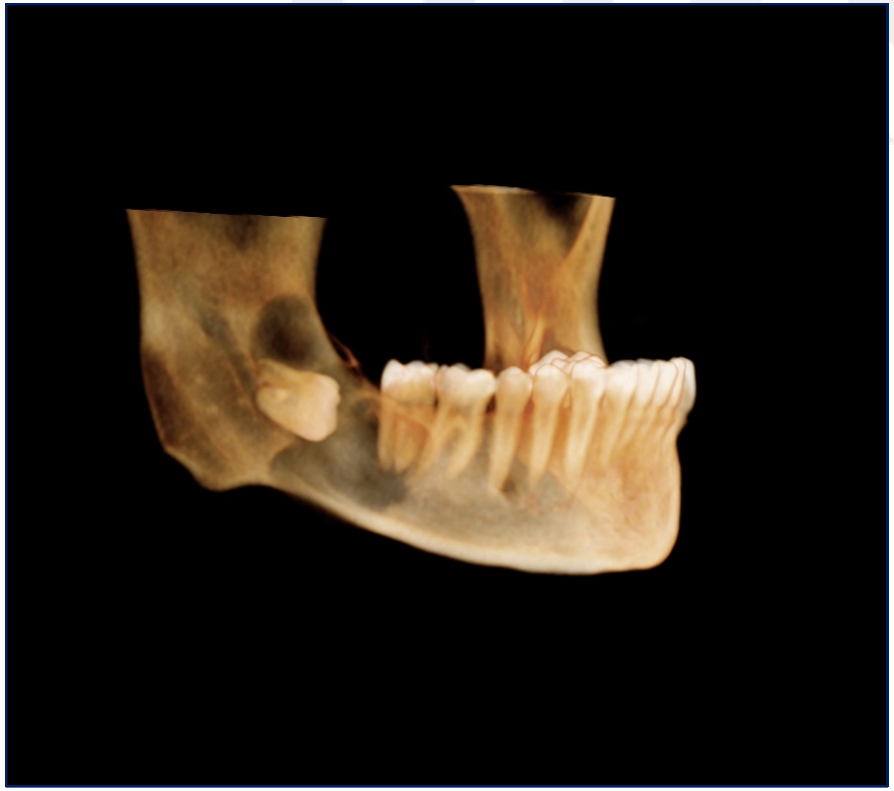


Figure 4.11. 3D view of the cyst before decompression

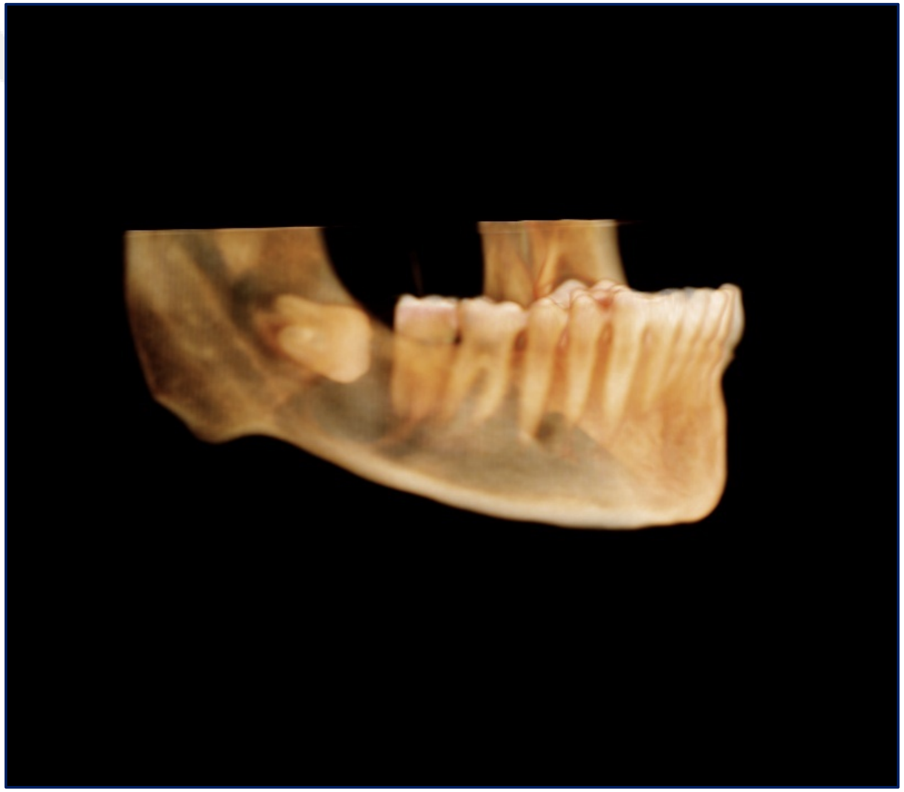


Figure 4.12. 3D view of the cyst before enucleation

100%
16 Months

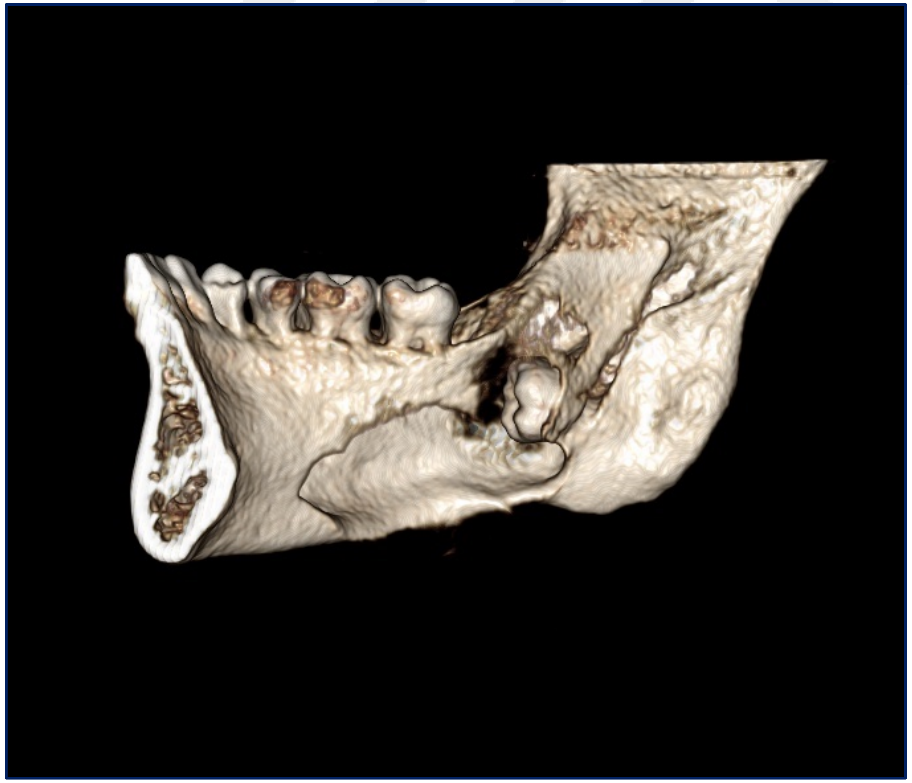


Figure 4.13. 3D lingual view of the cyst before decompression

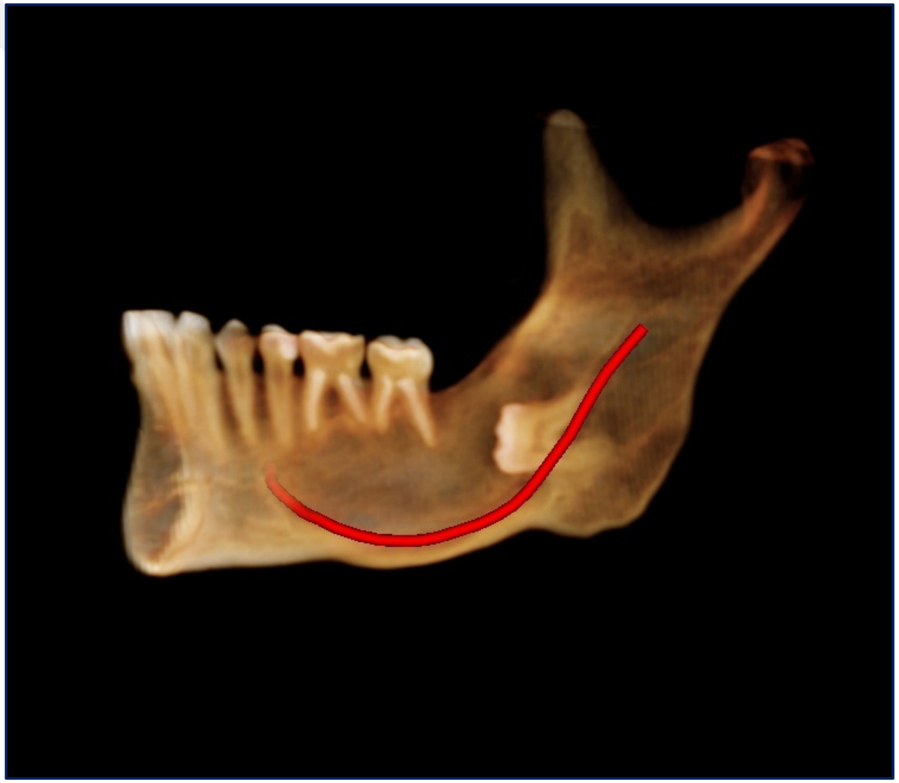


Figure 4.14. 3D lingual view of the cyst before enucleation

100%
16 Months

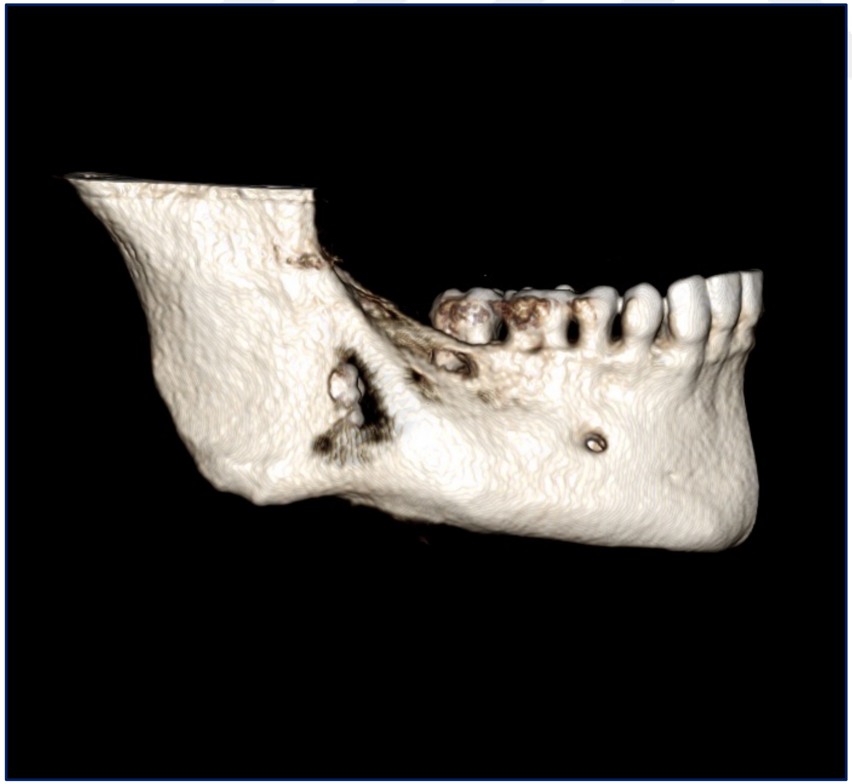


Figure 4.15. 3D view of the cyst before decompression

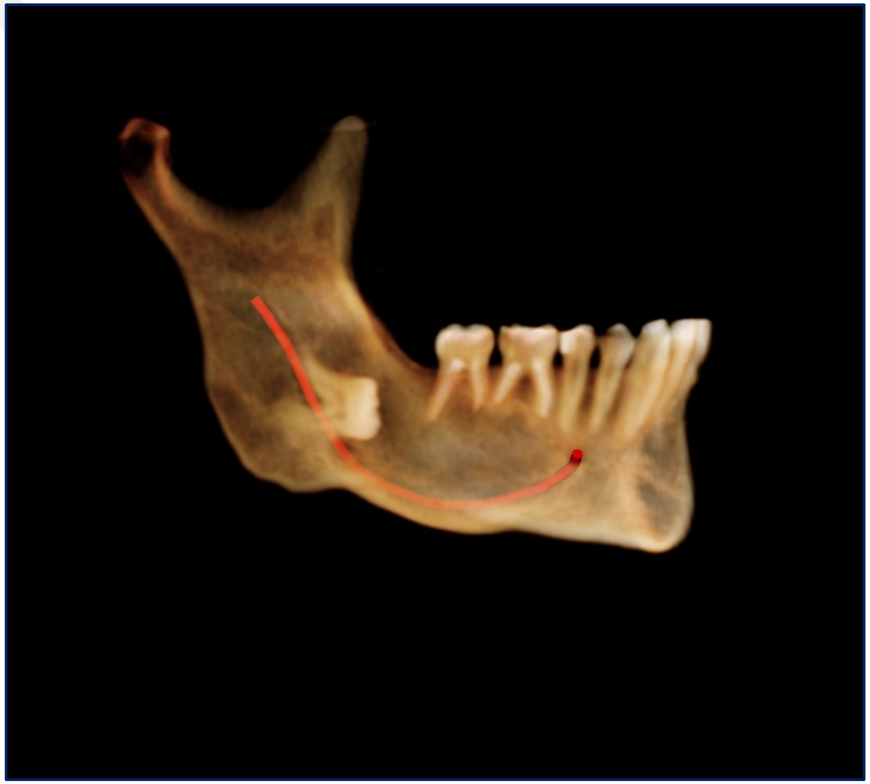


Figure 4.16. 3D view of the cyst before enucleation

56.9%
6 Months

Figure 4.17. 3D view of the cyst before decompression

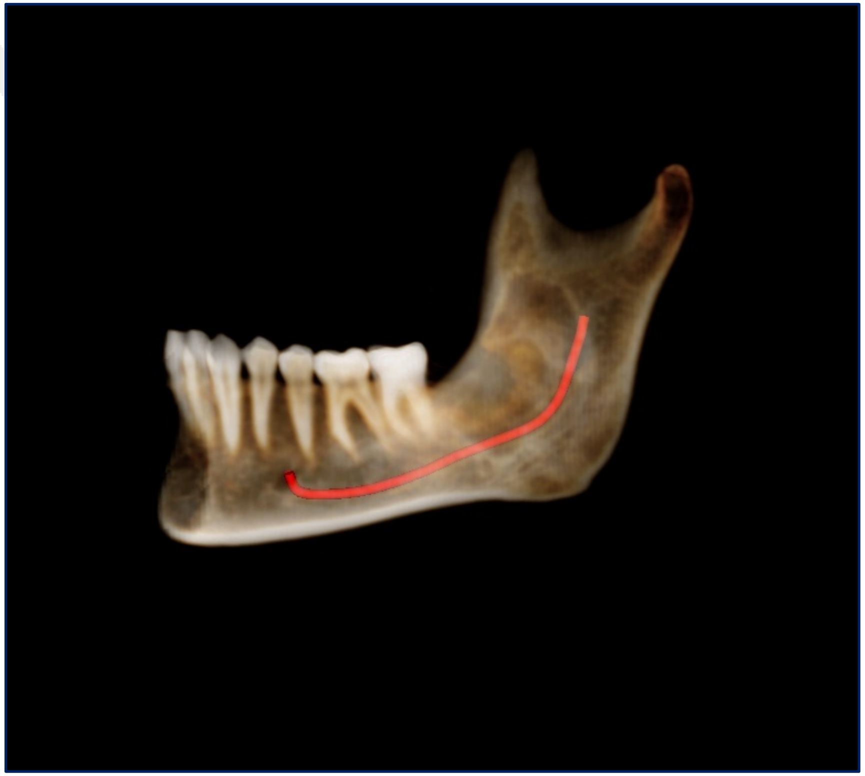


Figure 4.18. 3D view of the cyst before enucleation

65.7%
8 Months

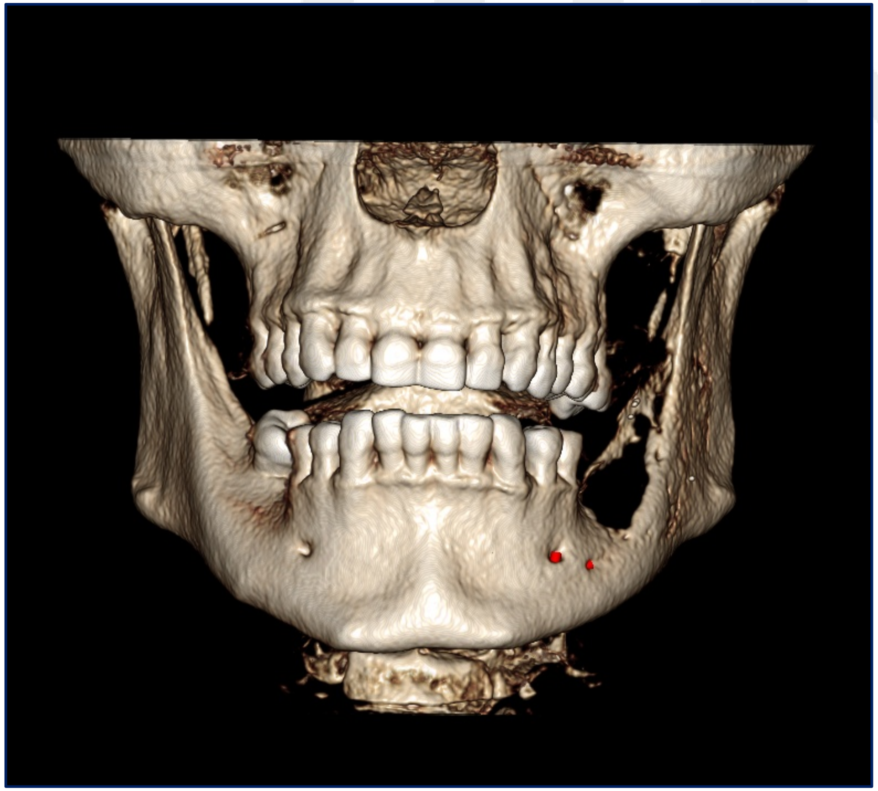


Figure 4.19. 3D view of the cyst before decompression

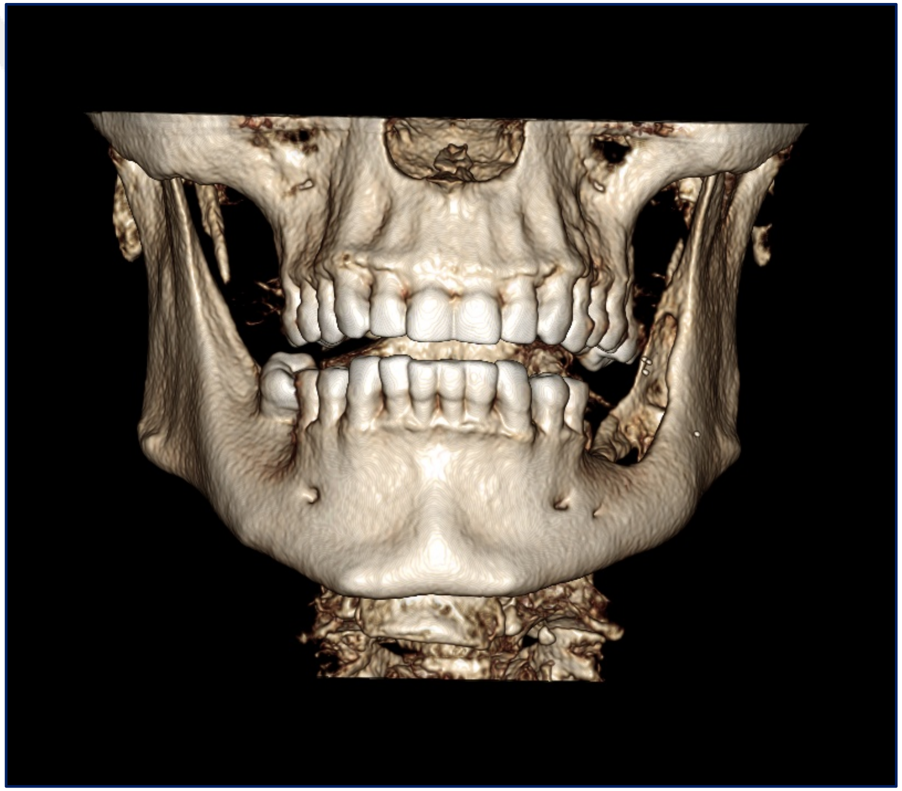


Figure 4.20. 3D view of the cyst before enucleation

65.7%
8 Months

Figure 4.21. 3D lingual view of the cyst before decompression

Figure 4.22. 3D lingual view of the cyst before enucleation

92.3%
8 Months

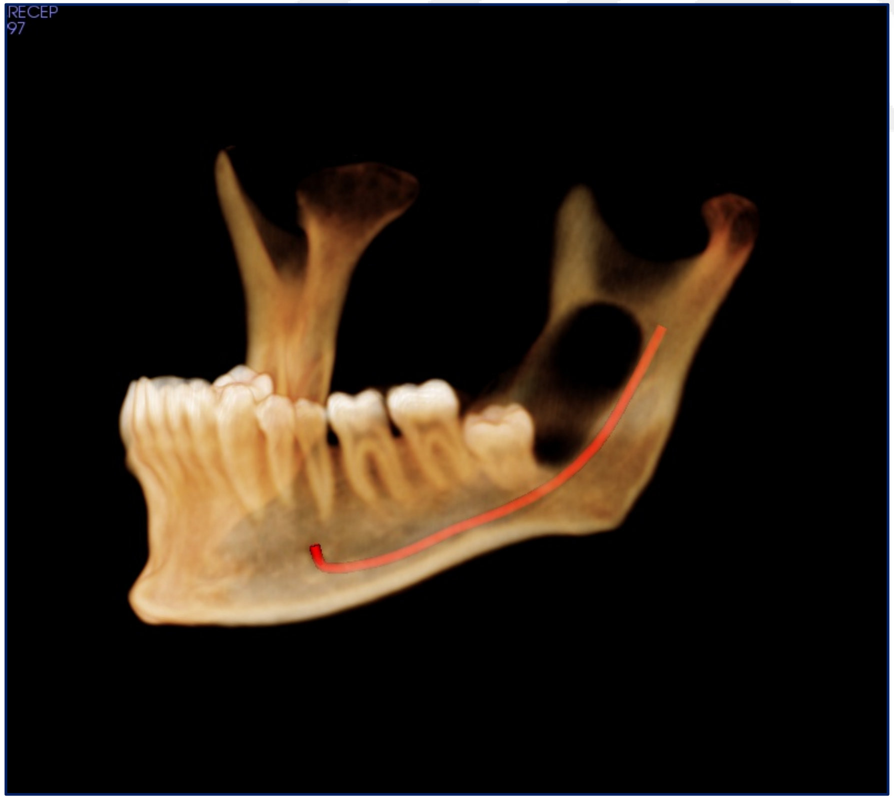


Figure 4.23. 3D view of the cyst before decompression

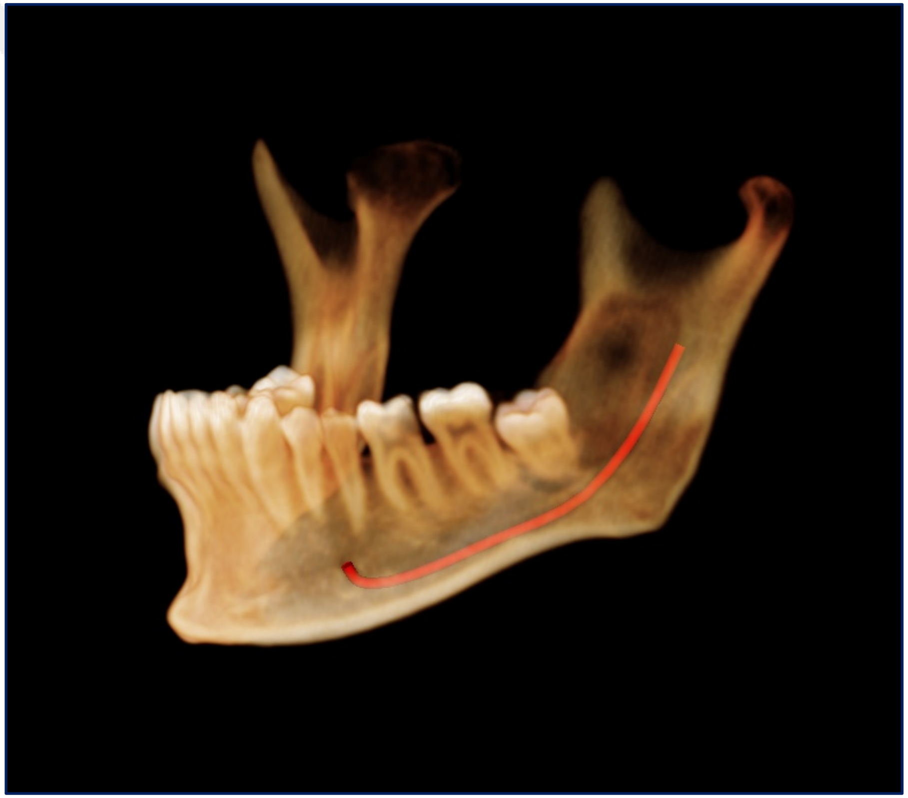


Figure 4.24. 3D view of the cyst before enucleation

92.3%
15 Months

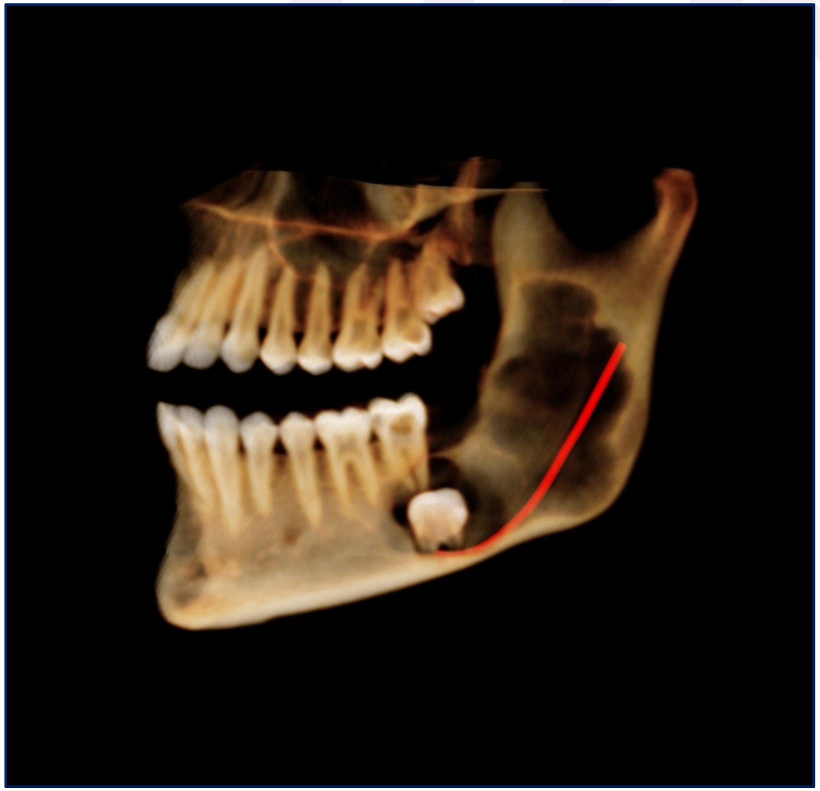


Figure 4.25. 3D view of the cyst before decompression

Figure 4.26. 3D view of the cyst before enucleation

58.2%
12 Months

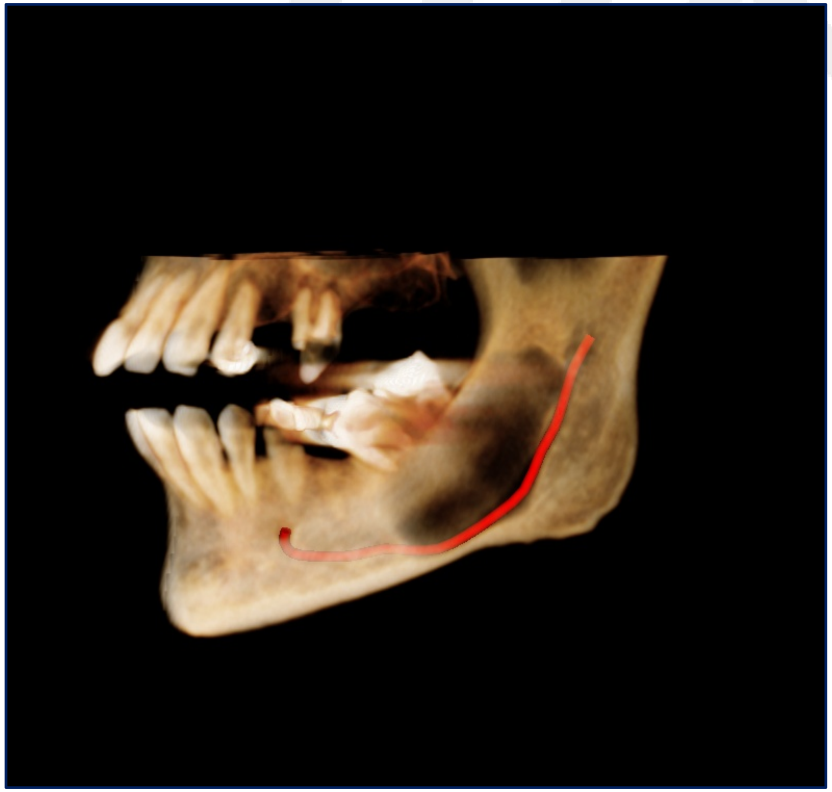


Figure 4.27. 3D view of the cyst before decompression

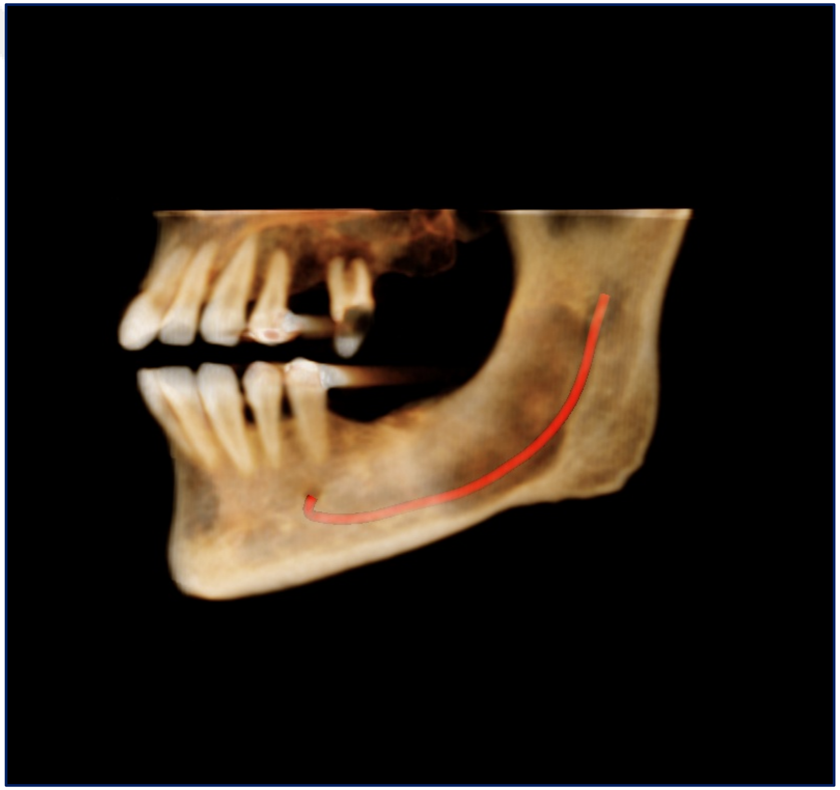


Figure 4.28. 3D view of the cyst before enucleation

67.3%
16 Months

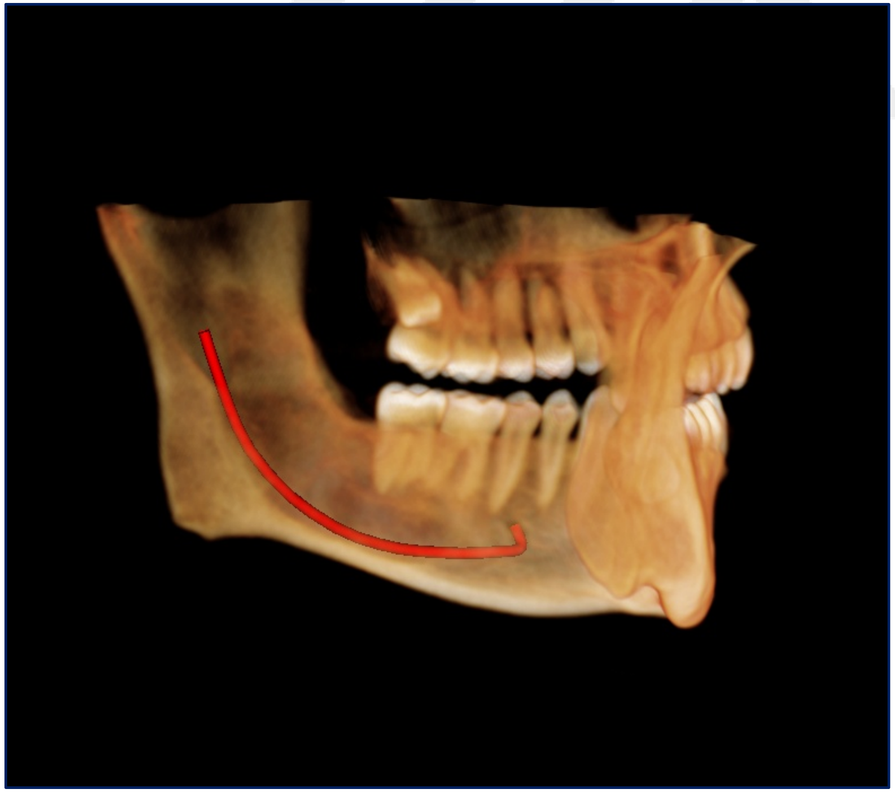


Figure 4.29. 3D lingual view of the cyst before decompression

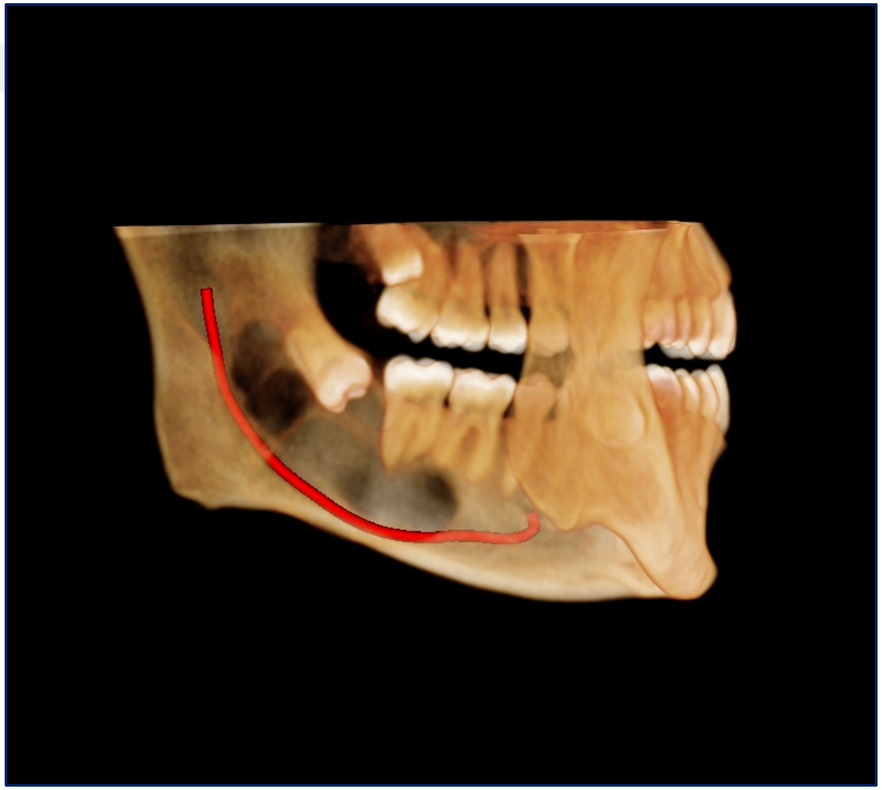


Figure 4.30. 3D lingual view of the cyst before enucleation

69.4%
6 Months

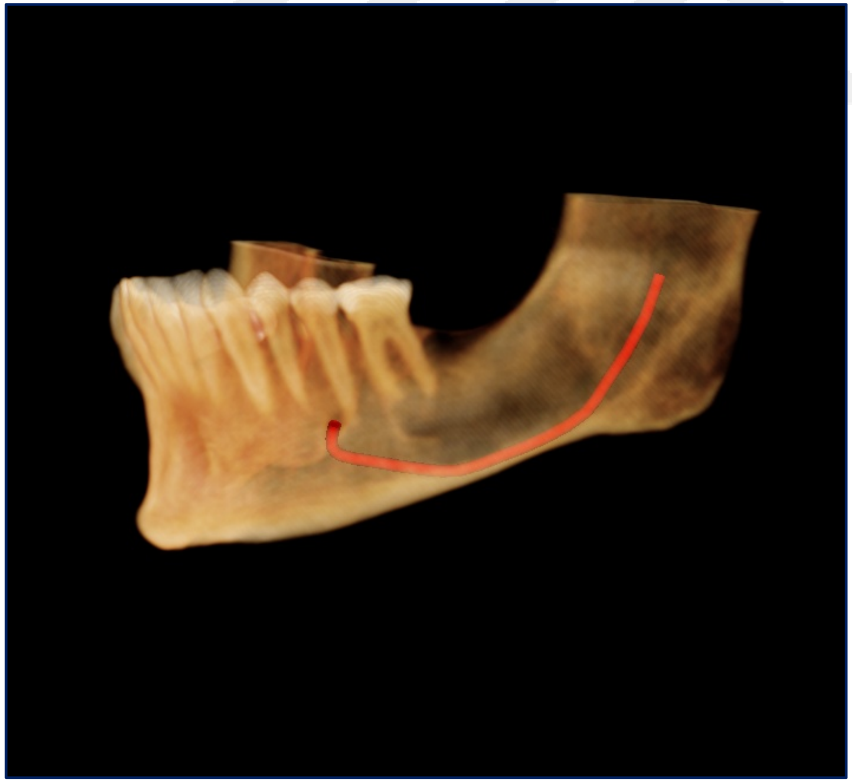


Figure 4.31. 3D view of the cyst before decompression

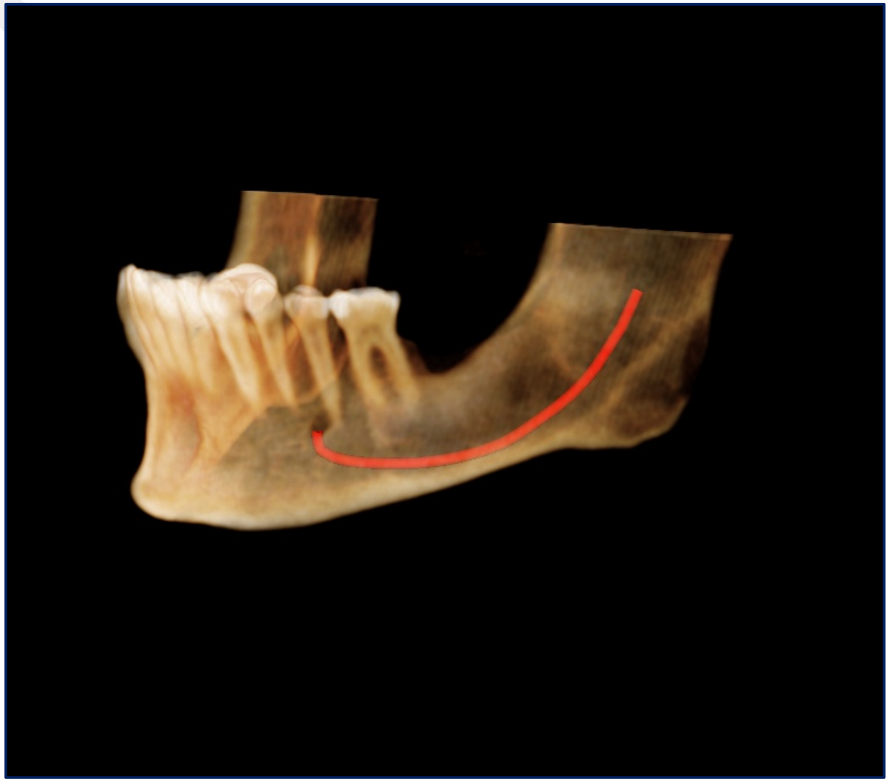


Figure 4.32. 3D view of the cyst before enucleation

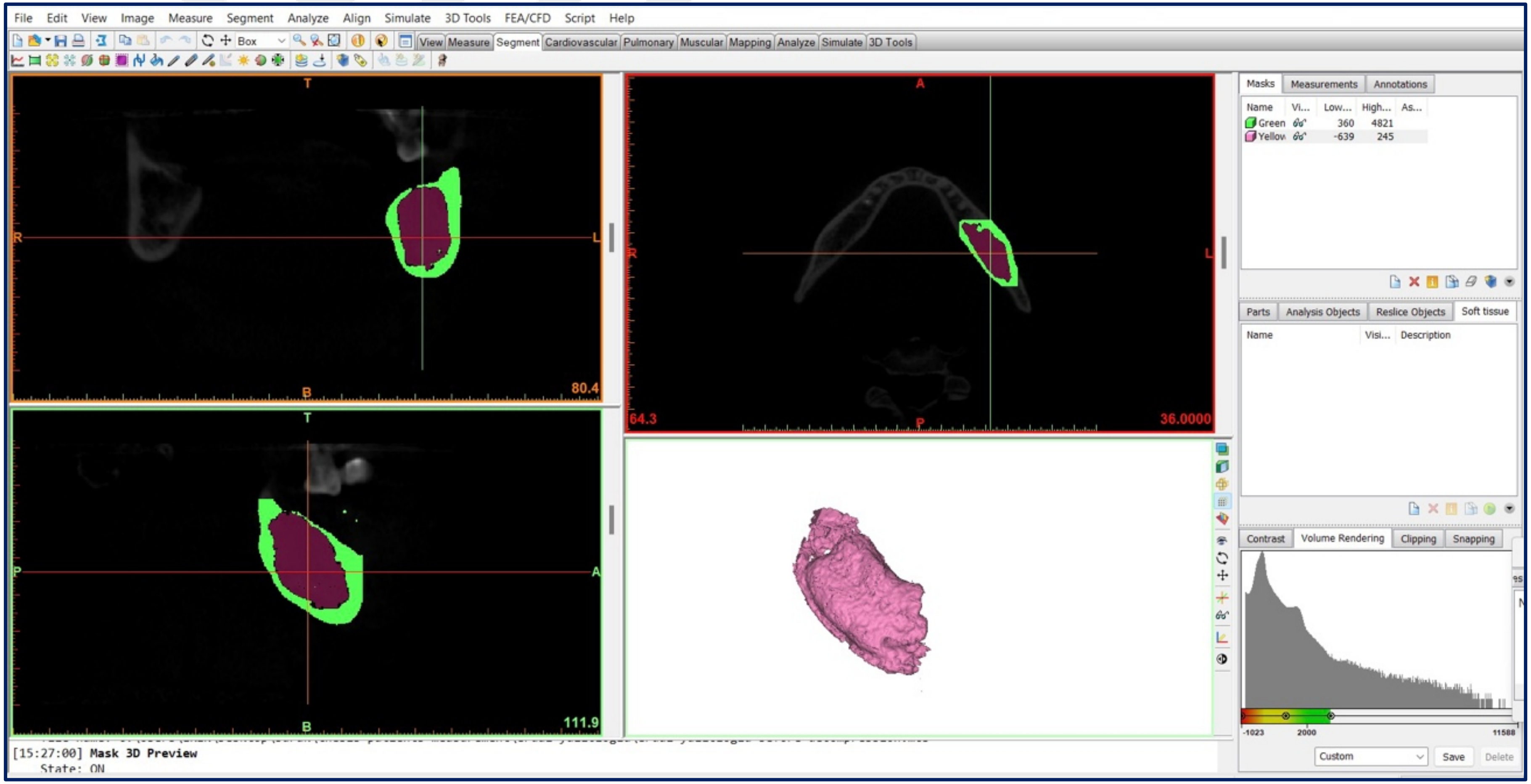


Figure 4.33. Coronal, sagittal, axial planes and 3D view of the cyst before decompression

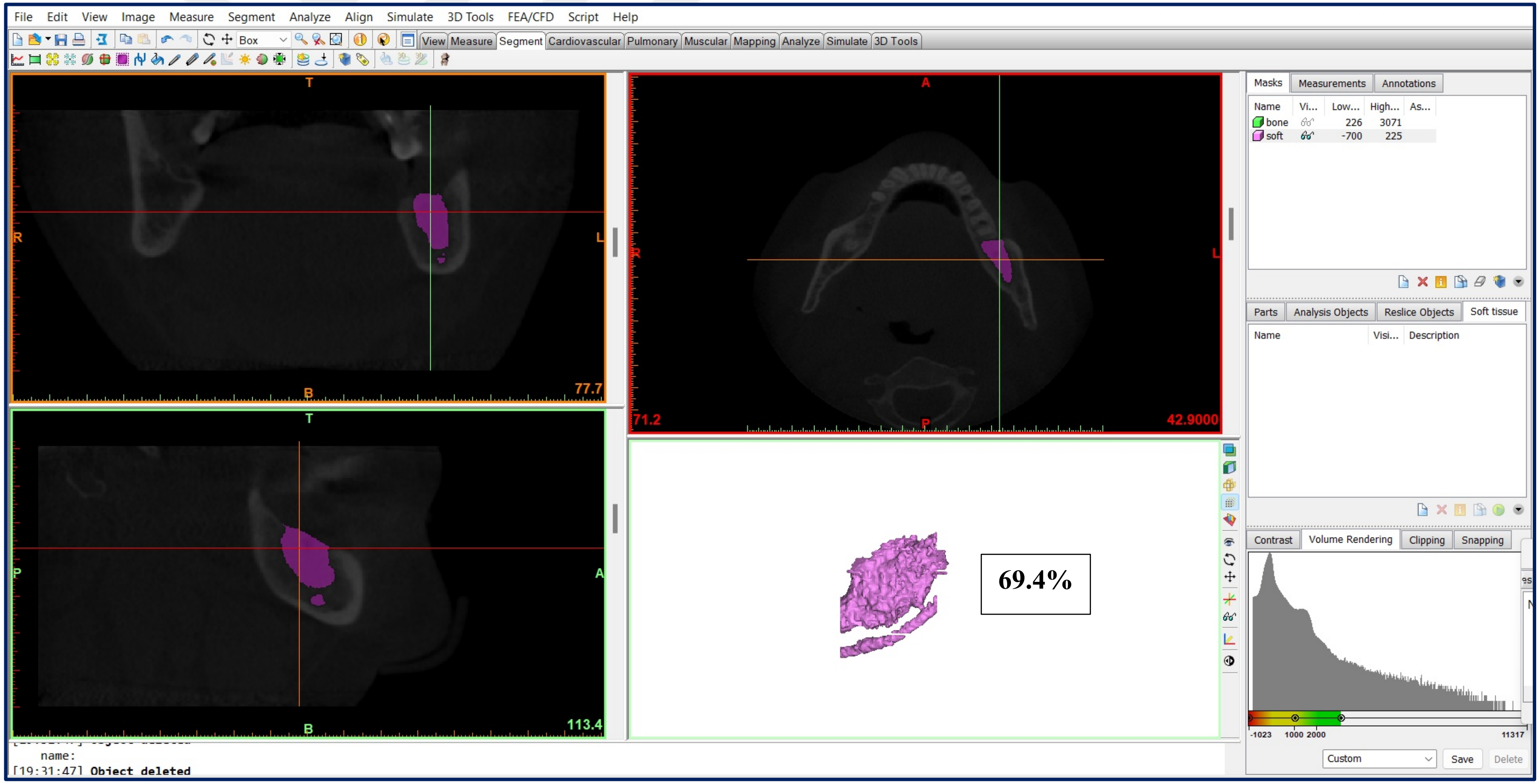


Figure 4.34. Coronal, sagittal, axial planes and 3D view of the cyst before enucleation (box: shrinkage rate)

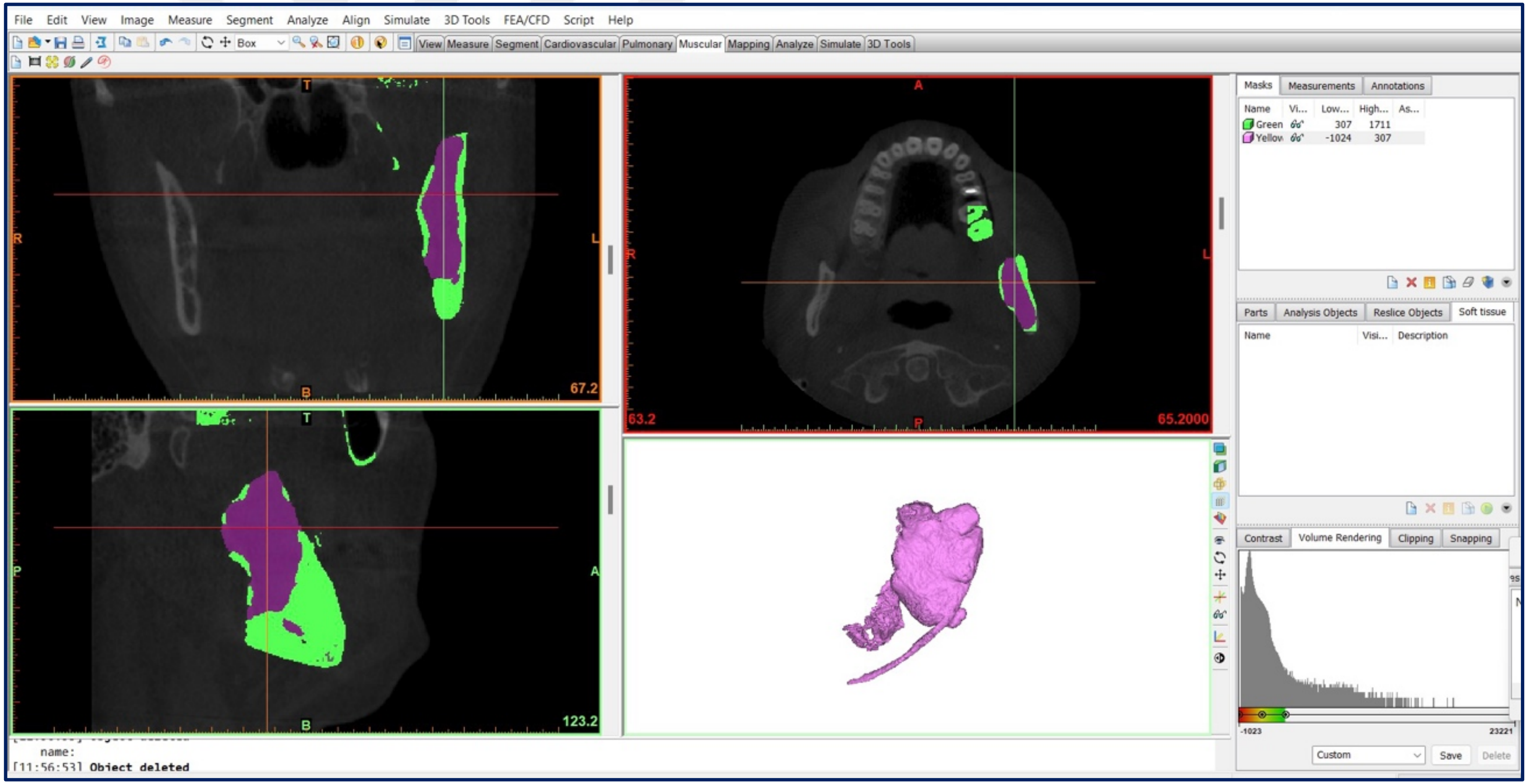


Figure 4.35. Coronal, sagittal, axial planes and 3D view of the cyst before decompression

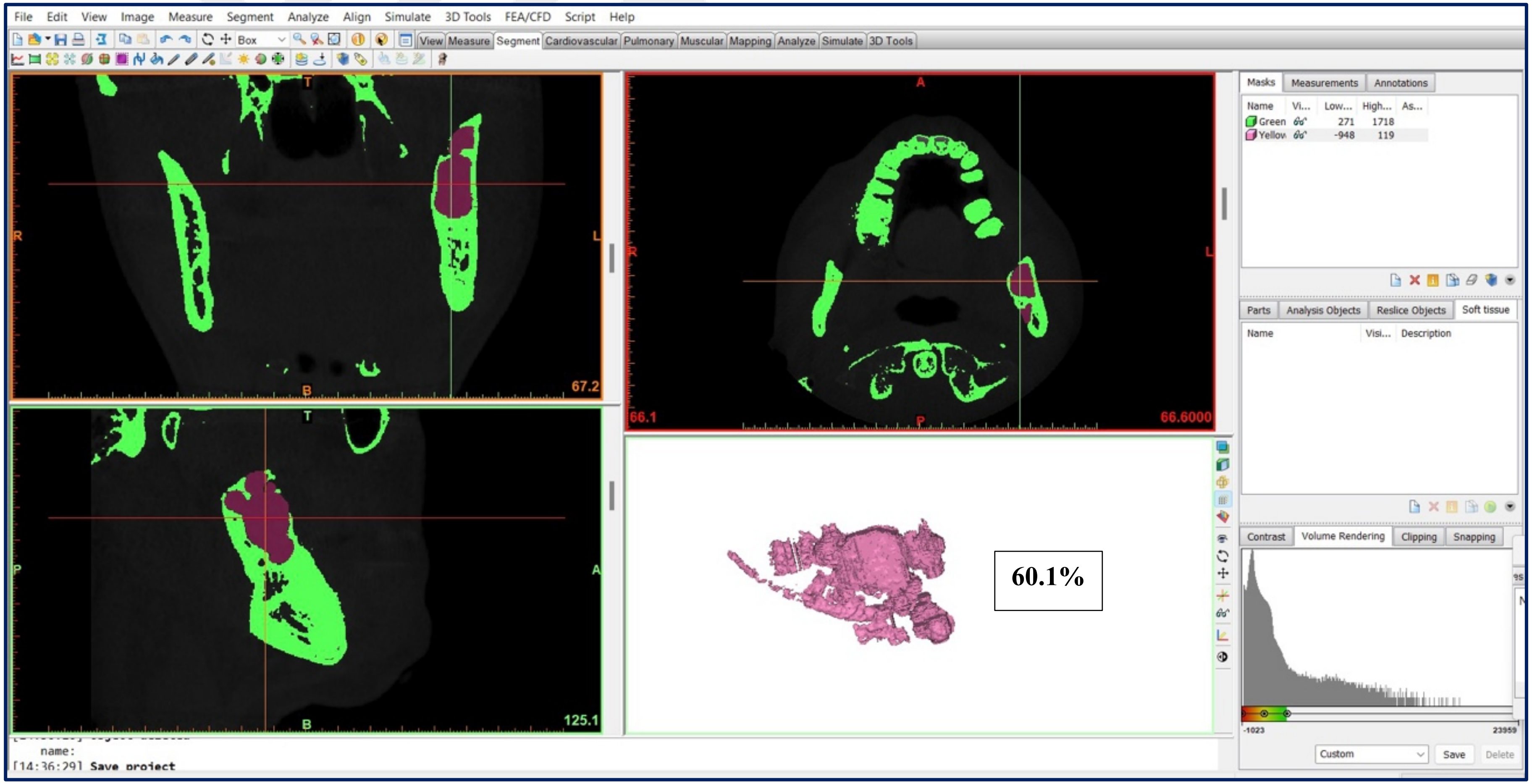


Figure 4.36. Coronal, sagittal, axial planes and 3D view of the cyst before enucleation (box: shrinkage rate)

5. DISCUSSION & CONCLUSION

A cyst is defined as a epithelium covered cavity with a variety of potential causes, which contains liquid or semi fluid substances and can form in both hard and soft tissue. Jaw bones are the bones in the human body with the superior occurrence of cysts. This is attributable to the considerable number of epithelial residuals present in the jaws. Jaw cysts can be categorized as epithelial or non-epithelial origin, odontogenic or non-odontogenic, and developmental or inflammatory in nature. The underlying mechanisms that trigger the proliferation and subsequent cystic transformation of resting epithelia remain largely elusive. But there is a prevailing hypothesis that inflammation plays a pivotal role in this process. The elevated prevalence of dental impaction and infection in the jaws is likewise a crucial factor in elucidating the greater incidence of cysts in these locations (80).

There is no accepted definitive treatment method for the treatment of cystic lesions in the jaws. The aim of the treatment is to completely eliminate the lesion and reduce the recurrence rate. The histopathological properties of the epithelial structure surrounding the lesion wall are significant in determining the differential diagnosis of cystic lesions, recurrence rates, and are also the most significant factor in determining the treatment protocol, thus first thing to do is to take a biopsy from the lesion and determine the treatment plan according to histopathological result. Enucleation and curettage are the most commonly used surgical methods. Lesions smaller than 5 cm in diameter are usually treated by enucleation. For lesions like Keratocysts, adjuvant therapies like peripheral ostectomy, chemical cauterization with Carnoy's solution, electrocauterization, cryotherapy could also be used. For larger lesions, the aim is to make the lesion's size to reduce progressively. As intraluminal pressure is released, the bone cavity of a cystic lesion is observed to reduce gradually in volume, with a corresponding progressive growth of adjacent osseous tissue. This approach aims to maintain the vitality and integrity of the supporting bone around teeth in proximity to the lesion. The objective is to prevent damage to the inferior alveolar nerve, maxillary sinus, nasal cavity, and developing teeth, as well as avoiding complications such as osseous fracture. Two methods, namely marsupialization and decompression, have been described in recent literatures as conservative treatment approaches. However, the difference between them is often not well-defined (86, 87). As described by ***Partsch*** (88, 89), marsupialization forms a pouch connecting the oral and cystic cavities, accomplished by suturing the cyst wall to the oral tissue (90, 91). As proposed by ***Thoma (***92), decompression necessitates the utilization of a device, such as a tube or a stent (93), which is sutured in situ to facilitate consistent drainage and establish a conduit between the cyst and the oral environment until an epithelial slit form. The decompression technique can be more straightforward to apply and easier than marsupialization, sparing more soft and hard tissue. It is especially recommended in children (84, 95, 96). This methodology is also more readily tolerated by adult patients, although it entails the prolonged use of a device within the oral cavity and the performance of everyday irrigation to prevent infection and prevent the formation of a wound closure. In our study, we chose decompression therapy because it is easier to perform, and the patients tolerate the procedure better.

There are three different methods for analyzing volume alterations in cysts pre and postoperative decompression therapy in the literature. These are, filling the cavity with saline solution, 2D and 3D radiographies. The most common imaging methods in dentistry are intraoral and panoramic radiographs, which provide two-dimensional imaging of oral and dental hard tissues. These 2D radiographies, however, are not capable of evaluating defects, anatomical variations and relationships in 3D. The CBCT imaging provides a three-dimensional view of the defect and structures by allowing the examination of structures in all three planes planning the correct surgical approach and in evaluating bone regeneration after decompression. Therefore, three-dimensional computed tomography is more reliable and precise than two-dimensional radiographies. Furthermore, compared with CT, CBCT has high resolution, involves lower radiation doses, and is more cost-effective. Furthermore, CBCT can be combined with additional program to create three-dimensional digital replica of teeth, thereby facilitating the expedient and exact determination of surface area and volume. Consequently, CBCT can be employed to accurately ascertain the volumetric characteristics of cysts. Because CBCT has such features, we chose to use CBCT in this study to assess mandibular posterior cyst shrinkage. The existing literature contains numerous researches that have identified factors that affect the reduction rate of cystic lesions through the utilization of conventional X-rays. Our study overcomes 2D radiographies limitations by using CBCT for volumetric analysis. To our knowledge, there are few recent studies aiming 3D evaluation of jaw cyst reduction with CBCT after decompression therapy.

In this study, our purpose was to evaluate the efficacy of decompression therapy with 3D volumetric analysis with CBCT, the volume reduction of the keratocysts and dentigerous cysts in the posterior mandible or ramus after decompression therapy and assessment of the correlation with certain parameters. In this context, this study will provide further information for other scientific studies with the choice of the mandibular posterior and ramus region in particular, using CBCT and certain variables that have mentioned in the literature few times like smoking, cortical bone expansion, drain type, extraction, impacted tooth presence or haven't mentioned in the recent literature at all such as cortical perforation and drain localization.

In the recent literature, different kind of cysts had been evaluated using different methods in terms of volume shrinkage of the lesions. The authors provide useful insights about the investigation method, effectiveness of the chosen treatment and radiological volume changes. There were various software programs utilized to calculate the diameter change and volume reduction of the cysts. After CBCT scans taken from patients, dicom formats are prepared and transferred to the software program authors chose to use such as Mimics program. The program is designed in such a way that it is simple to use. In the view of ***Martin et al.***, the program's ease of use nature and the extensive range of segmentation performances were significant factors in its high 3D modelling success. These findings were corroborated by ***Tuan and Hutmacher*** (113), who demonstrated that this program facilitated more effective image modification, representation, and functionality. Digital segmentation was used in this study for complex anatomic structure 3D reconstruction, because of its ability to contemporarily visualize the 3 spatial planes when defining the outlines of the lesion.

Shudou et al. (76) utilized CBCT in order to evaluate the reduction in volume and diameter change of the keratocysts in mandible using 3D shape analysis software Rugle5 (Medic Engineering, Kyoto, Japan) and their aim was to clarify how KCOTs are reduced during the marsupialisation process and to predict the best time for secondary enucleation.

Zhao et al. (72) examined the keratocysts in mandible too and applied saline solution to the cavity before decompression and enucleation to evaluate the volume reduction. Another aim of this study was to determine the amount of bone regeneration after marsupialization of mandibular OKCs using computer analysis of the bone density on pre and postoperative panoramic radiographs and they preffered the CR system regius (Konika, Minolta, Tokyo, Japan).

Park et al. (105) investigated dentigerous cysts, keratocysts and unicystic ameloblastomas in both jaws. Their purpose was to evaluate the effectiveness of the decompression of cystic lesions examining panoramic X-rays in order to measure the absolute and relative velocity of shrinkage. The delineation of the specified border was conducted using a computer program, specifically SketchUp version 8.0 for Windows, developed by Trimble Navigation Ltd., Sunnyvale, CA, USA. Moreover, in order to derive more clinically important insights, they evaluated the relationship between decompression and a number of factors, including age and the initial size of the cyst.

Song et al. (103) and ***Asutay et al***. (60) aimed to examine dentigerous cysts, keratocysts and ameloblastomas with CBCTs in mandible. Reduction rate and reduction volume were the parameters in the latter study, while reduction in volume, absolute and relative velocity of shrinkage were in the former study.

While ***Lizio et al.*** (93) evaluated dentigerous cysts in posterior mandible using CBCT after decompression protocol and calculated the reduction in volume prospectively, ***Gao et al.*** (106) evaluated dentigerous cysts, keratocysts and ameloblastomas in both jaws and their objective was to calculate bone mineralization, bone volume fraction, trabecular thickness, trabecular separation, and trabecular number via CBCT. The dicom format of CBCTs transferred to a workstation to be studied and analysed using open-source OsiriX medical imaging software (Pixmeo, Geneva, Switzerland) in a study conducted by ***Lizio et al.*** (107), while CBCT scan slices were opened in ImageJ software to make the evaluation for volume reduction in the study by ***Gao et al.*** (106).

Park et al. (111) examined mandibular keratocysts via CBCT and aimed to analyze the reducing pattern of decompression in terms of direction and speed of volume reduction and to determine the proper timing for secondary enucleation.

Kwon et al. (104) intended to investigate the efficacy of decompression on dentigerous cysts, keratocysts and radicular cysts in both jaws and by way of doing that they calculated percentage volume reduction by using CBCT. While in the research led by ***Park et al.*** (111), measurement data such as volume and other metrics was collected by InVivo software (Anatomage, San Jose, California). In a research conducted one year later by ***Kwon et al***. (104), the program ITK-SNAP, developed by the Penn Image Computing and Science Laboratory (PA, USA), was employed to quantify the volumetric alterations of the cysts.

While ***Hirayama et al.*** (109) aimed to examine dentigerous cysts in mandible involving third molars and calculate AVS, RVS and reduction in volume by using CBCT and utilized Zed view (LEXI Co., Ltd., Tokyo, Japan). Using this software, they created a 3D image of each dentigerous cyst and measured its volume. ***Ulu et al.*** (75) on the other hand, examined mandibular dentigerous cysts, keratocysts and radicular cysts to calculate volume reduction and they used CBCT too in order to do that.

In a study conducted by ***Wongrattanakarn et al.*** (77), dentigerous cysts, orthokeratinized odontogenic cysts, parakeratinized odontogenic keratocysts and radicular cysts in both jaws were examined. The objective was to examine the parameters affecting the reduction rate of these cystic lesions and the percentage volume reduction after decompression theraphy, utilising CBCT for 3D volume evaluation.

Shi et al. (79) examined jaw cysts in both jaws to aim to study three-dimensional (3D) image changes of bone remodeling after decompression with CBCT in a long term follow-up, especially the evolution of the unossified lesions after one year of decompression.

Lizio et al. (107) aimed to assess keratocysts, dentigerous cysts and ameloblastomas in both jaws with CBCT. The aim of their retrospective study was to assess the effectiveness of the preliminary decompression protocol in terms of reduction in cyst volume, analysing the CT images acquired pre and post-decompression with image-processing software open-source OsiriX® medical (Pixmeo, Geneva, Switzerland).

In a study conducted by ***Consolo et al.*** (110), the main purpose was to evaluate the keratocysts, radicular cysts and dentigerous cysts via CBCT and investigate the marsupialization procedure in terms of the radiologic volumetric reduction. They preferred using Amira imaging software, version 5.3.3 (Visage Imaging GmbH, Berlin, Germany) for this evaluation.

In our study, we preferred to choose Mimics (Materialise NV, Leuven, Belgium) software to evaluate and calculate the volume reduction same as in the recent studies conducted by ***Song et al***. (103), ***Asutay et al***. (60), ***Wograttanakarn et al.*** (77*)*, ***Shi et al.*** (79).

A comprehensive assessment of the factors influencing the reduction rate of cystic lesion is an important step towards gaining optimal outcomes. In the literature, researchers studied various variables and reported their results about the correlation between these variables and lesion's volume reduction and the literature has various opinions regarding this correlation. Studying this correlation provide important insight for evaluating the effectiveness of decompression therapy. In our study we chose to evaluate certain variables such as; age, gender, duration of decompression, initial volume, smoking, cortical bone expansion, cortical bone perforation, impacted tooth presence, drain localization, drain type, extraction, lesion type and their correlation with shrinkage.

The literature on the effects of gender on decompression is inconclusive. In a study by ***Wongrattanakarn et al.*** (77), 41 CBCT images were evaluated, and it was stated that gender was an important parameter affecting the volume reduction of cysts. The results indicated that males exhibited a higher reduction rate than females. These findings are in line with those of ***Jeong et al.***, who stated a higher reduction rate in male subjects than in females, although the observed disperancy was not statistically significant.

On the opposite site, studies conducted by ***Song et al.*** (103) and Kwon ***et al.*** (104) revealed that gender was not related with volume reduction of cystic lesions. Similarly, ***Lizio et al.*** (93) and ***Park et al.*** (105) pointed out that there was no correlation.

In our study, it was determined that the difference in the rate of change in cyst volumes according to gender was not statistically significant.

The literature has conflicting findings about the correlation between age and cyst volume reduction. There are studies reporting that the effectiveness of decompression does not depend on age. On the other hand, young patients with ongoing growth have been reported to have higher reduction rates as a result of decompression, as they have a higher recovery potential (25). ***Zhao et al.*** (72) evaluated panoramic x-rays in 53 patients and revealed that the mean decrease in cyst volumes did not correlate statistically with patient's age. ***Lizio et al.*** (93) came up with the same conclusion after investigating 20 CBCT images.

Another study, published by ***Lizio et al.*** (107) again found no association between age and decrease in volume. ***Rao et al.*** (108) stated that volume reduction after decompression does not associate with age.

Hirayama et al. (109) conducted a study and found no correlation between age and relative velocity of shrinkage (RVS) 6 months, whereas RVS 12 months was correlated with age. Similarly with these findings ***Wongrattanakarn et al.*** (77) declared no significant difference in the rate of reduction based on age.

On the opposite view, in a study conducted by ***Song et al***. (103), statistical analysis suggested that in dentigerous cysts, age seemed to be significantly negatively correlated with the reduction in volume, however there was no significant correlation in keratocyst and unicystic ameloblastoma groups. In addition to **Song et al.**'s study, a negative correlation was determined between cystic volumes reduction rate and age in the study designed by ***Asutay et al.*** (60).

Statistically significant correlation was found after evaluating the velocity of shrinkage in 3 cystic groups in 32 patients by ***Park et al.*** (105).

In another study conducted by ***Anavi et al.*** (83), they revealed that young patient has a higher percentage reduction volume. In 2020, after the factors had been assessed regarding its influence on decompression ***Kwon et al.*** (104) pointed out that that age was considered statistically significant.

Sivri D. reported that although lesion sizes decreased at a lower rate in patients over 40 years of age, these data were not found to be statistically significant, and it was noted that the treatment effectiveness was not related to age (25).

In our study, it was determined that there was no statistically significant relationship between the rate of change in cyst volumes and their ages.

There are no official criteria for the duration of decompression therapy and the desired size change. ***Park et al.*** (105) and ***Asutay et al.*** (60) revealed that the decompression time for cystic lesions should continue until the risk of injury to anatomical structures decreased before enucleation. In a study conducted by ***Zhao et al.*** (72) they supported similar idea as other authors about stopping the treatment when sufficient bone is formed to avoid damaging adjacent anatomical structures. ***August et al.*** (114) stated that histopathological changes occurred in cystic lesions with decompression application, and that these changes could occur during a treatment period of at least 9 months. For this reason, they argued that the treatment period should be at least 9 months. The study conducted by ***Sivri D.*** also supports the results in the literature. After that study it was determined that the average treatment duration was 8 months and the shrinkage rate was 63.3%. In addition, it was observed that there was a proportional reduction in the size of the lesions with a longer treatment period (25).

In the literature review, it was determined that some research provided some information like ***Lizio et al.*** (93,107), revealed that duration of decompression was significantly associated with volume reduction, similar to a study conducted by ***Consolo et al***. (110) which showed significant positive association between volume reduction and duration. **Kwon et al.** (104) examined 50 CBCTs and revealed that increased time were correlated with bigger influence of decompression.

On the other hand, ***Park et al.*** (111) conducted a study to analyze the reducing pattern of decompression on mandibular odontogenic keratocysts and found that there was no significant directional indicator in the rate of reduction such as duration of decompression, similar to another research conducted by ***Wongrattanakarn et al.*** (77).

In accordance with the results in our study, it was determined that there was no statistically significant relationship between the rate of change between cyst volumes and the measurement time.

While some research provided no correlation between initial volume of cystic lesions and volume reduction, other studies reported that there was significant association between these parameters. For instance, the volume of keratocysts were negatively correlated in a study published by ***Shudou et al.*** (76).

Park et al. (105) analyzed 3 cystic types, total 32 lesions and reported that all 3 types showed no correlation between the initial size and relative velocity of shrinkage (RVS). In another study conducted by ***Park et al.*** (111) found no correlation between initial volume and volume reduction.

Kwon et al. (104) examined 50 patients and fonund no significant difference between initial volume and reduction in volume.

On the other hand, ***Song et al.*** (103) examined 37 lesions consisted of dentigerous cysts, keratocysts and unicystic ameloblastomas and found significant correlation between initial size and absolute speed of shrinkage (ASS) and reduction of total volume in all 3 types of the lesions.

Lizio et al. (107) revealed that the starting volume was significantly associated with decrease in volume and monthly reduction rate.

The findings in a research published by ***Hirayama et al.*** (109) revealed that absolute velocity of shrinkage (AVS) was correlated significantly with initial volume, on the other hand, they observed no correlation between the relative velocity of shrinkage and initial cyst volume.

In a study published by ***Wongrattanakarn et al.*** (77), a statistically significant positively associated relationship was identified between the reduction rate and the preoperative volume. In our study, it was stated out that, initial volume was statistically significant with volume reduction.

To our knowledge, there is only one study that analyze the correlation between smoking and cyst volume reduction in the literature. ***Hirayama et al.*** (109) conducted a study and one of their parameters in their research was smoking status and they found that there was no correlation between relative velocity of shrinkage and smoking status.

According to the results of our study, it was determined that the difference in the rate of change in patient's cyst volumes according to their smoking status was not statistically significant. Patient's smoking does not affect the change in cyst volumes.

As far as we know, there are two studies about the correlation between the reduction and impacted tooth. ***Song et al.*** (103) conducted a study about effects of decompression on cystic lesions of the mandible and they revealed that impacted tooth being in the lesions had no significant influence on the pattern of reduction. Similarly, ***Hirayama et al.*** (109) led a study and reported that no correlation was observed between impacted mandibular third molar and RVS.

In accordance with the results in our study, it was determined that the difference in the rate of change between patient's cyst volumes according to their impacted tooth status was not statistically significant.

Based on our information, there is only one study which analyze the correlation between cyst reduction and cortical bone expansion. ***Kwon et al.*** (104) designed a study about effect of decompression on jaw cystic lesions and they revealed that there was no statistically significant difference in cyst reduction based on cortical bone expansion.

In our study, it was determined that the difference in the rate of change in cyst volumes of patients according to their cortical expansion status was not statistically significant according to the results of our study.

In the literature review, there is no study until now about analyzing the correlation between drain location & cortical perforation and cyst volume reduction. In our study, it was determined that the difference in the rate of change in cyst volumes of patients according to the drainage site & cortical perforation was not statistically significant.

The literature has conflicting findings about the lesion type and volume reduction. For instances, in their study, ***Asutay et al***. (60) examined jaw cysts after decompression therapy and found no significant differences in reduction rate and lesion type as a conclusion of their study. In terms of the effect of the lesion type on the velocity of shrinkage, ***Gao et al.*** (106) stated that decompression was more effective with radicular cysts than keratocysts or unicystic ameloblastomas. Similarly in a study conducted by ***Kubota et al.*** (115), the velocity of shrinkage after decompression was faster in radicular cysts than in keratocysts or dentigerous cysts. On the other hand, ***Kim and Lee*** (116) revealed that dentigerous cysts reduced more profoundly after decompression compared to keratocysts or radicular cysts. However, there were also no intergroup differences in the velocity of shrinkage in a study conducted by ***Park et al.*** (105).

Song et al. (103) evaluated keratocyst, unicystic ameloblastomas, dentigerous cysts and revealed no statistical association between speed of shrinkage and histological type correspondingly.

Anavi et al. (84) treated 57 patients diagnosed with odontogenic keratocyst, radicular cyst and dentigerous cyst with marsupialization and examined the relationship between histological diagnosis and shrinkage. As a result of the study, they reported that there was no statistically significant difference between the histopathological diagnosis and the shrinkage rate.

Similarly, no significant difference was found in the amount of volume reduction among the histological types ***Consolo et al.*** (110) which is parallel with the result of the study designed by ***Kwon et al.*** (104) and ***Wongrattanakarn et al.*** (77).

According to the results in our study, it was determined that the difference in the rate of change between patient's cyst volumes according to lesion types was not statistically significant.

In the literature review to this day, only one research result reported by ***Wongrattanakarn et al.*** (77) revealed that percentage of volume reduction did not show correlation with drainage types.

In accordance with the results in our study, it was determined that the difference in the rate of change in cyst volumes of patients according to drainage types was not statistically significant.

There are two studies carried out in the literature considering the correlation between tooth extraction during the decompression therapy and volume reduction. ***Kwon et al.*** (104) observed 50 patients and found no statistically significant association between tooth extraction and cyst volume reduction. This result shows similarity with the study by ***Hirayama et al.*** (109).

According to the results in our study, it was determined that the difference in the rate of change between patient's cyst volumes according to extraction was not statistically significant.

When the recent studies are examined, we saw that all cyst’s volume reduced on different levels after decompression therapy irrespective of the variable correlated. Correlation between reduction and these variables have inconsistent findings in the literature.

Our study was limited in some ways. It should be noted that, due to the retrospective nature of the research methodology, inconsistencies arose in terms of both time of CT scans and follow-up periods. A further drawback of this study was the non-normality of the data, which may be attributable to the relatively small sample size employed to ascertain the impacts on the outcome variable. After the exclusion criteria we had a small sample size. A significant limitation of this study is the relatively small sample size, which was restricted to patients who had previously received both preoperative and postoperative CBCT scans. Another limitation of this retrospective study is the relatively short follow-up of decompression therapy. Although we found that volume reduction of cystic lesions was not correlated with our parameters, in light of the drawback of this study, it is evident that more definitive and reliable standards of clinical practice are needed. A prospective study, with at least two post-operative CBCTs for every patient and with higher sample sizes would provide further perception about this protocol.

In this study, efficacy of decompression therapy with 3D volumetric analysis, the volume reduction of the cystic lesions in the posterior mandible or ramus after decompression therapy were evaluated and association with certain parameters were assessed.

The most significant findings of our study are as follows:

- After the evaluation to determine whether the cyst volumes of the patient included in the study differed according to the pre-test and post-test groups, it was determined that all patients had a decrease in cyst volumes after treatment ($p>0,05$).

- Gender, age, initial volume of the lesion, duration, presence of involved teeth, cortical bone expansion, cortical bone perforation, smoking, drain localization, drain type, extraction and pathological diagnosis were the parameters that evaluated. It was found that there were no association and no significant difference between these parameters and cystic volume reduction ($p<0.05$).

- Decompression represents a valuable treatment of large cysts in cases where it is a suitable option. It offers a number of benefits, including conservative surgery and a reduced risk of morbidity and complications such as infection, osseous fracture and IAN injury. Furthermore, decompression represents a primary treatment for large cystic lesions, resulting in a high rate of shrinkage in the volume and constant assessment of the cyst type.

- CBCT is a vital tool for the detection of unsought for findings in oral and maxillofacial cystic lesions. Furthermore, CBCT has been demonstrated to be an effective method for quantifying alterations in cystic volume following decompression. It is of the utmost importance for operators to be aware of the shrinkage of odontogenic cysts in order to assess the necessity for decompression prior to enucleation and to establish an appropriate management strategy.

- ♦ The results of the study contribute to a more comprehensive knowledge of the residual lesion size at any given time following cystostomy and enhance the ability to predict the requisite time frame for osseous regeneration following cystectomy. To permit a greater level of detail in their conclusions and to gain a fuller understanding of the results, it will be necessary to conduct further studies in due course, with longer follow-ups included.

In the light of these informations, decompression has been accepted and applied as one of the options to be preferred in the treatment of cystic lesions in the jaws. Selective application of decompression surgery in jaw cystic lesions is a good choice to achieve an optimal therapeutic effect.

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APPENDICES

APPENDIX 1: Curriculum Vitae

Personal Information

Name	Burak	Surname	SAYDAM

Education

Degree	Field	Name of Graduated Institution	Date of graduation
PHD	Oral Maxillofacial Surgery	Yeditepe University	2024
Master	Oral Surgery	Yeditepe University	2011
Bachelor	Dentistry	Yeditepe University	2008
High school		Burak Bora High School	2001

Foreign language	Foreign exam result
English	95

Work experience

Professional duty	Institution	Date
Oral Surgeon	Private Oral and Dental Health Center	2011-2024

Computer knowledge

Program	Skill
Microsoft	Advanced

Academic work

SCI, SSCI, AHCI indekslerine giren dergilerde yayınlanan makaleler

APPENDIX 2: Ethical Approval Form for Non-Invasive Clinical Research Committee

T.C.
YEDİTEPE ÜNİVERSİTESİ REKTÖRLÜĞÜ
Girişimsel Olmayan Klinik Araştırmalar Etik Kurulu

Sayı : E.83321821-805.02.03-297
Konu : Etik Kurul Karar Yazısı

Sayın Prof. Dr. Ceyda ÖZÇAKIR TOMRUK

Yeditepe Üniversitesi Girişimsel Olmayan Klinik Araştırmalar Etik Kuruluna etik onay için başvuru yapılmış olan araştırma önerisinin başlığı, araştırmacılar, başvuru numarası, sunulan belgeler ve toplantı bilgileri aşağıda yer almaktadır. İlgili araştırma önerisi, etik kurulumuz üyeleri tarafından değerlendirilmiş olup, etik ve bilimsel açıdan **UYGUN *** olduğuna karar verilmiştir.

***Açıklama bölümünde belirtilmiş olan maddelerin yerine getirilmesi koşuluyla kabulü uygundur.**

Araştırma Başlığı:	Mandibula Posterior Bölgedeki Çene Kistlerinin Dekompresyon Tedavsi Sonrası Küçülmesinin Konik Işınlı Bilgisayarlı Tomografi ile Retrospektif Olarak Değerlendirilmesi
Araştırmacılar:	Burak Saydam,Prof.Dr.Zehra Semanur Dölekoğlu,Prof.Dr.Ceyda Özçakır Tomruk
Başvuru Numarası:	202311Y0492

TOPLANTI BİLGİLERİ			
Toplantı Tarihi:	08.12.2023	**Toplantı Yeri:**	Çevirim içi (Google Meet)

***AÇIKLAMA**
• Araştırma yürütücüsü ünvanları eklenmelidir. • Dahil edilme kriterlerine gönüllülük esası eklenmelidir.

SUNULAN BELGELER
Islak imzalı başvuru dosyası, CD veya USB belleğe kaydedilmiş başvuru dosyası ve elektronik başvuru
Araştırma başlığı ve araştırmacıların isimleri
Başvuru dilekçesi
Başvuru formu
Araştırmanın;
Niteliği

Bu belge, güvenli elektronik imza ile imzalanmıştır.

Belge Doğrulama Adresi : http://belgedogrulama.yeditepe.edu.tr/bg.aspx?id=EF7EF708-7E5C-4987-A4D0-EFDBFFBD61A4

Yeditepe Üniversitesi 26 Ağustos Yerleşimi, İnönü Mahallesi Kayışdağı Caddesi 34755
Ataşehir / İSTANBUL
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İnternet Adresi www.yeditepe.edu.tr
Kep Adresi : yeditepeuniversitesi@hs03.kep.tr

Bilgi İçin: Sevgi BAYRAKTAR
Unvan: Uzman Yardımcısı
Telefon No: (0216) 578 00 00 / 6347

Önemi ve özgün değeri
Amaç ve hedefleri
Yöntemi
Yönetimi
Yaygın etkisi
Araştırma bütçesi (Mevcutsa)
Süresi ve uygunluğu (Zaman cetveli)
Kaynakları
Bilgilendirilmiş Gönüllü Olur Formu (yapılan araştırmaya özel olarak hazırlanmış)
Taahhütname-1 Araştırmanın yapılacağı kurumdan izin alma sorumluluğunun araştırmacılara ait olduğuna dair taahhüt
Taahhütname-2 Dünya Tıp Birliği Helsinki Bildirgesinin son versiyonunun ve Sağlık Bakanlığı'nın ilgili tüm kılavuzlarının okunmasına dair taahhüt
Taahhütname-3 Daha önce yapılmış etik kurul başvuruları mevcut olup olmadığına dair taahhüt
Taahhütname-4 Araştırma sırasında araştırma bütçesinde yer almayan ve gönüllünün kendisine veya Sosyal Güvenlik Kurumuna ek yük getirecek hiçbir işlem uygulanmayacağına dair taahhüt
Taahhütname-5 COVID-19 hastalarında tedavi yaklaşımları ve bilimsel araştırmalar genelgesi okunmasına dair taahhüt
Taahhütname-6 Millî Eğitim Bakanlığı Araştırma Uygulama İzinleri konulu yazının okunmasına dair taahhüt
Araştırmacıların her birisine ait özgeçmiş formu
Ek belgeler (Varsa kullanılan ölçek)

Prof. Dr. Didem ÖZDEMİR ÖZENEN
Başkan

Doç. Dr. Gökhan ERTAŞ
Başkan Yardımcısı

Prof. Dr. Elif SUNGURTEKİN EKÇİ
Raportör

Dr. Öğr. Üyesi Elif Çiğdem KELEŞ
Üye

Dr. Öğr. Üyesi Sevim ŞEN OLGAY
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Bilgi İçin: Sevgi BAYRAKTAR
Unvan: Uzman Yardımcısı
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APPENDIX 3: Informed Consent Form

GİRİŞİMSEL OLMAYAN KLİNİK ARAŞTIRMALAR ETİK KURULU BİLGİLENDİRİLMİŞ GÖNÜLLÜ OLUR FORMU

T.C. YEDİTEPE ÜNİVERSİTESİ

Araştırmanın Adı: Mandibula Posterior Bölgedeki Çene Kistlerinin Dekompresyon Tedavisi Sonrası Küçülmesinin Konik Işınlı Bilgisayarlı Tomografi ile Retrospektif Olarak Değerlendirilmesi

Sorumlu Araştırmacının Adı: Prof. Dr. Ceyda ÖZÇAKIR TOMRUK
Diğer Araştırmacıların Adı: Dt. M. Burak Saydam, Prof. Dr. Zehra Semanur DÖLEKOĞLU

Sayın gönüllü,

- Bu belge bilgilendirilmiş gönüllü onam formu olup aşağıdaki bilgileri okuduktan sonra onaylamak tamamen gönüllülük esası ile gerçekleştirilebilmektedir.
- Tüm bilgileri okuduktan sonra sorularınız olursa yanıtlanabilecektir.
- Kararınızı verip onay alındıktan sonra dahi herhangi bir nedenle katılım sağlamak istemediğiniz durumda onamınızı yazılı olmak şartıyla geri alma hakkınız vardır.
- Aynı zamanda bu formun bir kopyasını alma hakkına sahipsiniz.
- Gönüllü olarak gönüllü imzası olan tüm boşluklarda isim, soy isim, imza ve tarih bölümlerini doldurmalısınız.

Araştırma Konusu ve Amacı

Bu çalışma büyük lezyonlara sahip alt çenelerde uygulanan minimal cerrahi tedavi yaklaşımını içeren tedavi süreci hakkında bilgi sahibi olmayı amaçlamaktadır. İyileşmesi zor olan, çene kırığı riski oluşturabilecek ya da çevre dokulara zarar verebilecek cerrahi işlemler yerine kademeli olarak tedavi planlamak gittikçe daha fazla tercih edilen bir yaklaşım olmaktadır. Böylesi tedavilerde tanı için ve iyileşmenin durumunu değerlendirmek için 3 boyutlu tetkikler alınmaktadır. Bu çalışmada da sizden rutin olarak alınan tetkiklerin kullanımı ile süreç hakkında daha fazla bilgi edinmek mümkün olacaktır.

Bu çalışmaya katılmalı mıyım?
Bu çalışmada yer alıp almamak tamamen size bağlıdır. Eğer katılmak isterseniz bu yazılı bilgilendirilmiş olur formu imzalanmak için size verilecektir. Şu anda bu formu imzalasanız bile istediğiniz herhangi bir zamanda çalışmadan çekilebilirsiniz. Çalışma için öngörülen süre 6 aydır. Çalışmaya katılacak tahmini gönüllü sayısı 10 olarak belirlendi.

Bu çalışmaya katılırsam beni neler bekliyor?
Bu araştırma kapsamında size herhangi bir girişim yapılmayacaktır. Daha önceden hastanemizde çekilen, tedavinizin seyri gereği alınmış size ait tomografi görüntülerinin incelenmesi için onayınız istenmektedir. Sizden istenen tetkiklerin amacı tamamen kendi tedavinizin takibi ve değerlendirmesi için alındığını bilmelisiniz, çalışma özelinde sizden ayrıca bir tetkik istenmeyecektir.

Çalışmanın riskleri ve rahatsızlıkları nelerdir, görebileceğim olası bir zarar durumunda ne yapılacak?
Size yeni bir girişim yapılmayacağı için çalışmamız risk teşkil etmemekte ve görebileceğiniz olası bir zarar durumu bulunmamaktadır.

1

Paraf: Tarih:

T.C. YEDİTEPE ÜNİVERSİTES

GİRİŞİMSEL OLMAYAN KLİNİK ARAŞTIRMALAR ETİK KURULU BİLGİLENDİRİLMİŞ GÖNÜLLÜ OLUR FORMU

Bu çalışmada yer almamın yararları nelerdir?
Planlanan çalışmanın amaçları doğrultusunda, elde edilen veriler ve sonuçların bilimsel katkı sağlayacağı düşünülmektedir.

Bu çalışmaya katılmamın maliyeti nedir?
Çalışmaya katılmakla parasal yük altına girmeyeceksiniz ve size de herhangi bir ödeme yapılmayacaktır.

Kişisel bilgilerin korunması nasıl olacak?
Sorumlu araştırmacı ve diğer araştırmacılar kişisel bilgilerinizi, araştırmayı ve istatiksel analizleri yürütmek için kullanacaktır ancak kimlik bilgileriniz gizli tutulacaktır. Yalnızca gereği halinde, bilgileri etik kurullar ya da resmi makamlar inceleyebilir. Çalışmanın sonunda, sonuçlar hakkında bilgi istemeye hakkınız vardır. Çalışma sonuçları tıbbi literatürde yayınlanabilecektir ancak kimliğiniz açıklanmayacaktır.

Çalışma ile ilgili bir sorununuz olduğunda ya da çalışma ile ilgili ek bilgiye gereksiniminiz olduğunuzda aşağıdaki kişi ile lütfen iletişime geçiniz.
ADI: Burak SAYDAM
GÖREVİ: Araştırma Yürütücüsü

Araştırma için yapılacak harcamalarla ilgili herhangi bir parasal sorumluluk altına girmiyorum. Bana da bir ödeme yapılmayacaktır.

Bana yapılan tüm açıklamaları ayrıntılarıyla anlamış bulunmaktayım. Bu koşullarla söz konusu klinik araştırmaya katılmayı gönüllülük içerisinde kabul ediyorum.
İmzalı bu form kağıdının bir kopyası bana verilecektir.

Hasta
Tarih:
Adı Soyadı:
İmza:

Yasal Temsilci (Vasi) veya Veli (HASTANIN BİLİNCİ KAPALI VEYA 18 YAŞ ALTINDA İSE;)
Tarih:
Adı Soyadı:
İmza:

Araştırmacı Tarih:
Adı Soyadı:
Tel:
İmza:

Şahit Tarih:
Adı Soyadı:
Tel:
İmza

Paraf: Tarih: