International Journal of Research in Health and Allied Sciences

Journal home page: www.ijrhas.com

Official Publication of "Society for Scientific Research and Studies" [Regd.]

ISSN: 2455-7803

Original Research

Comparison Of Piezoelectric Bone Surgery With Conventional Rotary Instruments In Surgical Removal Of Impacted Mandibular Third Molars

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ABSTRACT:

BACKGROUND - Rotary bur is a conventionally used device for bone cutting during surgical removal of impacted molar. The use of rotary bur for bone cutting has numerous complications. To overcome these; piezosurgery was introduced. It is based on ultrasonic micro-vibration for precise cutting of the bone, without insulting the surrounding soft tissues. MATERIALS AND METHODS - 16 healthy patients with bilateral impacted mandibular third molars with similar difficulty were included in the study. 32 imp acted mandibular molars were divided (split-mouth design) into a control group(n=16) and a study group(n=16). In control group, the mandibular third molar were extracted surgically using conventional rotary bur whereas piezoelectric surgical unit was used in the study group. The duration of surgery was recorded from the point of placement of incision till the last suture. Facial measurement, mouth opening and were recorded preoperatively as baseline measurement and were noted postoperatively at fixed intervals, on 1st, 3rd and 7th day. RESULTS - The post-operative sequelae such as pain swelling and trismus were significantly high in the bur group while the duration of surgery was longer in the piezo group. CONCLUSION - Piezosurgery is superior than the conventional bur osteotomy in terms of post-operative sequelae.

KEYWORDS; peizosurgery, rotary, impacted, mandibular third molar

Received: 12 May, 2023 Accepted: 15 June, 2023

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This article may be cited as: Ahluwalia PKS, Singh A, Dhillon GK, Pandey M, Singh S, Arushi. Comparison Of Piezoelectric Bone Surgery With Conventional Rotary Instruments In Surgical Removal Of Impacted Mandibular Third Molars. Int J Res Health Allied Sci 2023; 9(3):82- 88

INTRODUCTION

Impacted third molars, whether partial or complete, are associated with numerous complications, including pericoronitis, regional pain, odontogenic abscess, trismus, distal caries of second molars, cysts, tumors, and arch crowding. Surgical extraction is widely recommended to prevent these issues. However, such procedures can lead to postoperative complications like pain, swelling, and trismus.

Pain following third molar removal arises due to tissue and cellular damage, releasing biochemical mediators such as histamine, bradykinin, and prostaglandins. Pain onset occurs as local anesthetic effects wane, typically peaking 6-8 hours after surgery and diminishing after 12 hours. Swelling is a common outcome, proportional to surgery difficulty and duration. It results from fluid extravasation due to post-capillary venule permeability increase following a cascade of mediators triggered by surgical wounding. Swelling peaks around the second postoperative day.

Trismus, a prolonged tetanic spasm of jaw muscles, is common after third molar surgery, peaking on the 2nd day and subsiding within a week. Additionally, inferior alveolar nerve injuries can occur, usually transient, classified as neurapraxia or Sunderland first-degree injury caused by conduction blockade from mild compression.

Historically, manual instruments like chisels and osteotomes were used for oral and maxillofacial surgical procedures. Rotary instruments are more efficient and minimally invasive. However, they generate high temperatures during bone cutting due to poor bone thermal conductivity, potentially causing thermal necrosis and

marginal osteonecrosis, hindering regeneration and healing. Rotary burs lack depth control, risking damage to vital structures.

Piezosurgery, a technique using piezoelectric ultrasonic vibrations, offers safer bone removal. It selectively cuts mineralized tissues, preserving bone structure and promoting faster healing. The "cavitation effect" provides a bloodless surgical field, and micro-streaming aids debris removal. Piezosurgery causes less bone damage, cellular stress, and patient discomfort compared to rotary techniques.

This study compares postoperative effects of conventional rotary and piezosurgery techniques for mandibular third molar removal. Sixteen patients underwent bilateral symmetrical surgeries. Piezosurgery demonstrated reduced facial swelling, pain, and trismus on days 1, 3, and 7 post-surgery. Though piezosurgery required longer operation times, its advantages, including selective cutting and cavitation, were evident. Furthermore, piezosurgery could potentially enhance bone density within extraction sockets and reduce bone loss near the distal aspect of the mandibular second molar

MATERIAL AND METHOD

Material and Methods

Study entailed the use of piezoelectric device for one group and rotatory bur for the other group of patients for the removal of mandibular third molars. A total of sixteen patients for surgical removal of bilaterally impacted mandibular third molars with similar difficulty (Pederson index) were selected from the patients visiting the outpatient clinics in Department of Oral and Maxillofacial Surgery, National Dental College and Hospital, Derabassi. Split-mouth design was executed in this study, thirty-two teeth in sixteen patients were alternatively allocated to the two interventions. Procedure was performed in two different appointments two weeks apart.

INCLUSION CRITERIA

- Individuals with presence of bilaterally asymptomatic impacted mandibular third molar with similar difficulty (Pederson Index).
- Patients under the category of ASA Grade I
- Patients who were in age range of 18- 40years.

EXCLUSION CRITERIA

- Medically compromised patients.
- Patients with any pathology or acute infection in third molar region.
- Patient with history of allergy to Local Anesthesia and medications to be prescribed.
- Smokers and alcoholics.
- Pregnant or lactating mothers.
- Non co-operative patients.
- Patients not willing to give consent for the study.

SURGICAL TECHNIQUE

Patient underwent the oral antibiotic prophylaxis with 1-gram Amoxicillin or 1-gram erythromycin 1 hour before surgery. Before beginning with the surgical procedure, the oral cavity was thoroughly rinsed with 0.2% chlorhexidine gluconate mouthwash for 10 seconds. Lignocaine 2% with 1:80,000 Adrenaline was used as local anesthestic solution for conventional pterygomandibular block. On both sides of the mandible, the impacted teeth were removed using Ward's or modified Ward's incision. After the flap reflection, required amount of bone guttering and tooth sectioning was performed to ease the removal of the tooth and subsequently extraction was done. On one side, bone guttering was done using piezoelectric unit and on the other side using conventional rotary instrument. The socket was curetted and irrigated with sterile 0.9% normal saline solution. Primary closure was done by placing simple interrupted 3-0 nonresorbable silk sutures. The patients were given analgesic Ibuprofen 400mg 8-hourly for 5 days post operatively. Further the patients were advised to the use 0.2% chlorhexidine gluconate twice daily for 7 days. Patients were instructed not to take any drugs other than the prescribed medicines.

RESULTS

In this prospective, comparative, split mouth study, sixteen patients underwent surgical removal of bilaterally impacted mandibular third molars. They were divided into two groups. Two weeks of latency period, was given in the removal of impacted third molar on the contralateral
side.

Groups were divided as follows:

GROUP A (BUR) - Bone cutting was done using conventional rotary instrument

GROUP B (PIEZO) - Bone cutting was done using piezoelectric unit.

Both the groups were statistically analysed using the following parameters.

PAIN

Comparison between different groups: On the first day after the surgery, Group A exhibited an average pain level of 2.75, while Group B had a mean pain score of 1.68. These findings revealed a significant statistical difference (P value of 0.0001). On the third day following the surgery, Group A demonstrated an average pain rating of 2.12, whereas Group B displayed a mean pain score of 1.31. These observations yielded statistically significant outcomes (P value of 0.0001).

Similarly, on the seventh day post-surgery, the mean pain scores for Group A and Group B were 1.06 and 0.68, respectively. These findings also indicated statistically significant results (P value of 0.0001).

TABLE 1- COMPARISON OF PAIN (VAS SCALE)

	GROUPS	1ST	3RD	7TH	P VALUE	POST HOC	
PAIN (VAS SCALE)	GROUP A (BUR)	2.75±0.55	2.12±0.33	1.62±0.48	0.0001*	1ST vs 3RD	0.0001*
						1ST vs 7TH	0.0001*
						3RD vs 7TH	0.013*
	GROUP B (PIEZO)	1.68±0.58	1.31±0.58	0.75±0.55	0.0001*	1ST vs 3RD	0.17
						1ST vs 7TH	0.0001*
						3RD vs 7TH	0.02*
P VALUE (T TEST)		0.0001*	0.0001*	0.0001*			

*P<0.05 is statistically significant

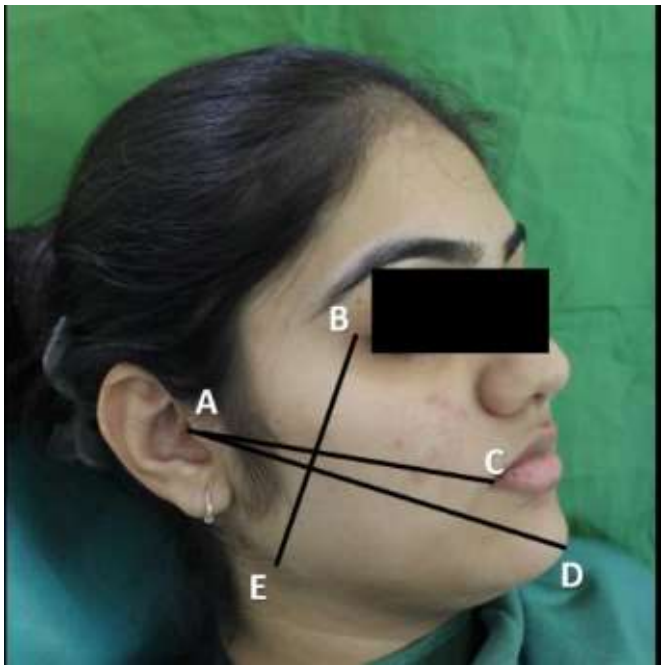
SWELLING

Initial measurements prior to surgery indicated a value of 11.15 for Group A and 11.12 for Group B, revealing statistically insignificant findings within both groups (P value of 0.67). Upon the first assessment of post-operative swelling, Group A exhibited a measurement of 11.98, while Group B recorded 11.41, signifying statistically significant outcomes for both groups (P value of 0.31). The third evaluation of post-operative swelling demonstrated a measurement of 11.76 for Group A and 11.4 for Group B, yielding statistically nonsignificant results within both groups (P value of 0.52). Subsequent to the seventh assessment of post-operative swelling, Group A displayed a measurement of 11.42, while Group B showed 11.25, indicating statistically nonsignificant findings within both groups (P value of 0.51).

TABLE 2- COMPARISON OF SWELLING

	GROUP S	GROUP A (BUR)	GROUP B (PIEZO)	P VALUE
SWELLING	PRE OP	11.15±0.70	11.12±2.10	0.67
	1ST POST OP	11.98±0.64	11.41±2.08	0.31
	3RD POST OP	11.76±0.63	11.4±2.10	0.52
	7TH POST OP	11.42±0.70	11.25±2.11	0.51
P VALUE (Repeated Measures of ANOVA)		0.006*	0.68	
POST HOC	PRE vs 1ST	0.006*	0.53	
	PRE vs 3RD	0.07	0.62	
	PRE vs 7th	0.68	0.48	
	1ST vs 3RD	0.80	0.92	
	1ST vs 7TH	0.11	0.56	
	3RD vs 7TH	0.50	0.56	

*P<0.05 is statistically significant



TRISMUS

The measurement in millimeters captured inter-incisal distance. Employing a single-use scale, this measurement was taken both before and after the procedure on the first, third, and seventh days. On the first day following the operation, the average inter-incisal distance for Group A was recorded at 3.78 millimeters, while Group B measured 3.66 millimeters. These findings demonstrated a notable outcome (p value of 0.0002). Interincisal distance postoperative day 3: the mean interincisal distance for group A was 3.16 and for group B was 3.66 showing significant results (p value 0.0009) c) Interincisal distance postoperative day 7: the mean interincisal distance for group A was 3.55 and for group B was 3.91 showing significant results (p value 0.0001).

TABLE 3- INTER INCISAL OPENING

	GROUPS	GROUP A(BUR)	GROUP B(PIEZO)	P VALUE
INTER INCISAL OPENING	PRE OP	4.15±0.25	4.15±0.25	0.89
	1ST POST OP	3.08±0.43	3.66±0.29	0.0002*
	3RD POST OP	3.16±0.42	3.66±0.28	0.0009*
	7TH POST OP	3.55±0.38	3.91±0.25	0.0001*
P VALUE (Repeated Measures of ANOVA)		0.0001*	0.0001*	
POST HOC	PRE vs 1ST	0.0001*	0.0001*	
	PRE vs 3RD	0.0001*	0.0001*	
	PRE vs 7th	0.0003*	0.07	
	1ST vs 3RD	0.93	0.99	
	1ST vs 7TH	0.006*	0.06	
	3RD vs 7TH	0.03*	0.06	

*P<0.05 is statistically significant

Comparison of Time

Statistical analysis showed that the duration of surgery is less in group A as compared to group B and proven to be statistically significant. The mean time for group A is 45.75 mins whereas in group B it is 52.13 mins.

DISCUSSION

Tomaso Vercellotti introduced Piezo surgery, an innovative osteotomy technique that utilizes ultrasonic scalpels' micro-vibrations at precise frequencies to conduct secure and accurate osteotomies. The term "Piezo" originates from the Greek word "piezein," which means pressure, and the technique operates on the principle of "pressure electrification."The Piezo electric ultrasound osteotomy device is particularly effective in complex surgical sites where delicate structures are in close proximity to osteotomy lines. Its unique feature is the selective cutting mechanism, which exclusively targets mineralized structures.

Despite the piezoelectric approach being linked to longer surgical durations, especially during tasks like hard tissue cutting (e.g., odontectomy), there is an expectation that as practitioners become more skilled and the technique advances, piezosurgery's procedural time will decrease.Beyond potential reductions in swelling and trismus, piezosurgery offers additional advantages. This device operates intermittently, pausing for 10 seconds after every 60 seconds of operation, and includes a water flow ranging from 25 to 110 ml/min. It functions within a frequency range of 24-36 KHZ, and its standout feature is the ability to selectively cut, assessing tissue hardness and targeting only mineralized structures. Throughout the study, osteotomies were performed with minimal risk of elevated temperature, thus preventing marginal osteonecrosis resulting from thermal injury.

The tips' linear vibrations span horizontally from 60 to 200 micrometers, accompanied by a vertical range of motion of 20-60 micrometers. The ultrasonic tip maintains a controlled speed of 60-200 mm/sec, calibrated specifically for incising mineralized tissue while safeguarding adjacent soft tissues. Importantly, a frequency exceeding 50 kHz is exclusively capable of cutting neurovascular and other soft tissues.

The action of piezoelectric device can be summarized by the following points:

Micrometric Cutting: Precise bone cutting accompanied by high tactile sensitivity.

Selective Cutting: Bone cutting without the risk of damaging adjacent soft tissues.

Asepsis: Sterile water.

Cavitation Effect: For maximum intra operative visibility and high predictability.

Minimum surgical stress: Excellent tissue healing

Post-operative swelling is a significant contributor to trismus. When tissue sustains injury, it triggers the release of various substances from the damaged tissue, leading to pronounced secondary changes that induce inflammation. The extent of this inflammatory response generally corresponds to the severity of the tissue injury. This focused cutting action could potentially account for the observed reduction in swelling. Furthermore, the meticulous handling of tissue during flap management might provide insight into the observed outcomes regarding pain, swelling, and trismus. In comparison to conventional rotating drills, Piezosurgery inflicts less structural and cellular damage, fostering accelerated new bone formation. Conversely, recent examination of bone samples revealed that the use of drills produces irregular surfaces and marginal osteonecrosis due to the elevated temperatures generated during bone drilling. piezoelectric bone surgery demonstrates enhanced effectiveness during the initial stages of bone healing. This technique prompts an earlier elevation of bone morphogenetic proteins, better regulation of the inflammatory process, and facilitates bone remodeling as early as 56 days post-treatment. The meticulous micrometric cuts with minimal surface area involvement are likely contributing factors to the favorable outcomes achieved.

Extraction of an impacted lower third molar consistently leads to varying degrees of pain, swelling, and trismus. Consequently, it is logical to infer that the intensity of postoperative symptoms could be connected to the surgical procedure's level of "aggressiveness."

CONCLUSION - The premise of successful treatment is based not only on the correct operative technique but also on the prevention of post operative sequelae. Over the years, various methods have been used for osteotomies. The conventional rotary bur is used commonly for the procedure. Recently peizosurgery has shown versatile results in terms of bone cutting. In this study it was concluded that, the piezoelectric osteotomy technique produced a reduced amount of facial swelling, pain and trismus, as per evaluation of these parameters on the 1st, 3rd and 7th day after surgery. A longer surgery time is required for piezosurgery when compared with the rotary technique for removal of impacted mandibular third molars. The piezoelectric device's property of selective cut and cavitation phenomenon has proven to be advantageous over rotatory bur during osteotomy. Also, it may play an important role in increasing bone density within the extraction socket and decreasing the amount of bone loss along the distal aspect of the mandibular second molar.

Conflict of interest All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Ethical Approval All procedures performed in studies involving human participants were in accordance with ethical standards of the institutional and/ or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individuals participants included in the study. Patients signed informed consent regarding publishing their data and photographs.

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