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ORIGINAL ARTICLE

Application of Piezosurgery in Surgical Extraction of Impacted Mandibular Third Molars Versus Conventional Rotatory Technique: A Randomized Controlled Trial

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Abstract

Objective: To compare the effectiveness of conventional rotatory and piezosurgery technique for surgical removal of lower third molars. **Material and Methods:** Twenty patients with impacted lower third molars (with no acute symptoms) were divided into two groups (G1 and G2) and evaluated clinically and radiographically. They were allotted alternately into rotatory (G1) and piezotome (G2). Parameters assessed were the pain, swelling, trismus, comfort, analgesics consumed, the time taken for the procedure, intraoperative soft tissue damage and any other complications. Findings were then tabulated and analyzed. **Results:** Findings of pain, swelling, trismus, analgesics consumed and tissue damage were favorable in the piezosurgery group. However, the time taken for the procedure was significantly more as compared to the rotatory group. Post-operative trismus, values from the piezosurgery group were found to approach normality by day seven while in the rotatory group, a significant difference was found to exist up to day 14, suggesting that patients tend to return to normal function faster in the piezo group. **Conclusion:** Piezosurgery was found to be a good alternative to the conventional rotatory handpiece in select cases where extraction of the tooth could be carried out with minimal bone removal.

Keywords: Oral Surgical Procedures; Tooth Extraction; Tooth, Impacted; Trismus.

Introduction

Mandibular third molars are the most frequently impacted teeth requiring surgical removal [1]. Eruption of these teeth may be delayed up to 25 years of age, however, unerupted/partially erupted teeth may be associated with a host of problems such as caries, periodontal diseases, development of associated pathologies, increased chance of fracture in case of trauma, pressure effect on adjacent teeth, and temporomandibular joint disturbances.

Surgical removal of the impacted lower third molar requires a good operating hand, with adequate training, skill, and experience, as this procedure can be a traumatizing experience to some patients, and can have worrying consequences if not performed in a technically accurate manner. In the past, chisel, osteotome, and mallet were used to split bone and tooth. This was time-consuming with indiscriminate malleting of bone leading to disastrous consequences, and hence surgeons preferred rotatory cutting instruments.

Electricity driven drills run at a speed of 35000-40000 rpm was a fast way to remove adequate bone, easy to learn, and provide a reasonable amount of control over the amount of bone removed. Over time, further studies on this technique showed that irregular bony surfaces and marginal osteonecrosis occurred due to the high temperature produced during bone drilling [2,3]. As the search for an ideal instrument for bone removal continued, techniques such as laser-assisted bone removal were attempted, however, did not gain much favor [4].

Piezosurgery as an alternative technique for bone guttering (or ostectomy) was first developed by Tomaso Vercellotti (1988), to overcome the drawbacks of the rotatory cutting instrument [5]. This technique modified and improved upon the conventional ultrasonic method and proved to have better-wound healing capacity and bone formation in histological and histomorphometric studies [3].

Ever since, the indications for the use of the piezosurgical unit in oral and maxillofacial surgery has only increased. Other disciplines such as neurosurgery, otorhinolaryngology, orthopedics and ophthalmology are also discovering the use of this delicate cutting instrument, which has improved access to difficult sites, protect vital soft tissue structures, reduce fatigue for the practitioner and post-operative trauma for the patient.

Piezoelectricity in the field of medical sciences was initially used to perform cuts on bone adjacent to vital structural units like the dura mater or the ethmoids or maxillary sinus in sinus lift procedures.

Electron microscope studies of alveolar bone during bone removal process showed well organized and well-vascularised bone with lamellar architecture surrounding the Haversian canals, with a precise and well-formed osteotomy line when the piezotome was used [6]. In contrast, irregular osteotomy lines and thermal necrosis were sampled from alveolar bone cut with a bur [6]. These findings would mean higher chances of healthy bone healing with fewer complications in the case of the piezosurgical unit, whereas the thermal damage caused by the rotary unit would increase the chances of undesirable sequelae such as alveolar osteitis, delayed bone healing, and osteonecrosis.

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A meta-analysis on the comparison between these two methods of ostectomy showed that the focus of the studies was primarily on postoperative sequel and complications [7]. However, the piezosurgical unit offers benefits to the surgical assistant as well, apart from the surgeon and the patient. With an attached irrigation system and an illumination at the tip of the instrument, visualization is improved.

It is utmost essential to evaluate the advantages of piezoelectric based ultrasonics in ostectomy during the removal of an impacted third molar. Hence we aimed to evaluate and compare the effects of the conventional rotatory handpiece and a piezosurgery unit in ostectomy procedure during surgical removal of impacted lower third molars.

Material and Methods

Study Design and Sample

A randomized controlled trial was conducted on 20 patients for surgical removal of impacted third molars using a piezosurgery unit or rotatory cutting instrument. The study was conducted at a single center, on systemically healthy individuals, requiring the surgical removal of impacted lower third molars.

Participant selection criteria included: patients above 18 years of age, who gave informed consent; teeth that were radiographically and clinically assessed to lie in the Pederson difficulty index 3-5 range and ASA I/ ASA II patients were included. Pederson difficulty index [8] is based on three characteristics viz., spatial relationship, depth and ramous relationship of the mandibular third molar. Spatial relationship is assessed by mesioangular (1), horizontal (2), vertical (3), and distoangular (4). Depth is assessed by high (1), medium (2), and deep occlusal level (3). Ramus relationship is assessed by sufficient (1), reduced (2), and no space (3). A cumulative score is calculated by substituting the weights given in the parenthesis and difficulty index is obtained that is graded as slightly difficult (3-4), moderately difficult (5-6) and very difficult (7-10).

Patients fitted with a cardiac pacemaker, with acute infections such as pericoronitis, acute alveolar abscess at the time of the procedure and those with radiographically determined dense sclerotic bone disease were excluded.

Equipment

The piezosurgical unit Piezotom 2 (ACTEON India Pvt Ltd., New Delhi, India), which operated at an automated frequency between 28-36 kHz, ideal for cutting mineralized tissue without causing damage to non-mineralised/ soft tissues with appropriate blades were used in bone removal. The conventional motorized instrument used was a standard micromotor fitted with a straight handpiece, operating at an rpm of 35000-40000. A number 702 carbide tapered fissure bur was used as the cutting tip. In both cases, cooled normal saline was used as an irrigant.

The primary objective was to assess the ease of use and efficacy of the piezoelectric unit in the surgical removal of third molars against conventional rotatory instrumentation, keeping

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postoperative swelling and pain as the primary parameters. The secondary objective was also to assess the following outcomes: trismus (measured by inter-incisal distance); intraoperative damage to soft tissues; other postoperative complications such as alveolar osteitis, lingual nerve paresthesia, if present; and the average time is taken for the procedure using piezosurgical unit versus rotatory instrument.

Procedure

Standard digital orthopantomogram was taken, and the teeth were assessed radiographically for the anticipated difficulty of the extraction procedure, using the Pederson's index. Patients were randomly allocated to the either of the groups alternately. The method to be used for osteotomy, recovery period and possible postoperative complications were also iterated clearly. Surgical removal of impacted third molar was done using a conventional rotatory technique or piezosurgical unit. Blinding was not possible in this study due to the nature of the same (patient as well as the operator were aware of the technique being used for bone ostectomy).

Surgical Technique

All surgical extractions were done by a single operator. Local anaesthesia 2% lignocaine with 1:200000 adrenaline (LOX 2% with adrenaline) was given by standard technique of inferior alveolar nerve block. Standard Ward's incision was given for all the extractions and Molt's periosteal elevator was used to elevate the full thickness mucoperiosteal flap and expose the impacted tooth and surrounding bone. Ostectomy and odontectomy (if required) were done using the assigned instrument. Once the tooth was removed, curettage of extraction socket and bone filing was done. Hemostasis was achieved by socket compression and pressure application for 2 minutes and simple interrupted sutures were placed with 3-0 silk suture. Patients have prescribed standard post-extraction antibiotics (oral amoxicillin 500 mg + clavulanic acid 125 mg 3 times a day for five days) and analgesics (Diclofenac 50). While the antibiotic course was fixed, analgesic consumption was left as per patient's discretion, with the advice to not exceed 3 analgesic tablets per day at an interval of 8 hours.

Data Collection

Pre-procedure mouth opening, cheek thickness, ala-tragal distance, tragus-angle of mouth distance was measured and noted. Time taken for the procedure, from time of the first incision to placing the last suture was noted. Soft tissues adjacent to the surgical site were evaluated for intraoperative damage such as bleeding from tissue edges, mucosal burns/abrasions, exposure of inferior alveolar canal (nerve / vessel) / lingual nerve. Soft tissue status post-operatively was evaluated such as minimal, moderate and severe. Evaluation for the dry socket or wound breakdown was done from postoperative day 3. Postoperatively, patients were reviewed on postoperative day 1, 3, 7 and 14 as per department protocol. Sutures were removed on day 7.

The following parameters were measured at each review visit: pain (facial pain rating scale), trismus (maximum interincisal distance) with a ruler; swelling (ala-tragus, tragus-corner of mouth using a measuring tape) and thickness of cheek measurement (at the level of the lower first molar cusp to the cheek skin tangent) using vernier caliper. Comfort level of the patient during the procedure and one day after the procedure was included as a parameter in the study. The number of analgesics consumed by the patient for adequate pain relief postoperatively was noted.

Data Analysis

All the analysis was done using IBM SPSS Statistics for Windows Software, version 18 (IBM Corp., Armonk, NY, USA). A p-value of <0.05 was considered statistically significant. Intra-group analysis for trismus was done using repeated measures ANOVA with post-hoc Dunnett test. An inter-group analysis was done using the Mann-Whitney U test.

Ethical Aspects

Permission to conduct the study was obtained from the Institutional Ethical Committee (IEC no 716/2015). The protocol was registered with the Clinical Trial Registry of India (CTRI /2018/04/013288).

Results

No significant difference regarding age, gender, the difficulty level of the impacted tooth was present between the two groups. The mean (SD) time taken for the procedure (flap elevation, bone removal, extraction of the tooth and suturing) using rotatory group was significantly lower (50 ± 13.82 minutes) than piezosurgery group (77.5 ± 29.37 minutes) (p=0.015). Pain scores were significantly higher in the rotatory group at day 1, 3 and seven than piezosurgery group (Table 1).

Table 1. Comparison of mean VAS scores between Piezosurgery and rotatory groups.

Pain (VAS)	Method of Disimpaction				p-value
	Piezosurgery		Rotatory		
	Mean ± SD	Mean Rank	Mean ± SD	Mean Rank	
Day 1	1.00 ± 0.67	5.6	3.50 ± 0.71	15.4	<0.001
Day 3	0.40 ± 0.52	5.5	3.60 ± 0.52	15.5	<0.001
Day 7	0.20 ± 0.42	6.0	1.60 ± 0.70	15.0	<0.001
Day 14	0.10 ± 0.32	8.5	0.50 ± 0.53	12.5	0.057

Mann-Whitney U test.

Post-operative trismus, values from the piezosurgery group were found to approach normality by day seven while in the rotatory group, a significant difference was found to exist up to day 14, suggesting that patients tend to return to normal function faster in the piezo group (Table 2).

There was no significant difference in the mean tragus-angle of mouth distance between the two groups except for day three where piezosurgery group showed significantly lower mean than

rotatory group (0.044) (Table 3). There were no significant differences seen in the mean ala-tragus distance between the two groups at baseline and any of the follow-ups (Table 3).

Table 2. Intra-group comparison of mean trismus from baseline through 14 day follow-up in both the groups.

Method of Disimpaction	Trismus	Mean	SD	p-value	Post-hoc test[a]
Piezosurgery	Baseline	42.20	5.35	<0.001	
	Day 1	39.90	5.72		Baseline vs Day1 (p<0.01)
	Day 3	40.60	5.91		Baseline vs Day 3 (p<0.01)
	Day 7	41.70	5.79		Baseline vs Day 7 (p>0.05)
	Day 14	42.50	5.30		Baseline vs Day 14 (p>0.05)
Rotatory	Baseline	43.00	5.33	<0.001	
	Day 1	37.90	4.98		Baseline vs Day1 (p<0.01)
	Day 3	36.80	5.37		Baseline vs Day 3 (p<0.01)
	Day 7	40.20	4.94		Baseline vs Day 7 (p<0.01)
	Day 14	42.10	5.36		Baseline vs Day 14 (p>0.05)

[a]post-hoc Dunnett test p-value.

Table 3. Comparison of mean Tragus-angle of mouth and Ala-tragus distance between piezosurgery and rotatory groups.

Variables	Days	Method of Disimpaction				p-value
		Piezosurgery		Rotatory		
		Mean	SD	Mean	SD	
Tragus-angle of Mouth	Baseline	11.69	0.40	11.70	0.67	0.399
	Day 1	11.77	0.49	12.03	0.66	0.206
	Day 3	11.75	0.44	12.16	0.67	0.044
	Day 7	11.68	0.40	11.91	0.53	0.147
	Day 14	11.69	0.40	11.71	0.68	0.4
Ala-tragus Distance	Baseline	11.62	0.36	11.40	0.74	0.724
	Day 1	11.71	0.37	11.68	0.69	0.541
	Day 3	11.69	0.35	11.73	0.71	0.316
	Day 7	11.63	0.35	11.51	0.71	0.783
	Day 14	11.62	0.36	11.43	0.75	0.815

Similarly, there were no significant differences seen in the mean cheek thickness among the two groups at baseline and any of the follow-ups (Table 4). There was a significant difference from the baseline on day 1 and 3 in the rotatory group while no such difference was seen in the piezosurgery group in the evaluation of ala-tragus and tragus- the angle of the mouth.

Table 4. Comparison of mean cheek thickness between piezosurgery and rotatory groups.

Cheek Thickness	Method of Disimpaction				p-value
	Piezosurgery		Rotatory		
	Mean	SD	Mean	SD	
Baseline	0.90	0.23	0.84	0.23	0.506
Day 1	1.06	0.23	1.16	0.33	0.486
Day 3	1.02	0.23	1.24	0.28	0.07
Day 7	0.99	0.24	0.95	0.28	0.784
Day 14	0.92	0.21	0.85	0.22	0.456

All patients in the piezosurgery group had only minimal soft tissue changes whereas six patients in the rotatory group had moderate soft tissue damage (p=0.011). The mean number of

analgesics consumed post-extraction was significantly higher in the rotatory group (9.1 ± 2.51) than piezosurgery group (5.8 ± 1.87) (p=0.009). There was no incidence of any serious soft tissue injury or complications, which required significant intervention. No incidence of mucosal/ skin burns, dry socket, and sensory alterations/ paresthesia was reported in either of the groups post-operatively.

Discussion

Piezosurgery is a safe and promising modality for ostectomy and osteotomies. The technology, although discussed decades ago, was not actively perused for bone cutting purpose [9]. In the year 2000, some authors helped renew interest in this method [3], and since then, clinicians had used the piezosurgical unit for varied purposes, especially when soft tissue preservation and minimal bone cutting was required.

With regards to the use of a piezosurgical unit for removal of impacted lower third molars, numerous studies are present in literature, that enumerate the benefits and difficulties of using this delicate instrument for this minor surgical procedure [10-16]. Comparisons with the conventional rotatory handpiece have been inevitable, and while most published reports have been encouraging, some drawbacks have been noted.

This study aims to compare the use of a conventional rotatory with piezosurgery for surgical extraction of lower third molars. The time taken for the procedure is a proxy measure to test the efficacy of the cutting instrument, and a significant difference of the cutting time was seen which was similar to earlier studies [10,17]. However, in a split-mouth study, it was found that the surgeon with more experience could perform the procedure with no significant difference in time with either of the instruments. This did not apply to the junior surgeons, who took significantly more time with the piezosurgery [11].

There was a significant difference from the baseline on day 1 and 3 in the rotatory group, which was absent in the piezosurgery group in the evaluation of ala-tragus and tragus-angle of mouth difference, which was similar to earlier studies. This may be due to the association between thermal damage to the bone and increased inflammatory response when rotatory handpiece was used [13]. Piezosurgical extraction produced less of an inflammatory response, probably because the ultrasonic vibration of the tip is less damaging to the bone. A previous study compared chisel, ultrasonic instrument and bur for osteotomies concluded that the most damage was produced by burs and the best healing was obtained by use of the chisel followed by the ultrasonic instrument [9].

Trismus was evaluated by measuring the inter-incisal mouth opening on the follow-up days. There was a significant decrease in the mouth opening in the piezo group on days 1 and 3. However, there was no significance in the values recorded on day 7 and 14, which indicated recovery would be between 3 and seven days concerning trismus. In the rotatory group, values were significantly lower on days 1, 3 and 7, which indicated that recovery would be between 7 to 14 days, which was in accordance with previous authors [18].

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The pain was evaluated by asking the patient to score on facial pain scale during the follow-up. The difference in pain between group 1 and group 2 on days 1, 3 and 7 were found to be significant whereas, on day 14, there was no significant difference. Piezosurgery group had a lesser pain as compared to the rotatory group. However, the previous study showed that difficult impactions performed with piezosurgery had significant post-operative pain [6]. Overall, the results of this study are in concordance with the meta-analysis which included seven studies that compared parameters viz., pain, edema, trismus and surgery time between piezosurgery and rotatory osteotomies [19].

Patients were assessed for comfort level during and one day after the procedure. Responses obtained from the piezosurgery group were significantly more comfortable than the rotatory group. The increased comfort level in the piezosurgery group can be attributed to the smooth micrometric cutting of the piezosurgical unit. This was in contradiction to some authors, who found that there were no significant differences in the noise-related disturbance, pain score, pain duration, or any noise levels produced by the devices [20].

The number of analgesics consumed post-operatively can also be seen as a measure of pain. In the piezosurgery group, the patients consumed significantly less number of analgesics as compared to the rotatory group. A strong association was found between the use of the piezosurgical unit and minimal intraoperative soft tissue damage. Piezosurgery is meant for more selective bone cutting, causing less damage to the adjacent soft tissues. Use of conventional rotatory handpiece was strongly associated with moderate tissue damage. It was reported in the literature one case of transient paresthesia with the conventional rotatory handpiece [11].

The major disadvantage of piezosurgery is expensive equipment, which limits its use to high resource tertiary care centers. Tooth sectioning with ninja blade was found to be time-consuming and is a common reason for prolonged operating time. The cutting efficiency of these expensive blades is limited to a few cases after which the blades need to be replaced. The illumination present at the cutting edge of the piezo handpiece improved the visibility, especially in deeper impactions. The cavitation effect produced by the vibration of the blade also kept the field relatively clearer.

Within the limitations of this study, piezosurgery had lower unfavorable post-operative sequelae. A more extensive study with larger sample size, and with increased difficulty of the surgical procedure will help us validate the findings of this study and establish if one technique is truly superior to the other.

Conclusion

Piezosurgery was found to be a good alternative to the conventional rotatory handpiece in select cases where extraction of the tooth could be carried out with minimal bone removal.

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Conflict of Interest: The authors declare no conflicts of interest.

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