Factors affecting the reduction rate of odontogenic cyst after decompression based on three-dimensional volumetric analysis

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A Thesis Submitted in Partial Fulfillment of the Requirements
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การศึกษาปัจจัยที่มีผลต่ออัตราการลดลงของถุงน้ำที่มีสาเหตุจากการกำเนิดของฟันภายหลังการลดแรงดันจากภาพถ่ายรังสีสามมิติ

นายศราวุธ วงศ์รัตนกาญจน์

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ศราวุธ วงศ์รัตนกาญจน์ : การศึกษาปัจจัยที่มีผลต่ออัตราการลดลงของถุงน้ำที่มีสาเหตุจากการกำเนิดของฟันภายหลังการลดแรงดันจากภาพถ่ายรังสีสามมิติ. (Factors affecting the reduction rate of odontogenic cyst after decompression based on three-dimensional volumetric analysis) อ.ที่ปรึกษาหลัก : อ. นพ.ทพ.วรภัทร ตราชู, อ.ที่ปรึกษาร่วม : อ. ทพญ. ดร.บุศนา คะบุศย์,อ. ทพ. ดร.พรกวี เจริญลาภ

การวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาปัจจัยที่มีผลต่ออัตราการลดลงของถุงน้ำที่มีสาเหตุจากการกำเนิดของฟันภายหลังการลดแรงดันจากการวิเคราะห์ภาพถ่ายรังสีสามมิติ โดยกลุ่มตัวอย่างคือผู้ป่วยที่ได้รับการลดแรงดันของถุงน้ำที่มีสาเหตุจากการกำเนิดของฟัน ที่ภาควิชาศัลยศาสตร์ช่องปากและแม็กซิลโลเฟเชียล คณะทันตแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย ตั้งแต่ปี พ.ศ. 2553-2565 จำนวน 30 ราย รวบรวมผลการตรวจเอกซเรย์คอมพิวเตอร์ก่อนและหลังการผ่าตัดของผู้ป่วยทุกรายเพื่อทำการวิเคราะห์อัตราการลดลงและเปอร์เซ็นต์การลดลงของปริมาตร (PRV) รอยโรคถุงน้ำ ตามปัจจัยต่าง ๆ ดังนี้ เพศ อายุ ปริมาตรเริ่มต้นของรอยโรค ระยะเวลาของการลดแรงดัน ตำแหน่งของรอยโรค เทคนิคการลดแรงดัน และการวินิจฉัยทางพยาธิวิทยา โดยการวิเคราะห์ความสัมพันธ์ระหว่างพารามิเตอร์เหล่านี้ ใช้ระดับความสัมพันธ์กับช่วงความเชื่อมั่น 95% (CI)

ผลการวิจัยพบว่าระยะเวลาเฉลี่ยของการลดแรงดันของถุงน้ำคือ 295 วัน เพศและปริมาณเริ่มต้นมีอัตราการลดลงที่แตกต่างกันอย่างมีนัยสำคัญทางสถิติ โดยพบว่าอัตราการลดลงในเพศชาย (31.25 ± 30.68) สูงกว่าในเพศหญิง (11.76 ± 6.06) ที่ระดับความเชื่อมั่น95%CI, (P-value =0.04) นอกจากนี้ ปริมาตรเริ่มต้นที่มีขนาดใหญ่มีอัตราการลดลงที่สูงกว่าปริมาณเริ่มต้นขนาดเล็กที่ระดับความเชื่อมั่น 95%CI (ค่า P - value <0.001) กล่าวโดยสรุปคือ การลดแรงดันของถุงน้ำมีประสิทธิภาพในเพศชายและในถุงน้ำที่มีปริมาตรเริ่มต้นที่มีขนาดใหญ่ การศึกษาการเปลี่ยนแปลงของปริมาตรของถุงน้ำภายหลังจากการลดแรงดันสามารถทำได้ง่ายและมีประสิทธิภาพด้วยการตรวจเอกซเรย์คอมพิวเตอร์ แต่อย่างไรก็ตาม ด้วยต้นทุนและปริมาณรังสีที่มากจึงควรได้รับการพิจารณาเลือกใช้อย่างเหมาะสม

สาขาวิชา	ศัลยศาสตร์ช่องปากและแม็กซิลโลเฟเชียล	ลายมือชื่อนิสิต ....
ปีการศึกษา	2565	ลายมือชื่อ อ.ที่ปรึกษาหลัก ....
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Sarawut Wongrattanakarn : Factors affecting the reduction rate of odontogenic cyst after decompression based on three-dimensional volumetric analysis. Advisor: VORAPAT TRACHOO, M.D., D.D.S. Co-advisor: BOOSANA KABOOSAYA, D.D.S., Ph.D., PORNKAWEE CHAROENLARP, D.D.S., Ph.D.

The purpose of this study is to investigate factors that affect the reduction rate of odontogenic cysts after decompression based on three-dimensional volumetric analysis. The sample consisted of 30 patients who underwent decompression of odontogenic cysts at the Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Chulalongkorn University, from 2010-2022. Preoperative and postoperative cone beam computed tomography results were collected. Volumetric analysis was performed to evaluate any differences in the reduction rate and percentage reduction in the volume (PRV) of the cystic lesion according to the sex, age, initial volume of the lesion, duration of decompression, location of the lesion, decompression technique, and pathological diagnosis. The correlation between these parameters was analyzed. The degree of association was used with a 95% confidence interval (CI).

The results of this study showed that the average duration of decompression was 295 days. There was a statistically significant difference in reduction rates by sex and initial volume. The reduction rate in males (31.25 ± 30.68) is higher than in females (11.76 ± 6.06), 95%CI, (*P-value =0.04*). In addition, the large initial volume had a higher reduction rate than the small initial volume, 95%CI, (*P - value<0.001*). The conclusion is that decompression cystic is more effective in males and has a larger initial volume of lesions. Computed tomography simplifies and efficiently measures the changes in cystic volume after decompression. Despite this, given the high economic cost and radiation dose, it should be considered a suitable therapeutic option.

Field of Study:	Oral and Maxillofacial Surgery	Student's Signature ....
Academic Year:	2022	Advisor's Signature ....
		Co-advisor's Signature ....
		Co-advisor's Signature ....

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Sarawut Wongrattanakarn

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CHAPTER 1
Introduction

Background and rationales

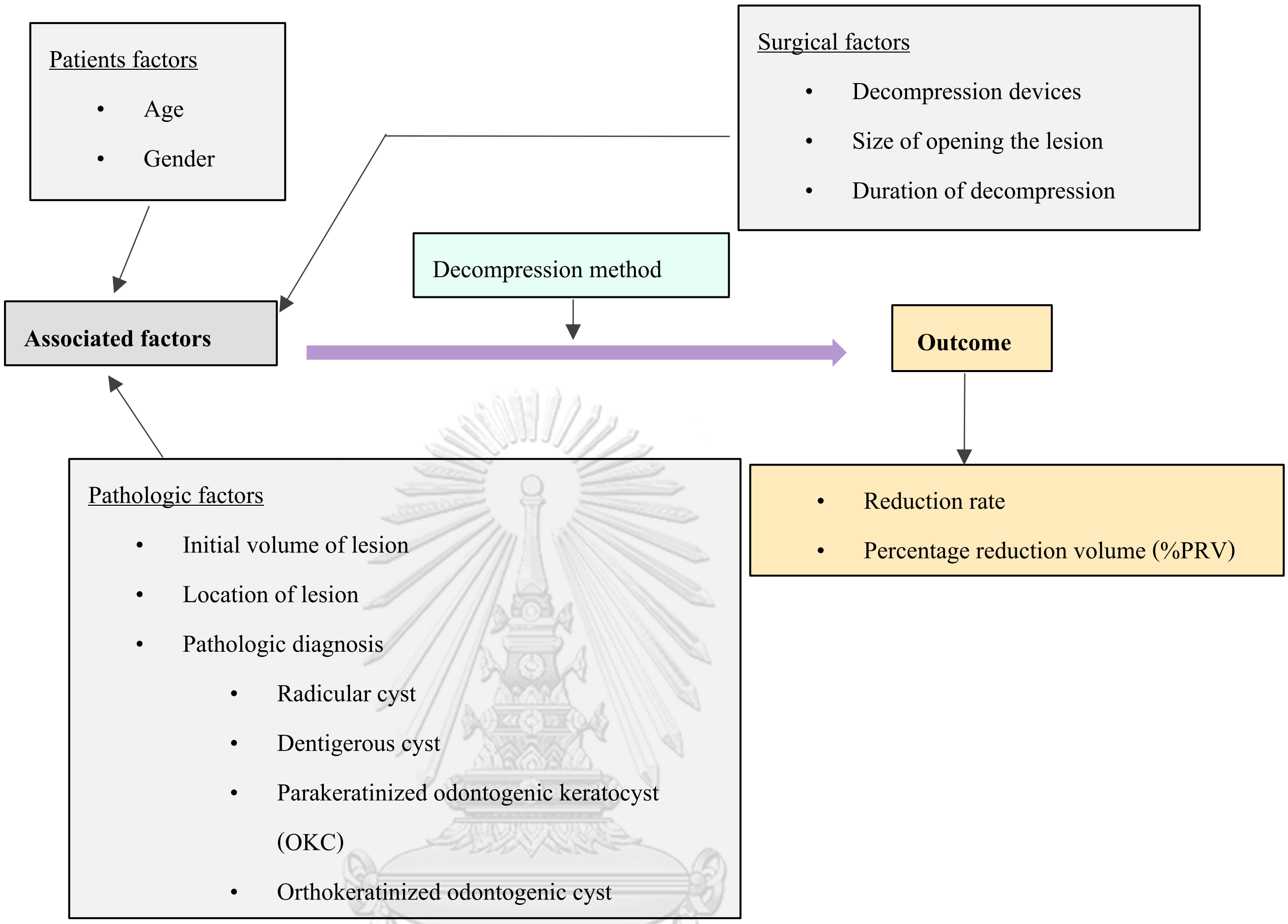
The odontogenic cysts are derived from remnants of epithelium and occur in the tooth-bearing region of the jaw. They are classified as either developmental or inflammatory in origin (1). Odontogenic cysts are pathological cavities consisting of fluid or semi-fluid contents that lead to increased intra-cystic fluid pressure and an increase in size (2),(3). The enlargement of cystic cavities results in damage to the adjacent vital structure, such as dental displacement, impingement upon the maxillary sinus or the nasal cavity, and pathologic fractures (4). The most effective way to prevent this problem is by reducing the pressure inside the cyst.

Decompression of cystic lesions is the method used to decrease osmotic pressure in the intra-cystic lumen, followed by enucleation. This process is divided into decompression techniques and marsupialization techniques. The decompression techniques aim to relieve the pressure within the cyst and alter the environment. This technique involves creating a small opening into the cyst and maintaining it open with a device. On the other hand, the marsupialization technique involves opening the cavity, exposing it to the oral environment, and suturing the cystic lining to the oral mucosa (5).

The reduction rate of odontogenic cysts is important because surgeons will assess the duration of decompression before enucleation (e.g., knowing when to enucleate a cyst following decompression). Furthermore, surgeons will determine the treatment plan and achieve a high success rate after decompression. Previous studies of factors influencing the reduction rate of the odontogenic cyst were frequently described in panoramic radiography.(6, 7, 8) It is difficult to determine the exact boundaries of the cystic lesion. Additionally, three-dimensional computer tomography, which has the advantage of being more precise, can be used to properly determine a cystic lesion's volume.

The aim of this study is to investigate factors that affect the reduction rate of odontogenic cysts after decompression based on three-dimensional volumetric analysis.

Conceptual framework



Objective

The aim of this study to investigate factors which affect the reduction rate of odontogenic cyst after decompression based on three-dimensional volumetric analysis.

Research question

- Do the reduction rate of odontogenic cysts after decompression associate with age, gender, initial volume of lesion, location, pathological diagnosis, decompression technique, duration of decompression?

Statistic hypothesis

Null hypothesis H_0 :

- The reduction rate of odontogenic cysts after decompression is not associated with age, gender, initial volume of lesion, location, pathological diagnosis, decompression technique, duration of decompression.

Alternative hypothesis H_1 :

- The reduction rate of odontogenic cysts after decompression is associated with age, gender, initial volume of lesion, location, pathological diagnosis, decompression technique, duration of decompression.

Research design

Retrospective analytical study

Expected benefit

-This study will help us evaluate the duration of decompression before enucleation.

-This study will help the surgeon determines the definite treatment plan and achieve an optimal therapeutic effect of decompression.

CHAPTER II
Literature review

Odontogenic cysts originate from epithelial cells found in the dental follicle or from remnants of odontogenic epithelium, such as reduced enamel epithelium, rests of Malassez, Hertwig epithelial root sheath, or rests of Serres. These cysts are classified as either developmental or inflammatory in origin. The osmotic pressure within the lumen of the cyst leads to enlargement of intraosseous cystic lesions. This results in increased hydrostatic pressure applied on peripheral bone, which is promoted by osteoclastic bone resorption(9). The pressure within the cyst was the cause of various factors such as the elasticity of the cyst wall, the osmotic stress of the fluid, the permeability and the blood pressure of the capillaries in the cystic wall, the lymphatic drainage, and the venous return from the cavity(10). In the previous study, the estimated intra-cystic fluid pressure for the odontogenic keratocystic was 337.6 ± 126.0 mm Hg/cm^2, the dentigerous cyst was 258.2 ± mm Hg/cm^2, and the radicular cyst was 254.0 ± 157.3 mm Hg/cm^2(11).

Odontogenic cysts predominantly occur in the mandible rather than the maxilla, with the exception of radicular cysts and residual cysts(12). On dental radiography, these cysts can appear as either unilocular or multilocular radiolucencies. The presence of cystic lesions in the mandible can weaken the bone, lead to functional changes, and increase the risk of infection and pathological fractures. Odontogenic cysts typically remain asymptomatic, particularly in the early stages, and are often incidentally detected during routine dental radiography. However, larger lesions may cause pain, swelling, paresthesia, tooth displacement, or mobility.(13)

The most common odontogenic cysts, according to a systematic review, were radicular cysts, followed by dentigerous cysts and odontogenic keratocysts (14).

Radicular Cyst

The radicular (periapical) cyst is the most commonly occurring cyst in the jaw. It typically develops as a progression of a periapical inflammatory lesion, which leads to pulpal necrosis in a tooth and subsequently the formation of a radicular cyst. Inflammation of the cyst occurs in the bone around the root apex and is often associated with necrotic pulp (13). This type of cyst tends to occur more frequently in men during their third to fifth decades of life (15). Radiographic findings typically reveal a well-defined, corticated radiolucency at the apex of a non-vital tooth. In larger lesions, cortical expansion may also be observed. The cyst can lead to root resorption and displacement of adjacent structures. Histologically, cholesterol crystals can be observed moving towards the epithelium-lined cyst cavity (16).

Figure 1. Showed that as radiography, radicular cyst appeared as unilocular radiolucency associated with the maxillary central incisor, which exhibits significant root resorption (1).

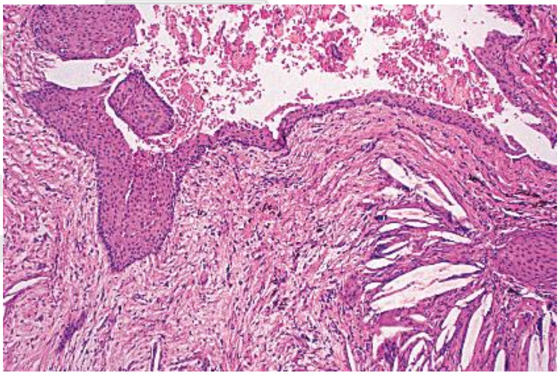


Figure 2. Showed histological of radicular cyst appeared stratified squamous epithelium lining and connective tissue wall, which contained a chronic inflammatory infiltrate and numerous cholesterol clefts (1).

The management of odontogenic cysts involves determining the appropriate approach based on factors such as the cyst's location, size, bone integrity of the cyst wall, and proximity to vital structures. The non-surgical treatment options include marsupialization or enucleation (17). However, if these interventions fail to resolve the periradicular pathology, alternative strategies such as nonsurgical retreatment or periapical surgery should be considered (18).

Dentigerous cyst

Dentigerous cysts are the second most common type of odontogenic cysts and typically occur in association with the crown of an unerupted or developing tooth (19). These cysts predominantly affect the mandibular third molars in male patients. Dentigerous cysts are commonly seen in adolescents or young adults, typically between the ages of 10 and 30. They often present as slow, painless swellings and can be associated with the displacement of adjacent teeth, root resorption, and bone destruction. In more extensive cases, facial asymmetry may be observed, and large cysts may cause pain. Radiographic images appeared as well-defined, corticated radiolucent lesions around the crowns of unerupted teeth, frequently third molars (13). Histologically, these cysts are characterized by a cavity lined with non-keratinizing thin epithelium without rete pegs. The cyst wall is typically fibrous and lacks inflammatory cells (20).

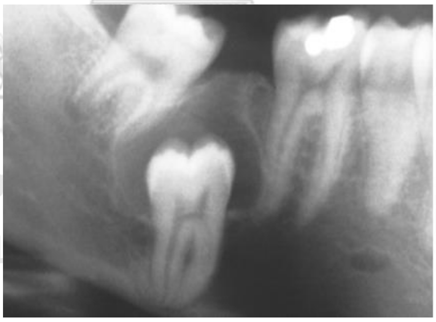


Figure 3. Showed that as radiography, dentigerous cyst appeared as unilocular radiolucency with crown projected into the cystic cavity (1).

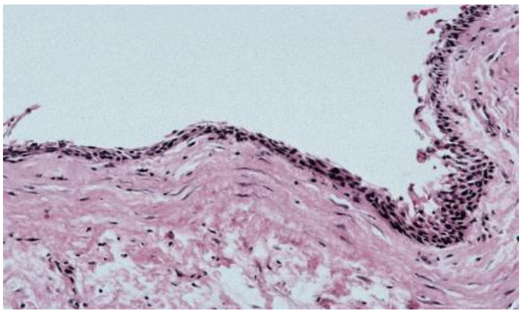


Figure 4. Showed histological of dentigerous cyst appeared a thin, nonkeratinized epithelial Lining (1).

The management of dentigerous cysts involves considering factors such as cyst size, involvement of the dentition, patient age, and the presence of vital structures. The primary surgical procedure for treating dentigerous cysts is total enucleation. However, in cases of large cysts, an alternative approach such as marsupialization and decompression via fenestration may be considered (21).

Parakeratinized odontogenic keratocysts (odontogenic keratocysts)

In 1956, Philipsen first described odontogenic keratocysts, which were found to account for 10% of jaw cysts (22). These keratocysts are commonly located in the posterior body and ramus of the mandible. In approximately 25% to 40% of cases, an unerupted tooth may be observed within the lesions.

Radiographic images appeared as well-defined radiolucent lesions with corticated margins. The radiographic finding may present as either a multilocular or unilocular radiolucent lesion. Histologically, odontogenic keratocysts are characterized by the presence of dental lamina remnants and desquamated keratin. The cysts are lined with a parakeratinized squamous epithelium, typically consisting of 5 to 10 cell layers. The basal epithelial layer is composed of palisaded columnar or cuboidal cells, which often appear hyperchromatic. Small satellite cysts, islands, or cords of odontogenic epithelium may be seen in the fibrous wall. Odontogenic keratocysts had more mitotic activity than other cysts of odontogenic origin, aggressive behavior, and correlated with a mutation of the tumor suppressor gene (protein patched homolog (PTCH) gene).

Figure 5. Showed that as radiography, odontogenic keratocyst appeared as a large multilocular radiolucency involving of ascending ramus (1).

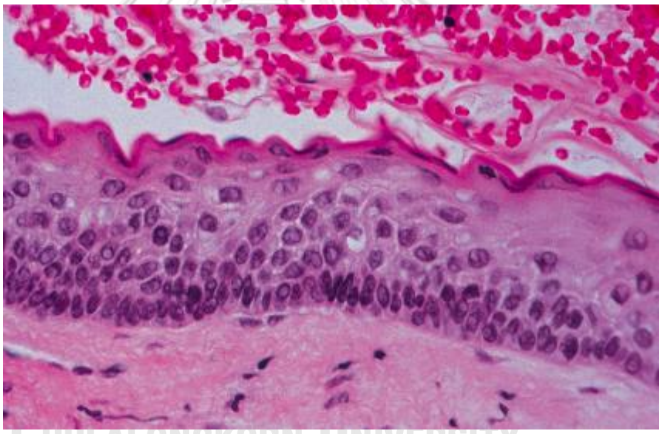


Figure 6. Showed histological of odontogenic keratocyst appeared the epithelium lining is 6-8 cells thick, with hyperchromatic and palisaded basal cell layer. Note corrugated parakeratotic surface(1).

The management was surgical treatment. Some investigators recommended tanning the cyst cavity with Carnoy's solution (absolute alcohol 6 ml, chloroform 3 ml, glacial acetic acid 1 ml and ferric chloride 1 g) before enucleation or a combination of enucleation and liquid nitrogen cryotherapy. Other investigators had recommended decompression of the cysts followed by secondary enucleation. (23)

Orthokeratinized odontogenic cyst

Orthokeratinized odontogenic cysts are developmental odontogenic cysts. In the past, orthokeratinized odontogenic cysts were classified as odontogenic keratocysts due to the formation of orthokeratin instead of parakeratin. However, it is generally accepted that there are pathological differences between orthokeratinized odontogenic cysts and odontogenic keratocysts, therefore they should be placed into different categories. These cysts are predominantly found in young adults and are more common in males than females. The lesion occurs more frequently in the mandible than in the maxilla, with a ratio of 3:1. Radiographic images show a unilocular radiolucency and rarely present as a multilocular radiolucency. It most commonly involves an unerupted mandibular third molar tooth. Histologically, an orthokeratinized odontogenic cyst was found in a stratified squamous epithelium lining in cystic wall, which shows an orthokeratotic surface of varying thickness. Keratohyaline granules may be prominent in the superficial epithelial layer.

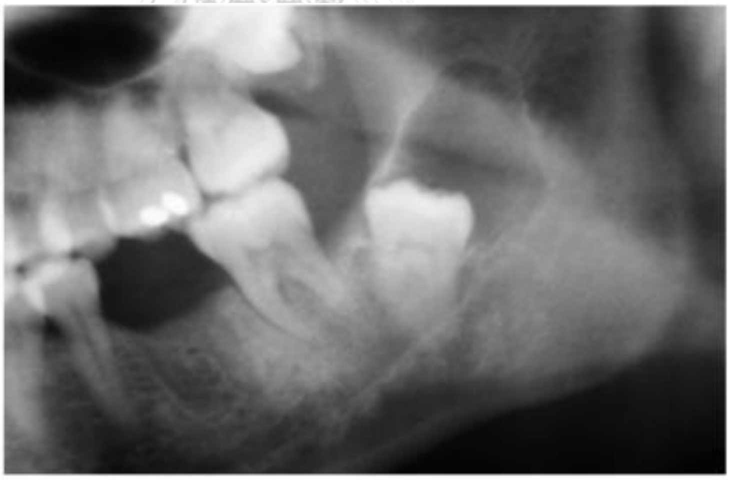


Figure 7. Small unilocular radiolucency associated with the impacted mandibular left third molar.(1)

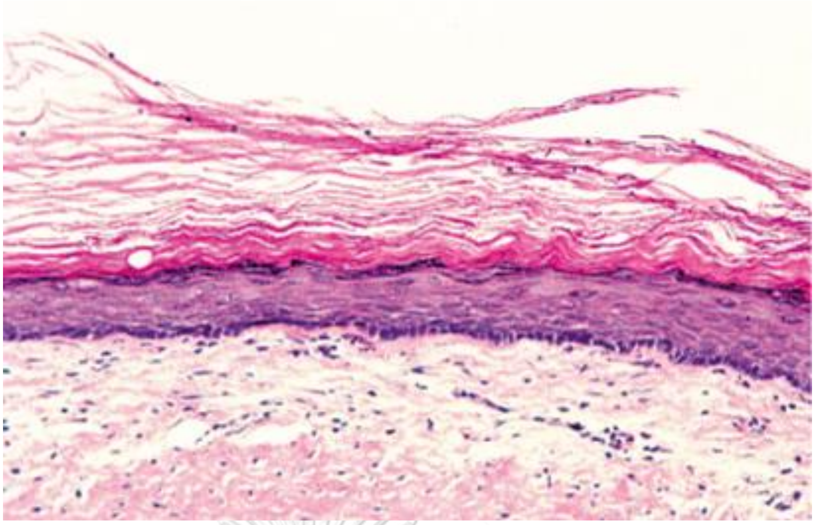


Figure 8. Microscopic features showing a thin epithelial lining. Keratohyaline granules are present, and a thick layer of orthokeratin is seen on the luminal surface.(1)

The management was enucleation with curettage. The reported recurrence rate was about 2%, and orthokeratinized odontogenic cysts are typically not associated with nevoid basal cell carcinoma syndrome.

In 2011, Anavi et. al (8), performed decompression of the odontogenic cyst followed by cystectomy. They found that decompression was faster in younger patients compared to older patients, and there were no statistically significant differences in the reduction rate based on gender, which correlated with the study conducted by Asutay et al. (24). Furthermore, this study found no statistically significant differences in pathologic diagnosis. However, this study found the reduction rate of dentigerous cysts was faster than that of radicular cyst lesions.

In 2017, Ho-gul jeong et.al(25), conducted a study involving 46 patients to evaluate the effectiveness of decompression based on reduction parameters by measuring cystic volume. This study found that lesions with a large initial volume had a higher reduction rate compared to lesions with a small initial volume. These findings are consistent with the research conducted by Luis Oliveros Lopez et al (7). Additionally, there were no significant differences observed based on sex, age, location, expansion of the cortical layer, or pathological diagnosis. However, in a study conducted by Yeh-jin Kwon et al. (26), it was found that decompression was more effective in younger patients, over a longer period of time, and specifically in cases involving the posterior maxilla. This study utilized ITK-SNAP software to measure the volume of the cystic lesion on the axial plane of CT digital images. The researchers defined the lower threshold range from -1000 to -500 HU and the upper threshold range from 500 to 1000 HU in the CT scans. The automatic program accurately assessed the boundary of the cyst within clear limits. However, one limitation of this approach was the presence of an unclear surface boundary, which necessitated manual segmentation. In a previous study, Consolo U. et al. (27) studied the analysis of marsupialization of mandibular cysts in improving the healing of related bone defects in 15 patients using Amira software. They discovered that 50% of the cystic lesion was reduced within 8 months. The volume reduction correlated with the treatment duration, and the reduction rate correlated with the initial volume. However, this study has limitations related to the Amira software, such as a high error rate in placing 3D measures and its time-consuming nature (35).

Asutay F. et al (23), conducted a study on the assessment of the effect of decompression on large mandibular odontogenic cystic lesions in approximately 40 patients using 3-dimensional volumetric and Mimic software. The study revealed no significant difference in histological lesions, age, or gender. However, a notable limitation of the Mimic software was the difficulty in accurately placing measurements in 3D (27).

Balazs Feher et al.(28) used ImageJ 3D to evaluate the volumetric shrinkage after jaw cyst surgery, set manual localization of the cyst on the axial plane, and automated reconstruction in the coronal and sagittal planes. They found that the patient’s age, location of the cyst, and type of treatment were not significant.

Martin CM et al.(29) conducted a comparison of three 3-dimensional software programs, namely Amira software, Mimic software, and ITK-SNAP software, for various morphometric research projects. The study revealed that Mimics proved to be the most effective approach. It was found to be user-friendly, enabling the generation of anatomical models with ease, and offering a wide range of helpful measurement tools. On the other hand, Osirix was deemed suitable for quickly creating educational tools, as operators could produce them easily. Amira, while being the best option, would be preferred if the creator of the learning tool intended to manually segment complex structures, create complex dynamic movies, and had the time to learn a difficult software.

Decompression device

The term "decompression" encompasses marsupialization and is defined as any method used to relieve intra-cystic pressure by maintaining a patent opening to the exterior, which can be the mouth, nose, or maxillary sinus (figure 9-11).

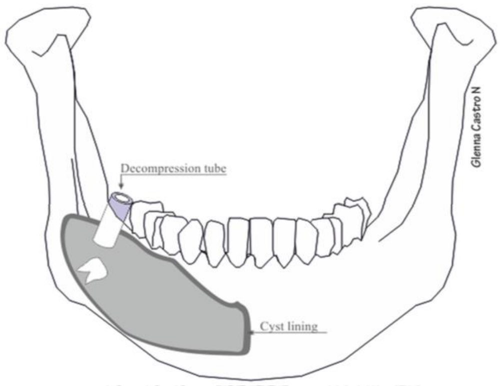


Figure 9. The decompression tube was inserted into the mouth for decrease intra-cystic pressure (30).

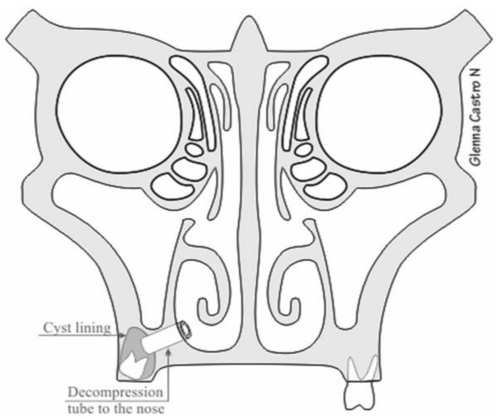


Figure 10. Decompression to the nose (30).

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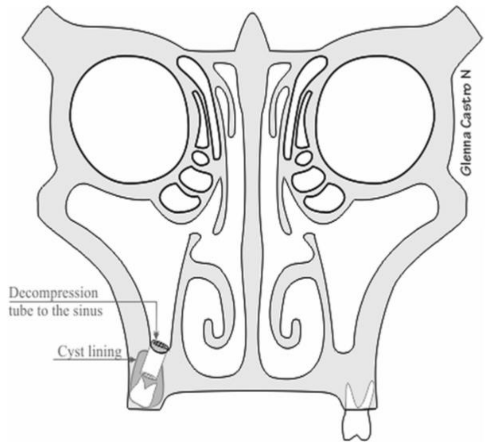


Figure 11. Decompression to the nasal sinus (30).

The marsupialization surgical technique involves creating a large window in the cystic wall and suturing it to the oral mucosa.

Decompression can be performed through a small window in the lesion and suture the tube on its periphery. The decompression devices have been identified to sustain this opening after decompression such as customized acrylic stent, tube, iodoform gauze impregnated with bacitracin ointment (31).

In 1996, Marker et al., achieved successful decompression of 23 odontogenic keratocysts using small polyethylene tubes. Their findings indicated that, on average, the cysts were reduced by 50-60% as measured across the cavity on panoramic X-rays. Additionally, the study concluded that there was evidence of new bone formation, thickening of the cyst wall, and preservation of bone and anatomical structures.

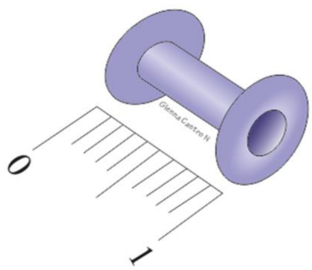


Figure 12. The decompression plug as described by Marker et al.(30).

Tolstunov 2008 (32), used a catheter for the treatment of cysts derived from the jaw. The design of the catheter had characteristics that prevented it from descending into or protruding out of the bone cavity. It was small enough to not interfere with mastication, easily fixable, and allowed for easy daily cleaning of the cystic cavity. One inconvenience associated with decompression is the potential displacement of the tube over time. Therefore, Kolokythas et al.(33), proposed the use of a 16-gauge needle to create a passage through which a 28-gauge wire could be threaded and secured to the teeth, aiming to prevent this issue.

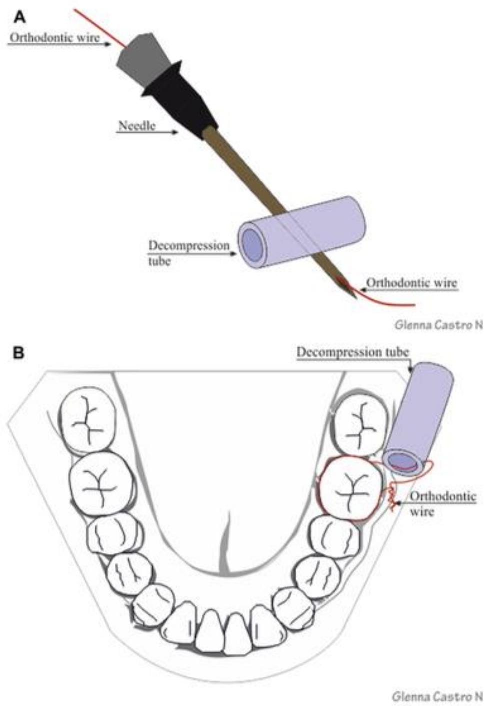


Figure 13. The Fixation method using a wire as described by Kolokythas et al (30). (A) Passing the wire through the needle., (B) Fixing the tube to the teeth.

In 2017, Leva Gendviliene et.al (34), conducted a study on conservative management of large mandibular dentigerous cysts using marsupialization with an obturator. They examined two cases and considered marsupialization or marsupialization with delayed cyst enucleation as approved conservative treatments for large cysts. One patient reported slight discomfort from the obturator, particularly during the oral hygiene process and when cleaning the obturator. However, the other patient had no complaints during the decompression period. The obturator was designed to prevent it from falling into the bone cavity or becoming loose. Additionally, attention was given to the shape of the obturator, with a slimmer neck and a wider top, to ensure stability and coverage of the cavity opening, thereby preventing food impaction.

CHAPTER III
Material and methods

Population and sample

- The retrospective analytical study was conducted on patients who underwent decompression of odontogenic cysts from 2010-2022 at the Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Chulalongkorn University.

Inclusion criteria

- Patients who underwent decompression of odontogenic cyst at Chulalongkorn University
- Patients who underwent preoperative and postoperative computed tomography once or several times.
- Patients who were histopathological diagnosis with radicular cyst, dentigerous cyst and parakeratinized odontogenic keratocyst or orthokeratinized odontogenic cyst.
- The lesion was unicystic lesion.

Exclusion criteria

- The patients who lack adequate clinical and radiological data.
- Patient with systemic condition such as endocrine disorders, rheumatoid arthritis, parathyroid disease, multiple myeloma or other metabolic bone disease.
- Patient who currently use some medications such as steroid, chemotherapy, thyroid hormone, antiresorptive and antianabolic drug.

Sample size calculation

Sample size estimation was performed by using G*power version 3.1.9.2. from previous study by Console U.et.al, (35).

Effect size= 3.545

Alpha err prob = 0.05

Power = 95%

Number of predictions = 7

Total sample size = 16

The minimum required sample size is at least 16 subjects. In case of losing any data, the sample size we used in this study was 41 subjects.

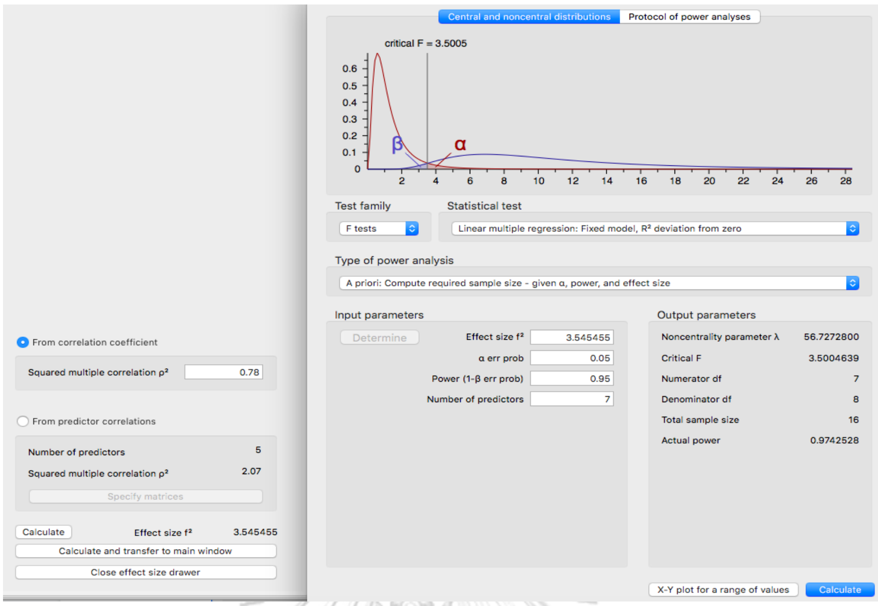


Figure14. Sample size calculated by G*power version 3.1.9.2.

Methods

The patients who underwent decompression of an odontogenic cyst at the Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Chulalongkorn University, between 2010 and 2022 were evaluated. Patients were classified according to sex, age, initial volume of the lesion, duration of decompression, location of the lesion, decompression technique, and pathological diagnosis. The 3D computed tomography technique utilizes cone beam computed tomography devices (3D Accuitomo 170 Morita, Osaka Japan) with a resolution of 0.25mm and standard mode exposure settings of 90 kVp and 5mA. The cone beam computed tomography (CBCT) was exported as Digital Imaging and Communications in Medicine (DICOM) files and imported into Mimics software. The Mimics 21.0 software (Materialise, Leuven, Belgium) was used to analyze the cystic area in the axial plane, coronal plane, and sagittal plane. To set the margin of the cystic lesion, the Hounsfield unit (HU) value was set at 400 for bone density, while soft tissue and fluid were given an upper threshold of 399 and a lower threshold of 0 (figure15) (36). The crop mark was placed around the area that contained features of interest (figure16). The measurement area was marked as the blue region along the widest portion from the central part of the cystic site to the healthy bone, while the remaining area was marked as the red region (figure17). We utilized a programmed automatic system to create a Stereolithography (STL) file, which was subsequently used in a 3D medical program to generate a 3D model (figure18). The volume of the cystic lesion was calculated in cubic millimeters and measured to determine the reduction rate and the percentage reduction in volume (PRV).

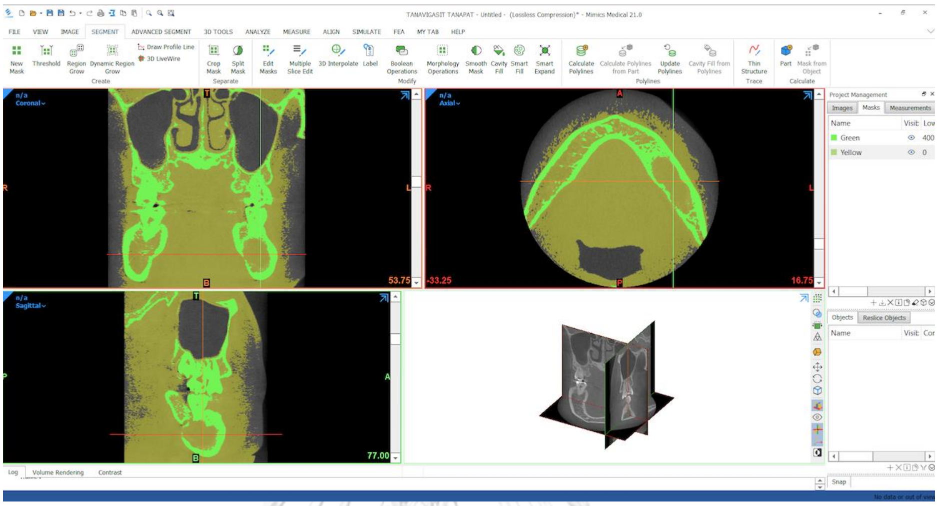


Figure 15. The Hounsfield unit value for bone density is set at 400, while soft tissue and fluid are assigned an upper threshold of 399 and a lower threshold of 0.

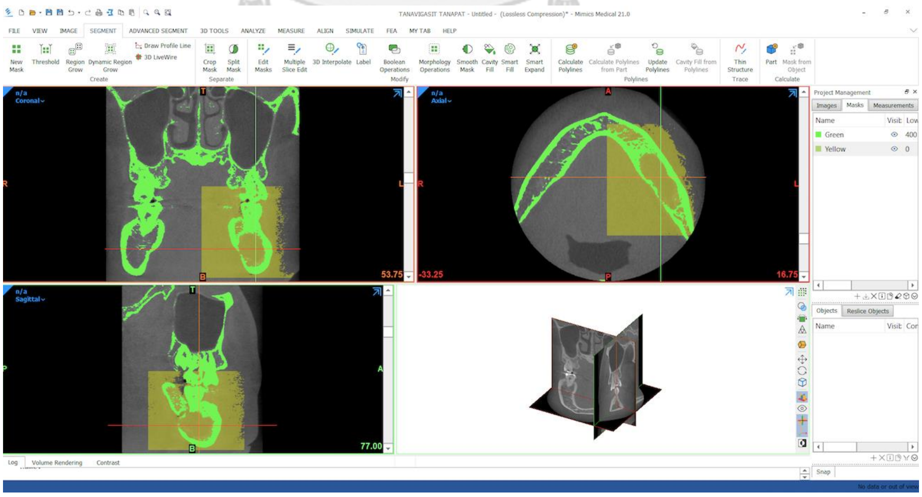


Figure 16. The crop mask was performed in an interesting area.

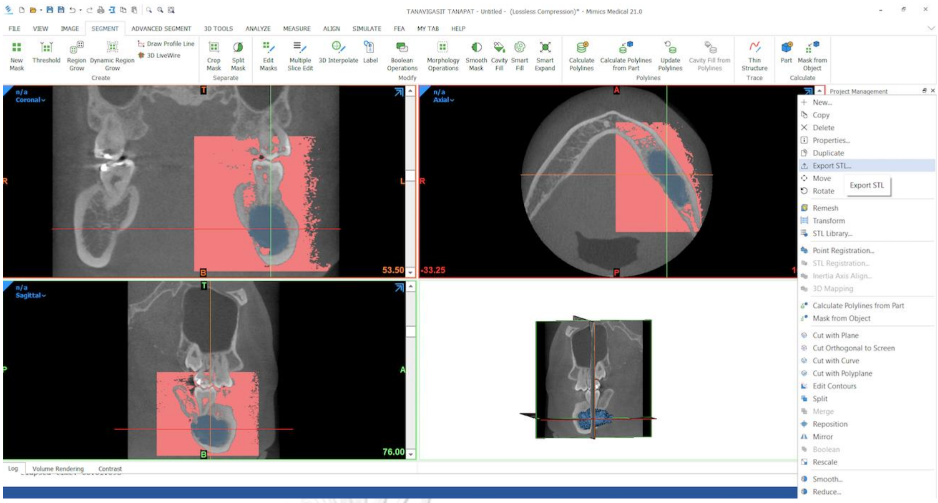


Figure 17. The cyst lesion area, represented by the blue region, and the uninterested area, indicated by the red region, were selected.

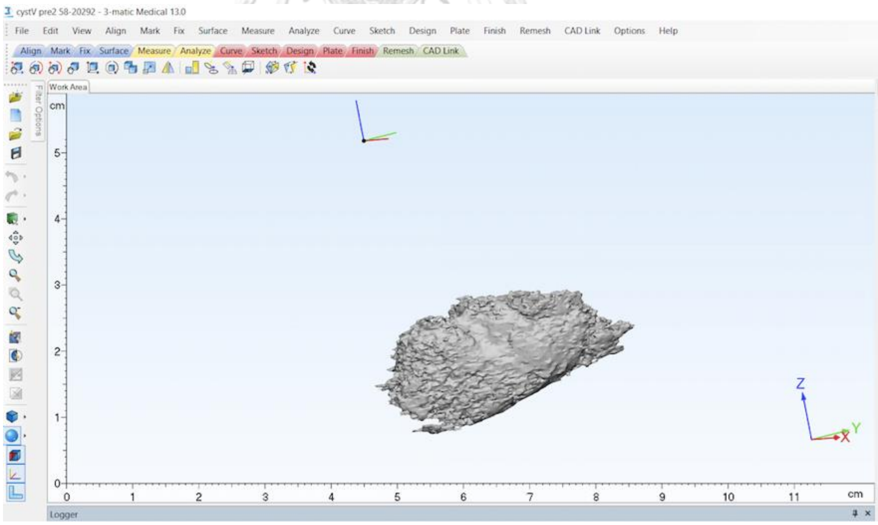


Figure 18. Computerized 3-dimensional reconstruction of the lesion.

The following variables that can affect the impact of decompression were analyzed: sex (male, female); age (≤30 years, >30 years); the initial volume of the lesion (≤ 10,000 mm^3, >10,000 mm^3); the duration of decompression (120-240 days, 241-360 days, or >360 days); location of lesion (anterior maxilla, anterior mandible, posterior maxilla, posterior mandible); decompression technique (tube drain, marsupialization); pathological diagnosis (dentigerous cyst, orthokeratinized odontogenic cyst, parakeratinized odontiogenic keratocyst, radicular cyst).

The age criterion was determined based on the results of the Ihan Hren et al. study. (37) We used 10,000 mm^3 as the initial cystic volume criterion according to the research of Ho-gul Jeong et al.,(25) which classified the size of the initial lesion on the basis of 10 ml. According to Yi Zhao et al.,(38) who discovered that bone density and a significant decrease in the cystic cavity were found 3 months after marsupialization, we set every 3 months for evaluating the reduction rate of odontogenic cysts.

Intraobserver agreement

-To quantify intraobserver agreements, 10 CBCTs were selected from the sample and analyzed twice by the main observer under the supervision of a professional radiologist.

-The intraclass correlation coefficient (ICC) was used to quantify intraobserver agreements.

$$\textbf{Reduction rate} = \frac{\text{Cystic Volume before Decompression - Cystic Volume after Decompression)}}{\text{Time express in Day observation}}$$

$$\textbf{PRV (\%).} = \frac{\text{(Cystic Volume before Decompression - Cystic Volume after Decompression)}}{\text{Cystic Volume before Decompression}} \times 100$$

Statistic analysis

The data including gender, age, initial volume of the lesion, duration, location of the lesion, decompression technique and pathological diagnosis were collected.

The factors possibly related to reduction rate and PRV were statistically calculated. The data distributions were assessed by the Shapiro-Wilk test. If the data shows a normal distribution, a paired t test was used to compare the difference between groups. On the other hand, if the data did not show a normal distribution, Mann-Whitney U test and Kruskal-Wallis test were used. After comparing the differences between the associated factors, they were analyzed using Spearman's Rank Correlation Coefficient. The degree of association was used with a 95% confidence interval (CI). All statistical analyses were performed with SPSS software version 22.0 (SPSS Inc., U.S.A.).

Ethical consideration

This research was reviewed by the ethical committee of the Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand. All data related to patients will be kept in confidential throughout the study.

Budget

Document 5,000 Baht

Time Schedule Activities

Process	Apr 2021 - Aug 2021	Sep2021 - Mar 2022	Apr 2022-Jul 2022	Aug2022 - Oct 2022	Nov 2022-Feb 2023
Literature review and writing proposal					
Proposal defense and Submit ethical committee					
Data collection					
Data analysis					
Report and publication					

CHAPTER IV

Results

The present study included 41 subjects, 25 (61%) male and 16 (39%) female, with an average age of 37.68 years (range 10 to 72 years). The mean initial volume was 12,257.97 mm^3 (range 1,466.21-53,675.73 mm^3). The average duration of decompression was 316 days (range 147-740 days). The location of the lesion was in the anterior maxilla, posterior maxilla, and posterior mandible in 5, 3 and 33, cases respectively. The decompression techniques with tube drain and marsupialization were 22 and 19, respectively. The pathological diagnosis is shown in Table1.

Table 1. Reduction rate (mm^3/days) (according to parameters)

Independent factor	Number	Reduction rate (mm^3/days)	
		Mean ± SD	*p* Value
Sex			
Male	25	27.93 ± 28.11	0.028[a] *
Female	16	13.91 ± 10.63	
Age			
≤ 30	16	19.84 ± 20.15	
>30	25	24.14 ± 26.06	0.483[c]
Initial volume of the lesion (mm^3)			
≤ 10000	21	10.18 ± 5.91	< 0.001[c] **
> 10000	20	35.36 ± 28.45	
Duration of decompression (Days)			
120-240	12	29.40 ± 35.22	
241-360	15	14.88 ± 10.03	0.317[b]
> 360	14	24.64 ± 21.51	
Location of lesion			
Anterior Maxilla	5	8.09 ± 5.49	
Posterior Maxilla	3	20.38 ± 10.91	0.082[b]

Posterior Mandible	33	24.82 ± 25.61	
Decompression technique			
Tube drain	22	22.73 ± 26.72	0.958[a]
Marsupialization	19	22.14 ± 20.52	
Pathological diagnosis			
-Dentigerous cyst	15	17.91 ± 9.89	
-Orthokeratinized odontogenic cyst	5	52.58 ± 47.15	0.093[b]
-Parakeratinized odontogenic keratocyst	19	19.76 ± 19.43	
-Radicular cyst	2	6.96 ± 7.29	

- The anterior mandible has no data.

[a] Chi-squared Tests

[b] Kruskal-Wallis Test

[c] Mann-Whitney U Test

* Significantly different mean reduction rate P < 0.05

** Significantly different mean reduction rate P < 0.001

There was a significant difference in the reduction rate between sexes (*P* = 0.028) and based on the initial volume of the lesion (*P* < 0.001). However, there was no statistically significant difference in the reduction rate based on age, duration of decompression, location of the lesion, decompression technique, or pathological diagnosis (Table 1).

Table 2. Percentage reduction in volume (according to parameters)

Independent factor	Number	PRV (%)	
		Mean ± SD	*p* Value
Sex			
Male	25	53.31 ± 16.85	0.404[a]
Female	16	56.06 ± 20.37	
Age			
≤ 30	16	58.39 ± 14.71	
>30	25	51.82 ± 19.84	0.361[c]

Initial volume of the lesion (mm^3)			
≤ 10000	21	52.78 ± 19.34	0.725[c]
> 10000	20	56.07 ± 17.04	
Duration of decompression (Days)			
120-240	12	48.52 ± 19.91	
241-360	15	50.97 ± 19.70	0.120[b]
> 360	14	63.07 ± 11.35	
Location of lesion			
Anterior Maxilla	5	51.57 ± 21.67	
Posterior Maxilla	3	57.72 ± 7.086	0.995[b]
Posterior Mandible	33	54.51 ± 18.59	
Decompression technique			
Tube drain	22	53.45 ± 16.59	0.480[a]
Marsupialization	19	55.46 ± 20.13	
Pathological diagnosis			
-Dentigerous cyst	15	56.27 ± 18.84	
-Orthokeratinized odontogenic cyst	5	48.18 ± 17.00	0.713[b]
-Parakeratinized odontogenic keratocyst	19	55.43 ± 18.17	
-Radicular cyst	2	45.73 ± 25.08	

The anterior mandible has no data.

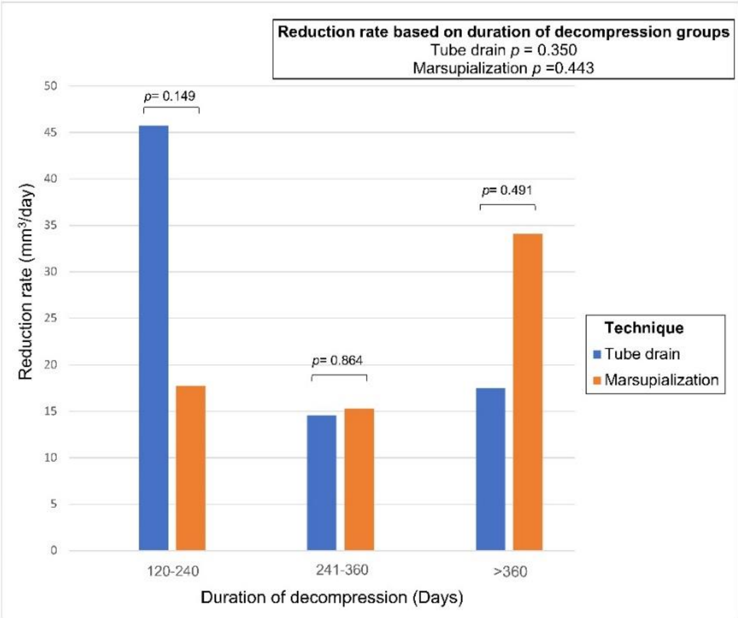
[a] Chi-squared Tests

[b] Kruskal-Wallis Test

[c] Mann-Whitney U Test

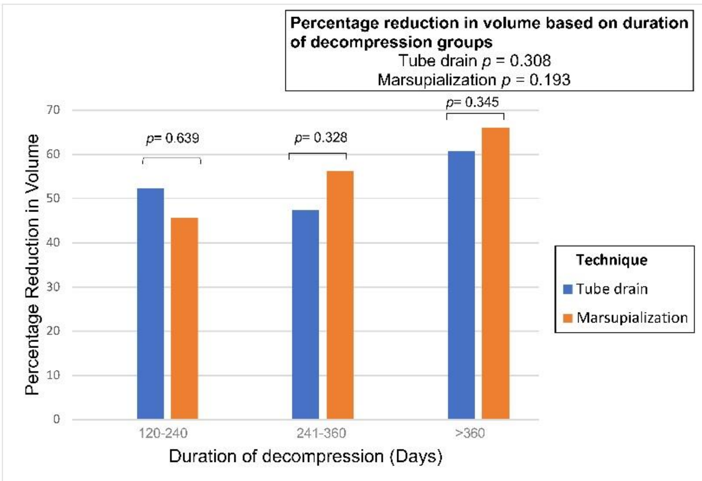
The study revealed that there were no statistically significant differences in PRV based on sex, age, initial volume of the lesion, duration of decompression, location of the lesion, decompression technique, and pathological diagnosis (Table 2).

The reduction rate for a given duration of decompression did not show any statistically significant difference between the tube drain (P = 0.350) and the marsupialization (P = 0.443) groups (Figure19). Similarly, the PRV also did not demonstrate a statistically significant difference between the tube drain (P = 0.308) and marsupialization (P = 0.193) groups (Figure 20).



Significantly different at $p < 0.05$

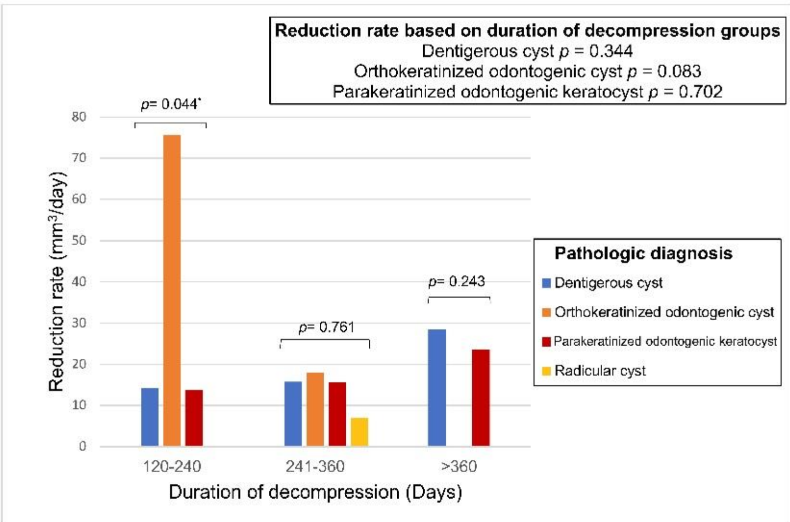
Figure 19. Reduction rate of the decompression technique according to duration of the decompression



Significantly different at $p < 0.05$

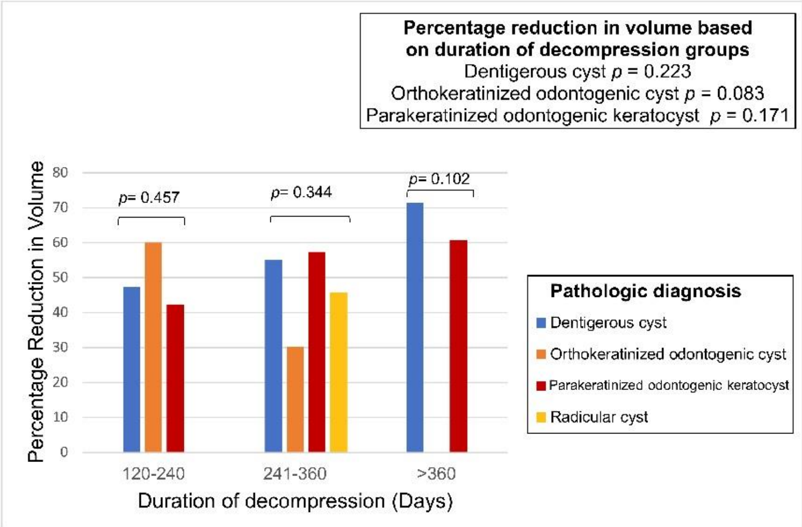
Figure 20. Percentage reduction in volume of the decompression technique according to duration of the decompression

The reduction rate for a given duration of decompression did not show any statistically significant difference between different pathologic diagnoses, including dentigerous cysts (P = 0.344), orthokeratinized odontogenic cysts (P = 0.083), and odontogenic keratocysts (P = 0.702) (Figure 21). Similarly, the PRV based on the duration of decompression showed no statistically significant difference within each diagnosis group of dentigerous cysts (P = 0.223), orthokeratinized odontogenic cysts (P = 0.083), and parakeratinized odontogenic keratocysts (P = 0.171) (Figure 22).



*Significantly different mean reduction rate $P < 0.05$

Figure 21 Reduction rate of the pathologic diagnosis according to duration of the decompression



Significantly different at $p < 0.05$

Figure 22 PRV of the pathologic diagnosis according to duration of the decompression

Table3. Spearman's Rank Correlation Coefficient

		Age	Duration of decompression (days)	Initial volume (mm^3)
Reduction rate	Coefficient	0.12	0.06	0.855**
	Significant	0.455	0.702	<0.001
PRV	Coefficient	-0.29	0.35*	0.14
	Significant	0.071	0.027	0.394

*. Correlation is significant < 0.05 level (2-tailed)

**. Correlation is significant < 0.001 level (2-tailed)

The Spearman's rank correlation coefficient revealed a weak positive correlation between the duration of decompression and the initial cyst volume (r=0.320), Including the duration of decompression and PRV, which was statistically significant (*p* = 0.041 and *p*=0.027, respectively). A strong positive correlation was observed between the reduction rate and the initial volume (r=0.855), which was statistically significant (*P* <0.001). (Table3)

CHAPTER V
Discussion

Since the decompression was used in conservative treatment for odontogenic cysts and a high success rate was reported in various studies(6, 7, 8). The period of decompression is important because this technique is a long-term treatment, and surgeons will assess the duration of decompression before enucleation.(26)Therefore, the study of factors affecting the reduction rate of odontogenic cysts is useful in achieving clinical success.

Sex, age, initial volume, duration of decompression, location of decompression, technique, and pathologic diagnosis are factors in this study that affect the result of decompression. After each factor had been statistically evaluated in terms of its effect on decompression, sex, initial volume, and duration of decompression were found to have statistically significant differences ($P < 0.05$).

According to a prior study by Ho-gul Jeong et al., the volume lesion's decrease rate was related to the large initial volume group.(25) We referred to Gao L et.al, studied the relation between relative shrinkage speed and the primary radiolucent area before decompression and found that the speed of shrinkage of larger cystic lesions was faster than that of smaller lesions after decompression. Nevertheless, in the study by Anavi et.al, found that the initial size did not affect the outcome of decompression.(8) In our study, the initial volume factor of the cystic lesion was considered a significant difference. The large initial volume group has a higher reduction rate than the small initial volume group. We anticipated that the large initial volume caused by the cyst's capacity to absorb fluid from its surroundings and the development of its epithelial cells would raise the volume pressure inside the cystic cavity due to osmosis pressure. As a result of the larger cystic lesion, the cyst shrinks more quickly.(39)

This study discovered that sex is one of the significant factors influencing the reduction rate of cystic lesion decompression; males showed a greater decrease rate than females. According to Yeh jin Kwon et al. they found that the percentage reduction in volume in males was higher than in females. However, it does not have statistically significant differences.(26) Furthermore, this may be caused by the large initial volume of odontogenic cysts such as odontogenic keratocysts and dentigerous cysts, which occur more frequently in males than females.(40) Which affected the high reduction rate due to the large initial volume.

The effects of decompression based on age are controversial; Yeh-Jin Kwon et al, reported that young age had a significantly higher reduction rate than older age. (26) Furthermore, Ihan Hren et al, suggested that density in bone defects is worse after the age of 30–33 years, while another study reported that age is not associated with reduction rate. However, in this study, there was no significant difference. The findings are consistent with a study by Sun-Tae Lee et al.,(6) they discovered that age does not influence the reduction rate. Therefore, in older age groups with large cystic lesions within the jaw, they can be reduced by decompression technique.

This study showed that the volume reduction rate was higher during the initial duration of decompression (120 to 240 days). But there was no statistically meaningful result. In the report of Zhao et al., they suggest that the initial decompression period had a high reduction rate and that enucleation can be conducted 6 to 12 months following marsupialization when enough bone growth has taken place.(38) In addition, our study showed the percentage reduction in volume was high in the initial period as well. Kwon et al. suggested that the ideal periods of decompression were 3-14 months and a 50%-60% reduction in size. (26)

Ho-gul Jeong et al. suggested a mean reduction rate for the maxilla that was higher than the mandible based on where the cystic lesion was located.(25) In contrast, Luis et al. found statistical significance in a mandibular reduction rate of odontogenic cysts higher than the maxilla. However, we discovered that there were no significant differences in our study. These results correspond to those of Anavi et al.(8) who suggested the reduction rate of odontogenic cysts was similar in the maxilla and mandible. These results are controversial; however, we believe enucleation is the main choice of treatment, including the complete removal of the lesion.

This study could not find any statistical significance for the decompression technique. However, we found that the initial period of decompression (120 to 240 days) was related to the high reduction rating of the tube drain technique. On the other hand, in a later period (>360days), the highest reduction rate was found in marsupialization techniques. Therefore, we suggested switching to marsupialization techniques later in large cystic lesions with a slowly decreasing tube drain lasting more than 360 days. Because marsupialization removes the surrounding bone surface tension, which inhibits the proliferation and differentiation of osteogenic precursors, it activates signaling pathways to promote osteogenesis, and modifies the expression of osteonectin and collagen type I,(35) which helps promote bone formation while also relieving cyst pressure.

Anavi et al. and Ho-gul Jeong et al. reported that pathological diagnosis had no effect on the effect of decompression. We discovered that, like theirs, it was not statistically significant. However, this study showed a reduction rate of orthokeratinized odontogenic cysts than the other types. Because an orthokeratinized odontogenic cyst has a large initial volume, it may have a high reduction rate.

In a comparative study of the reduction rate and period of cystic lesions in terms of before and after, there have been several analysis methods, but most studies analyzed the size of preoperative and postoperative decompression cystic lesions with panoramic radiographs.(7, 8) These studies have the advantage of requiring less radiation exposure and being less expensive than computer tomography. Nevertheless, the limitations of two-dimensional analysis make it difficult to determine distinct boundaries of the cystic lesion, especially in the overlapping position of the spine. Furthermore, the measured volume of a cystic lesion can be determined by three-dimensional computer tomography, which has the advantage of being more accurate because it's possible to define the cyst boundaries more precisely.(24, 25) Three-dimensional computer tomography was used in our study. Hounsfield unit (HU) values were used to examine the volume and shape of cystic lesions in the axial, coronal, and sagittal planes, providing a more exact volume and precise result. The volumetrics of cysts were assessed in this investigation using Mimics software. There is a straightforward function that is available. Consistent with Martin et al., they suggest that the user-friendly interface and wide range of segmentation capabilities of the program contribute to the high scores for the 3D modeling performance of the Mimics software.(27) These conclusions are supported by Tuan and Hutmacher's research, which found that Mimics allowed for greater levels of image manipulation, visualization, and functions.(41) The limitation of this study was the difficulty in determining certain boundaries of cystic lesions that are in an unclear position. In addition, only patients who had received the CT were considered for the study, resulting in the sample size used to determine the effects of the outcome was somewhat limited.

CHAPTER VI
Conclusion

The conclusions of this study are as follows.
1. The average duration of decompression for 30 cystic was 295 days.
2. There was a statistically significant difference in reduction rates by sex and initial volume. Males have a higher reduction rate than females. In addition, the large initial volume had a higher reduction rate than the small initial volume.
3. There was no statistically significant difference in reduction rates by age, location, duration of decompression, technique, or pathologic diagnosis.

In conclusion, the decompression cystic is more effective in males and larger initial volume of lesions. Computed tomography is beneficial for measuring the changes in cystic volume after decompression. However, it should be considered appropriately selected for treatment due to the high economic cost and radiation dose.

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