Iraq Dental Journal Volume 47 – Issue 1 February 2025

Segmental Mandibular Resection during Orofacial Surgery: Analysis of Hand Mallet/Osteotome and Dental Drill/Bone-Cutting Bur Osteotomies

Running title: Mandibular resection during ablative surgery.

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Submit: 19/10/2024 | **Accepted**: 23/1/2025 | **Published**: 13/2/2025

Abstract

Objective: To determine if there was advantage on the use of dental drill/bone-cutting burs osteotomy technique over hand mallet/osteotome in relation to tissue repair, treatment outcome and morbidity/complication after ablative surgery. **Methods:** This study was retrospective and comparative of cohort subjects diagnosed with mandibular ameloblastoma treated by segmental mandibular resection over 23 years at a tertiary health institution. Patients were grouped into two: those whose mandibular resection was done with hand mallet/osteotome formed the study group, and those treated with dental drill/bone-cutting bur, control group. Data for analysis were categorized into demographic, clinical and histopathological variables. Bivariate and descriptive statistics were computed. **Results:** Overall, 63 patients were evaluated, 33 in the study and 30, control. Subjects' age ranged between 31 and 48 years. There was equal distribution of subjects in the two groups if gender, age, histopathological variants of ameloblastoma and span of surgical defect are considered. The operation time was found to be 0.4 min longer in the control group. The distribution of early (P = 0.68) and late (P = 0.58) morbidities and complications between the two cohorts after surgery was insignificant. However, subcutaneous emphysema (0.9%, P= 0.89) in the control category was the only morbidity/complication related to armamentarium used for osteotomy. **Conclusions:** The study shows no significant advantage of one armamentarium over the other. They are not independent variables affecting tissue healing and treatment outcome.

Keywords: Ameloblastoma, Mandible, Resection, Segmental, Osteotomy.

Introduction

Wide excision of neoplastic tissues in the orofacial region often leads to significant defects in composite tissues. [1] As a result of neoplasm, segmental mandibular resection often results in retrusion of the mandible including the cheek, and ptosis of lower lip among other complications that lead to esthetic, functional, and social challenges, in addition to a reduction in health-related quality of life of the patients. [1-3] Innovative technologies to minimize morbidities, complications, and surgical times during this procedure and healing phase are still being researched and explored even in oral and maxillofacial surgery. [4, 5]

Osteotome is an instrument used for cutting or preparing bone during resection, and are similar to a chisel but beveled on both sides. [6] In contemporary practice, they are used with mallet in plastic, orthopedic and dental surgeries particularly during third molar surgery and jaw resection. [7-9] Osteotomy can be done with a thin osteotome and hand mallet. The armamentaria are used with care and caution to slowly advance the depth of bone cut avoiding excessive use that can be deleterious to adjacent normal tissues. [10]

The two types of dental drills most commonly used in clinical dental practice are the electric and turbine powered. [11, 12] The turbine-powered drills are the fastest and use compressed air to rotate the bur. The turbine rotates the bur very fast when in use, and consequently requires the use of built-in water jets to keep it cool. These drills have been widely applied in most dental treatment settings as it provides efficiency. The drill is equipment used by dental surgeons to drill through hard tissues and in cleaning, removing plaque/calculus from the teeth surfaces. [13] It has made dental surgeons work more efficiently, with less pain and discomfort for the patient. [14, 15] However, both the hand mallet/osteotome and dental drill/bone-cutting burs have their short comings in clinical practice. [7, 13, 14, 16]

Technologically, equipment that cuts hard tissues with burs offers the most efficient osteotomy. [14, 17] Consequently, with advances made over the centuries, the use of dental drill/bone-cutting burs, cryotherapy, ultrasound piezo surgery and laser are preferred over hand mallet/osteotome for osteotomy during mandibular resection for ablative surgeries. [17, 18] This study determined if there was advantage on the use of dental drill/bone-cutting burs armamentarium over hand mallet/osteotome for osteotomy evaluating tissue repair, treatment outcome, and morbidity/complication rates after ablative surgery. The Null hypothesis was that the uses of hand mallet/osteotome or dental drill/bone-cutting bur for osteotomy during segmental mandibular resection for ablative surgery are not independent variables affecting treatment outcome.

Materials and Methodologies

This was a retrospective comparative cohort investigation of patients diagnosed with mandibular ameloblastoma treated by segmental mandibular resection at a tertiary

health institution from June 1998 to May 2021. The location of the ameloblastoma in the mandible studied was between the symphyseal region and body of each quadrant such that the resection with adequate safety margin of bone was still within these regions after the procedure. These sites are the most common location of the lesion in the study community. [19, 20] The resection method employed was related to the tumour size at the time of surgery. What determined the use of either hand mallet/osteotome or dental drill/bone-cutting bur for osteotomy was availability during the procedure and surgeons' preference. Ethics approval was waived by the Regional Research Ethics Committee of the tertiary health facility (UCTH/HREC/33/584).

Mandibular ameloblastoma was diagnosed based on the clinical and radiological data obtained from the medical files of the subjects. The inclusion criteria were:

- Patients without symptoms and signs of temporomandibular joint (TMJ) disease.
- Subjects who had mandibular ameloblatoma on one quadrant of the mandible such that the resection will not extend beyond the symphyseal region as well as body of one quadrant.
- Non-smokers of tobacco including illicit drugs and substances.
- Those not on steroid therapy and without systemic medical disease that would negatively impact their medical status.
- Subjects with good and fair oral hygiene, complete medical records, compliant to treatment regimen, and attended a minimum of 5 years follow-up appointments after being discharged home.

Exclusion criteria include:

- Those who have TMJ symptoms like pain, limitation of mouth opening, clicking sound or crepitus and temporomandibular myofascial dysfunction (TMD).
- Subjects having systemic conditions like rheumatoid arthritis, osteoarthritis, lupus erythematosus and other joint conditions in other parts of the body.
- Patients with poor oral hygiene, incomplete data, non-compliant to treatment regimen.
- Subjects who are medically compromised, use tobacco in any form, alcoholics, narcotic and illicit drugs, on steroid therapy.
- Those who did not attend minimum five years post-operative follow-up after discharge from the hospital.

The subjects received antibiotics for 7 to 10 days, and this was started 24 h before surgery whereas non-steroidal anti-inflammatory drugs (NSAID) were commenced immediately postoperatively for a period of one week. After this duration, further management of pain was done by advising patients to use paracetamol 1000 mg pro rata. Subjects were grouped into two: cases that mandibular resection was done with hand mallet/osteotome formed the

study group, and those treated with dental drill/bone-cutting bur, the control. The surgeries for ameloblastoma were all done under standard protocols and general anesthesia in the same theater. Subjects were discharged home 4 to 6 days after surgery. None of the patients had reconstructive surgery during or after the ablative procedures. However, all the patients had maxilla-mandibular fixation done on the first recall visit between 11 to 13 days post-surgery, that is, 7 days after being discharged home from the hospital and this was worn for six weeks by each patient before removal.

The primary predictor variables were the presence of ameloblastoma whose site and surgery was limited between symphyseal and body regions of one quadrant of the mandible and the use of either hand mallet/osteotome or dental drill/bone-cutting bur for the segmental resection.

The primary outcome factor was rate of morbidities and complications determined after segmental resection. Other variables were age, gender, span of the defect after resection, histopathologic types of ameloblastoma, dates treatment commenced, duration of surgery which was measured in minutes, and when a patient presented with complaint(s), types of morbidities/complications and their treatment. The primary healing was considered unsatisfactory or satisfactory.

The outcome variables included morbidity at the resection site and contiguous structures. Outcome measures are successful healing of surgical site and absence of sepsis, postoperative oro-cutaneous fistula and sinus, aseptic bone necrosis, and pain when the jaws are in function including temporomandibular joint (TMJ) symptoms/signs like clicking, crepitus and limitation of mouth opening. Fistula was regarded as an extraoral round or oval wound with a diameter < 10 mm, not only adjacent to the resected mandible communicating with the oral cavity or with an abscess formation. Dehiscence was an intraoral and/or extraoral wound contiguous to the incision line with a longitudinal extent of > 10 mm.

The following variables were also compared in the two cohorts: presence or absence of pain within the remnant mandible, infection, postoperative oro-cutaneous fistula, aseptic bone necrosis, sinus, wound dehiscence with or without bone exposure, patient-reported limitation of mouth opening, TMJ symptoms/signs like clicking and crepitus. Complications were categorized as early or late. Early complications occurred within 30 days after surgery and late complications thereafter.

The data were documented from the patients' records by two examiners: an oral and maxillofacial surgeon who is an oral oncology expert but different from the ones that treated the subjects initially and a dental surgeon who has interest in orofacial oncology. Before the study commenced, these professionals were trained and acquainted themselves with the use of the instrument. Information gathered from the case files were documented in some pro forma prepared for the study.

Statistical Analysis

The data recorded were computed with EPI Info 7, 2012 software (US Centers for Disease Control and Prevention, Atlanta, GA, USA). For analyses, descriptive and bivariate statistics including tests of significance, Chi-square and Fisher's exact tests were computed. *P*-values <0.05 were considered significant. The Chi square (χ^2) test was used to identify if there was a difference in the distribution of two attributes. The Fisher's exact test was used to compare the incidence of complication between the two test groups. The student's t test compared the means of continuous variables between the two cohorts with a 95% confidence interval.

Results

With the initial available data, Fisher's exact test was used to investigate the Null hypothesis, and was seen to be correct (P= 0.53). However, 63 patients were evaluated in the present study (n= 33, study and n= 30, control). The patients' ages in years ranged from 31 to 48 with the mean as revealed in Table 1.

Table 1: Distribution of demographic, histological variants of ameloblastoma and span of defect after resection

Variable	Study	Control	Test	P-value
Gender				
Male	18 (54.6%)	16 (53.3%)	χ^2	0.867
Female	15 (45.4%)	14 (46.7%)		
Age (Years)				
Mean (SD)	37.2 (7.15)	36.6 (8.85)	t = 0.5263	0.642
Histopathological type				
Follicular	19 (57.6%)	17 (56.7%)	χ^2	0.789
Plexiform	14 (42.4%)	13 (43.3%)		
Span of mandibular defect after resection				
Mean in centimeter (SD)	6.2 (1.47)	6.1 (1.59)	t = 1.481	0.18

NB: SD is standard deviation

Table 1 revealed equal distribution of subjects between the two groups regarding gender, age, histological variants of ameloblastoma, the span of the surgical defect after segmental mandibular resection, and these variables were insignificant relative to each group. The operation time was 0.4 min longer in dental drill/bone-cutting bur group (Table 2).

Table 2: Period of procedure for both armamentaria

Osteotomy technique	Procedure time (min) Mean (SD)	df	t	P-value	Mean difference
Hand mallet/osteotome	85.3 (4.1)	92	1.577	0.35	-0.4
Dental drill/bone-cutting bur	85.7 (5.8)				

Table 3 shows distribution of early morbidities and complications after the procedure. The two groups under investigation showed no significant difference (P= 0.68).

Table 3: Distribution of early morbidity and complications following treatment

Variable	Study (%) no. =33	Control (%) no. =30
Malocclusion	33 (100.0)	30 (100.0)
Limitation of mouth opening	33 (100.0)	30 (100.0)
Pain	27 (81.8)	25 (83.3)
Numbness of lower lip	19 (57.6)	17 (56.7)
Wound dehiscence with IBE	5 (15.2)	4 (13.3)
Infection	1 (3.0)	0 (0.0)
Subcutaneous emphysema	0 (0.0)	2 (6.6)

NB: IBE= Intraoral bone exposure

Fisher's exact test= 178.543, df=8, P= 0.68.

Similarly, Table 4 shows the distribution of late complications after surgery between control and the study cohorts (P = 0.58).

Table 4: Distribution of late complications after treatment

Variable	Study (%) no. =33	Control (%) no. =30
Malocclusion	33 (100.0)	30 (100.0)
Limitation of mouth opening	12 (36.4)	10 (33.3)
Numbness of the lower lip	9 (27.3)	8 (26.7)
Pain	8 (24.2)	7 (23.3)
Sinus	8 (24.2)	7 (23.3)
Clicking sound in TMJ	2 (6.1)	2 (6.7)
Orocutaneous fistula	1 (3.0)	1 (3.3)

Fisher's exact test= 178.543, df=8, P= 0.58.

Furthermore, Tables 3 and 4 show that subcutaneous emphysema (0.9%, P= 0.89) in control cohort was only morbidity/complication related to the armamentarium used for osteotomy. Table 5 also revealed no significance (0.31) in treating complications among the cohorts. Most of the complications were successfully treated including those that required no active intervention.

However, malocclusion persisted among all the patients. Postoperative reviews were done between 5.2 to 17.4 years (mean 11.3 ± 2.6 years).

Table 5: Treatment of complications

Treatment	Study	Control
n(%)	n(%)	
Physiotherapy (jaw exercises)	12(26.7)	10(24.4)
Extraction of bone spickles	8(17.8)	7(17.1)
Dressing of wound with honey	5(11.1)	4(9.7)
Maxillomandibular fixation	2 (4.4)	2(4.9)
Excision and repair of fistula	1(2.2)	1(2.4)
No active treatment	17 (37.8)	17(41.5)
Total	45 (100.0)	41(100.0)

Fisher's exact test= 178.543, df=8, P= 0.31.

Discussion

Osteotomies in contemporary oral and maxillofacial surgery practice are preferably done with bone cutting equipment/instruments like burs (tungsten carbide cylindrical burs), lasers (Er:YAG; Er, Cr:YSGG), ultrasound piezo surgery (type I and II) and cryotherapy. [21] Tissue healing after segmental mandibular resection is dynamic, complex, and the various stages of haemostasis, inflammation, granulation tissue formation and maturation of the wound provide a suitable avenue for comprehending the principles. [22, 23] This enables the health care provider develop techniques to care for wound with minimal discomfort, morbidity/complication to the subject. [22, 24]

The study suggests that osteotomy can be performed safely and effectively by either of the two armamentaria and both do not affect wound healing or treatment outcome. However, the 100% morbidity and complication rate recorded for limitation of mouth opening and malocclusion respectively in the two groups are to be expected because of the traumatic nature of the procedure and the composite defect created in the mandible after the surgery rather than the armamentarium used for osteotomy. The morbidities and most of the complications that occurred are due to the inflammatory response associated with trauma induced by the procedure. [22-24] The severity of the morbidities and complications particularly the inflammatory edema, limitation of mouth opening, malocclusion and pain show the discomfort the patients endure during the post-operative period. [2, 24]

The demographic distribution of patients in this study including the histopathological variants of ameloblastoma is consistent with previous reports from earlier researchers. [1, 3, 4] The prognosis and adverse effects of mandibular ameloblastoma are influenced

by multiple factors, including size and location of tumor, its proximity to mandibular nerve canal, pathological subtype, and even the relationship between the doctor's bone-cutting site and the position of various nerves and major blood vessels, such as the mental foramen. However, it is difficult to find in the available literature studies comparing these two methods of osteotomy techniques during segmental mandibular resection, but studies carried out independently using either of the two armamentaria have shown that the procedure in conjunction with other confounding variables can cause varying frequencies of the same morbidities and complications recorded in this study during recovery period after the surgery. [2, 3, 19] These differences in frequency apart from being determined by the duration and extent of procedure can be due to personal variations with regard to inflammatory response to the injury caused by the procedure. [22, 23] Furthermore, during the procedures, suturing particularly when tight favors edema, limitation of mouth opening and pain by creating a unidirectional valve that allows food debris to reach site of the procedure, but not to leave it easily causing impaired drainage. [25, 26] This leads to local infection, inflammatory edema, and wound break down. [26] This infection may sometimes lead to formation of intraoral sinus which if not properly managed can progress to orocutaneous fistula. [24, 25]

Intraoral wound dehiscence is considered a troublesome postoperative sequel because the tissues are exposed to irritants and infective agents causing delayed healing. [2, 4, 9] The frequency of dehiscence obtained is in the range of 2.5–33.0% documented by earlier investigators. [2, 4, 26] The wound break down can be due to non-compliance to postoperative medication and instructions, inadequate bony base for the flap after suturing, unstable nature of remnant mandible and inappropriate wound drainage. Politis et al., [27] opined that the factors contributing to impaired postoperative intraoral wound repair are related to local surgical confounding variables or the patient's general health status. However, certain subjects are also expected to have wound dehiscence even if appropriate surgical technique and postoperative management are used. Dehiscence will lead to added discomfort to the subject and can extend the periods of treatment and recovery including hospital stays. [2, 8, 23, 24] However, it has a good treatment outcome requiring few weeks healing with secondary tissue epithelialization. [22-24]

As reported by earlier researchers, in this study, there were operations inferior alveolar nerve was not damaged and the subjects in this category did not complain of numbness of the lower lip, chin or cheek. [9] Numbness of the lower lip may be due to direct effect of trauma on the inferior alveolar nerve during the procedure and the accompanying inflammatory response of the tissues after surgery while malocclusion of the jaws is always a consequence of segmental mandibular resection due to the composite defect irrespective of the armamentarium used during osteotomy. [1, 9]

Temporomandibular joint (TMJ) disorders like click can occur in some patients that have dysfunctional mandible, but the cause is however, multifactorial. [1, 28] Stress, anxiety, malocclusion, internal derangements, spasms of muscles of the orofacial region, eating and functional anomalies over time are implicated as confounding variables predisposing to it. [28] These factors are considered as causing microtrauma to the TMJ. Malocclusion of the jaws due to instability of the remnant mandible would also be regarded as macrotrauma to TMJ and have shown to be a significant variable linked to TMJ dysfunction. [28, 29] Studies have also revealed that trauma to the mandible lead to biochemical changes within the joint, cartilage degeneration, and intraarticular adhesions. [28, 29] In the long term, some subjects do respond favorably well to malocclusion and TMJ clicking sound. [28] Furthermore, trauma to the mandible can play a significant role in the onset of acute TMJ symptoms or may exacerbate preexistent and subclinical symptoms. [28, 29] However, malocclusion persisted among all the patients in the present study because reconstructive surgery was not done to remedy the composite defect of the remnant mandible.

The treatment methods used to manage morbidities and complications have been documented by earlier investigators. [1, 4, 8, 9, 30] Physiotherapy by means of jaw exercises using acrylic screw or stacks of wooden spatula were the techniques used to manage limitation of mouth opening, and maxillomandibular fixation corrected clicking sound in the TMJ after four (4) weeks of immobilization of the jaws.

Intraoral dehiscence was managed successfully by intensive oral hygiene measures, copious irrigation with warm saline, and dressing the wound with ribbon gauze impregnated with Obudu honey at intervals of three (3) days until it was unnecessary to do so. Extraction of bone spickles resolved intraoral sinuses and infection, whereas debridement, excision of fistulous tracts, soft tissue repair and antibiotics closed the oro-cutaneous fistula.

Numbness of the lower lip and pain, including subcutaneous emphysema resolved without any definitive treatment. Some of these complications are related to inability of subjects to overcome the various neuromuscular and physiological problems caused by the surgery. This may be the reason some complications resolved without definitive treatment as some subjects were physiologically able to overcome these clinical conditions. However, subcutaneous emphysema might relate to rapid air inflow of air-powered drills which probably resolved due to other empirical treatments given to the patients. [31-33] The air-and-water-cooled turbine bur drill in the control group allowed air and water under pressure to be driven into the surgical site tracking through the soft tissues and fascial planes. If large quantity of air is injected, it may also track into the mediastinum, pleural space, and retroperitoneal space. [32] This was not experienced in this study. Furthermore, cervico-facial emphysema and pneumo-

mediastinum are not commonly reported complications of dental and surgical procedures in oro-facial region that is linked to the use of dental drill. They are life threatening, but most cases like in the present study are benign and self-limiting. [33] Soft tissue emphysema may lead to acute swelling of the cervico-facial region that may resemble allergic reaction. [32, 33]

After segmental mandibular resection, wound healing occurs in oral fluid containing many microorganisms, and the tissue repair comprises complex biological processes. [34, 35] The tissues usually heal uneventfully in the absence of risk factors. [34] The affected tissues are capable of regeneration to an extent, but healed tissues do not always possess the same functional or morphological characteristics as the lost ones. [34-36] Also, technologically, dental drill, lasers, cryotherapy and ultrasound piezo surgery offers the most efficient osteotomy technique.

This study determined if there was advantage on the use of either dental drill/bone-cutting bur osteotomy over hand mallet/osteotome evaluating tissue repair, treatment outcome, andmorbidity/complication rates after ablative surgery of the mandible. Most of the complications recorded in this study like malocclusion, limitation of mouth opening, pain, numbness of lower lip or chin, soft tissue dehiscence or infection can be attributed directly to the nature and extent of the surgical procedures rather than the dental drills or hand mallets/osteotome armamentarium used for osteotomy. Consequently, the result suggests that osteotomy can be done safely and effectively by either of the two armamentaria, but they are not independent variables affecting treatment outcome. Hand mallet/osteotome is therefore recommended as an alternative instrument, and this could be useful specifically in centers that are less well equipped and where access to bone-cutting equipment is limited. An adequately powered prospective clinical study is recommended in future to determine the immediate post-operative pain, trismus and swelling caused by each of the armamentarium that will assess the degree of morbidity/complication and patients' comfort during the recovery phase.

The retrospective nature of this study limit control over the data obtained. One of the limitations of this study is that the morbidities and complications caused directly by the osteotomy procedure using either hand mallet/osteotome or dental drill/bone-cutting bur armamentarium could not be determined independently from those caused by the manipulation of soft tissues around the surgical site. In addition, the severity or degrees of pain reported by the subjects were not measured. The study is also limited by the relatively small sample size due to the strict inclusion criteria but frequency of participants was appropriate if type and site of lesion studied are considered. Furthermore, some of the patients that were treated were lost during the postoperative reviews. Consequently, not all subjects were evaluated, and this may have affected the total number of patients

studied. These subjects may have chosen alternative treatments or to live with their conditions. The management of subjects was done by more than one surgeon and these surgeons have different surgical skills. This might have as well influenced management outcome. This study is retrospective; a prospective clinical investigation is recommended which will be devoid of defects associated with retrospective research. Dental drill with bone-cutting bur for osteotomy results in the production of aerosol, consequently, hand mallet/osteotome could be preferred in certain situations that require minimizing aerosol production. [37] The study also failed to explore the value of cryotherapy, ultrasound piezo surgery and laser guided osteotomy in the management of orofacial tumours. [21, 38-40]

Conclusion

The study shows no significant advantage between the two armamentaria, and consequently, are not independent variables affecting tissue healing and treatment outcome. Manual cutting method using mallet is an excellent alternative to bur cutting based method. It is cheap, can be performed with available armamentarium, and with no chance of emphysema.

Acknowledgements

The author is grateful to the staff of the Department of Oral and Maxillofacial Surgery of the study institution for their assistance during the management of the patients and data collection. Special thanks also go to staff of the Department of Information Technology and Health Records of the tertiary institution for their involvement in sorting the patients' medical folders.

The manuscript has been read and approved by the author, the requirements for authorship have been met, and the author believes that the manuscript represents honest work.

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