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Conventional Rotary versus Piezoelectric Techniques for Extraction of Impacted Mandibular Third Molars; Comparison of the Duration of Surgery and Post-operative Pain

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ABSTRACT

Objective: Comparison of piezoelectric surgery and conventional rotary procedures to remove impacted mandibular 3rd molars with respect to average surgical time and post-operative pain

Materials and Methods: Seventy patients with mesioangular impacted mandibular third molars were included in this randomized clinical trial. Patients were divided into two groups i.e., Group A: the control (conventional) group (n = 35), in which the third molar was extracted by using a slow-speed handpiece, and Group B: an experimental (piezoelectric) group (n = 35), in which the third molar was extracted by piezosurgery. The clinical parameters were evaluated by a self-reported questionnaire. The procedural time was noted in both groups and pain level was assessed at 1st and 7th post-operative days using a Visual Analogue Scale.

Results: The average age of the study subjects are 30.60±7.39 years, whereas gender distribution was 20 (28.6%) males and 50 (71.4%) females. The mean duration of surgery was significantly lower in Group A as compared to Group B (36.5±4.44 vs. 50.6±7.43, p<0.001). The mean pain score was significantly higher in Group A as compared to Group B on 1st postoperative day (5.80±0.86 vs 4.40±0.81, p<0.001) and 7th postoperative day (3.68±0.79 vs 3.28±0.62, p=0.022), respectively.

Conclusion: Piezoelectric surgery reduces postoperative pain significantly therefore it is more reliable, effective, and valuable than traditional rotary systems for surgically removing impacted mandibular third molars.

Keywords: Molars, Piezosurgery, Pain, Rotary

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INTRODUCTION

Impacted teeth are frequently encountered in clinical setups, with a prevalence of 33-58%.[1] The trans alveolar extraction of impacted lower third molars produces a significant degree of trauma to the surrounding hard and soft tissues, which results in inflammation manifesting as pain, oedema, and reduced mouth opening.

Impacted third molars, either partial or complete, have been the cause of a multitude of problems like pericoronitis, caries in the adjacent second molar tooth, regional pain, crowded teeth, dentoalveolar abscess, trismus, cysts, and tumours. To treat or prevent these problems the third molars need to be extracted.[2]

Surgical removal of impacted third molars may lead to postoperative pain, oedema, and trismus. However, problems like infection, dry socket, nerve damage, and, in rare cases, mandibular fractures can also occur therefore the surgical extraction of the impacted third molar is a sophisticated procedure that requires the removal of bone around the teeth.[3]

Dental surgery has come a long way since the early days of using basic hand tools. With technological advancement, various methods have been developed to make dental surgeries safer, more precise, and less invasive. Osteotomy is one of the most critical steps involved and various methods have been described traditionally, impacted third molars are often removed using rotary osteotomy techniques. This bone removal is conventionally done with a rotary handpiece which can result in excessive heat generation and damage to the surrounding tissues. The morphological investigation of bone cut with a bur utilizing a rotary handpiece revealed irregular areas and marginal bone necrosis due to the high temperature produced during the technique, which can hinder wound healing and tissue restoration.[4]

Piezoelectric surgery techniques have ushered in a new era for osteotomy, osteoplastic, and exodontia in maxillofacial and oral surgery. In addition to being selective, the micrometric cuts enabled by these techniques optimize surgical precision, resulting in minimal soft tissue damage. Furthermore, the cavitation effect delivers maximum intraoperative visibility and a blood-free surgical site.

Piezosurgery is an innovative, valuable alternative to the drawbacks associated with traditional rotating bone-cutting instruments. Piezosurgery may have advantages over traditional rotary surgery in terms of reducing post-operative sequelae and discomfort during surgery, precisely cutting the bone, and improving the visibility of the surgical site.

Piezosurgery has been used effectively for various surgical operations since it was certified for commercial use in 2002, for obtaining autogenous bone grafts, maxillary sinus lifts, splitting of bone, also during inferior alveolar nerve lateralization, orthognathic and neurologic operations.[5]

Piezosurgery osteotomy makes use of tiny vibrations that can cut bone.[6] A nitride-hardened or diamond-coated core with a rate of 25 to 30 KHz allows for targeted and accurate bone tissue removal of some ceramics and crystals to distort when an electric current flows through them, leading to ultrasonic micro-vibrations, which enables selective and precise bone tissue cutting.[7,8]

A study done in 2016 showed that patients who had undergone surgery via piezosurgery osteotomy showed less post-operative pain which was statistically significant when compared to patients on whom conventional rotary osteotomy had been used. The mean SD of the study population was 0.10 ±0.32 and control population 1.00 ± 0.67 and the *p*-value was 0.001.[9] Another study done in 2017 showed that the piezosurgery technique (48.20±15.39 and *p*-value 0.009), takes significantly more time to extract impacted mandibular third molar when compared with conventional rotary mean 34.33 and 11.31 SD although this might be due to its being a relatively newer technique.[10] Numerous studies have compared the duration of operation and patient discomfort using both piezoelectric surgery and rotary instruments. However, these factors have not been assessed in complicated cases and osteotomy methods, with inconsistent results reported. This trial has been conducted to compare piezosurgery with traditional rotary techniques regarding post-operative sequelae of impacted third molar extraction.

Therefore, this research aims to compare piezosurgery and traditional rotational surgery during extraction of impacted mandibular third molars, with regard to operational length and postoperative pain levels.

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MATERIALS AND METHODS

This prospective clinical study was conducted on patients reporting to the Maxillofacial Surgery Out-Patient Department at Foundation University College of Dentistry and Hospital, Islamabad (FUCD). Non-probability consecutive sampling technique was used in this study. All the patients reporting to the dental OPD, requiring removal of impacted lower third molar fulfilling study inclusion criteria were enrolled in the study. The inclusion criteria comprised of age 18-31 years, either gender, non-smoker, non-alcoholic, having mesioangular impactions of mandibular wisdom teeth based upon radiographic analysis, and ability to give voluntary consent for participation in the study. Participants with systemic diseases, pregnant females, individuals with acute local infection around impacted teeth, periapical infection, or any other associated pathology, or those who refused to participate were excluded from the study. Written informed consent was obtained from all the study participants before data collection. The flow chart of this study is presented in Figure 1.

Patients were divided into two study groups in a single-blinded way using the lottery method. Patients belonging to control group A underwent tooth extraction via conventional technique, while patients in experimental group B underwent extraction via piezoelectric technique. Patients in the control group had their extractions with the help of conventional rotary osteotomy whereas patients in the test group have their extractions done with the help of the piezoelectric osteotomy technique. The duration of surgery was noted commencing with the incision and ending with the suturing. The pain level was measured using a Visual Analogue Scale (VAS) that is a horizontally drawn line 10 cm long with verbal signals on both ends and a number provided after every centimetre, for a total of 10 numbers. Number one was no pain at all, and number ten was the most terrible pain ever. Participants were asked to pinpoint a number that depicts their level of pain. The pain score was represented by the numerical mark. The pain was measured on day 1 and day 7 post-operatively.

The minimum required sample size (n=70, 35 in each group) was calculated with the help of the WHO sample size calculator, considering a 95% level of confidence, 5% alpha error, 80% study power, pooled standard deviation of 0.70, 0.10[9,10] as test value of the population means, and 10% precision.

The data was entered and analyzed using IBM SPSS software (version 22.0). The descriptive statistics of quantitative variables were reported as mean and standard deviation, while for categorical variables percentages and frequencies were reported. The independent sample t-test was used to compare mean pain and duration of surgery between the two groups. The chi-square test was used to compare categorical data. A *p*-value of 0.05 was deemed significant. Stratification was done to control effect modifiers such as age and gender.

RESULTS

The overall mean age was 30.60±7.39 years, while 29.69±7.0 and 31.51±7.76 years for groups A and B, respectively. Similarly, there were 20 (28.6%) males and 50 (71.4%) females in the study group, with similar gender distribution among the study groups. The baseline characteristics are summarized in Table 1 for the two study groups.

The baseline pain score before starting the procedure was measured by using the VAS log, and it was the same for both groups. At the first post-op follow-up, on day 1 after the surgery, there was a significant difference noted in the mean pain score between the two study groups. The mean pain score in group A was significantly higher (5.80±0.86) as compared to the mean pain score in group B (4.40±0.81) with $p<0.001$ as shown in Table 2. Similarly, at the second post-op follow-up, on day-7 after surgery, again there was a significant difference noted in the mean pain score between the two groups. The mean pain score was significantly higher in group A as compared to group B (3.68±0.79 vs. 3.28±0.62, $p=0.022$) as shown in Table 2. In terms of the duration of surgery, there was a significant difference in procedure time between the two groups. It was noted that the surgery duration was significantly lower in the conventional technique group as compared to the piezoelectric group (36.5±4.44 vs. 50.6±7.43, $p<0.001$).

To assess the possible interaction of gender and age toward mean pain score, stratified analysis was done as shown in Table 3. In conventional technique group A, at post-op day 1, the mean pain score was significantly higher among females as compared to males ($p=0.004$),

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while no difference was noted at post-op day 7. In piezoelectric technique group B, there was no difference in mean pain score on either day 1 or day 7 postoperatively. On the other hand, it was noted in group B that day 7 post-op mean pain score was significantly higher among older age group patients as compared to younger patients (p=0.004), while no difference in pain score was noted at post-op day 1 for the same group. In group A, there was no association of age groups with post-op mean pain scores at any follow-up.

Table 1: Baseline characteristics for participants in two study groups

Characteristics	**Overall (n=70)** (mean±SD)	**Group A Conventional (n=35)** (mean±SD)	**Group B Piezoelectric (n=35)** (mean±SD)	***p*-value**
Mean age in years	23.96±3.0	24.3±3.4	23.69±2.5	0.455*
Age groups				
18 – 24 years	39 (55.7%)	18 (51.4%)	21 (60.0%)	0.470**
25 – 31 years	31 (44.3%)	17 (48.6%)	14 (40.0%)	
Age range	18 - 31	18 - 28	19 - 31	-
Gender				
Male	20 (28.6%)	11 (31.4%)	9 (25.7%)	0.597**
Female	50 (71.4%)	24 (68.6%)	26 (74.3%)	
Baseline Pain Score (VAS)	1.0±0.0	1.0±0.0	1.0±0.0	-

**Independent samples t-test, **Chi-square test*

Table 2: Comparison of 7-day post-operative pain score with baseline, and duration of surgery in two study groups

	Overall (n=70) (mean±SD)	**Group A Conventional (n=35)** (mean±SD)	**Group B Piezoelectric (n=35)** (mean±SD)	***p*-value**
Post-op pain score (Day 1)	5.10±1.10	5.80±0.86	4.40±0.81	<0.001*
Post-op pain score (Day 7)	3.48±0.73	3.68±0.79	3.28±0.62	0.022*
Duration of surgery	43.5±9.3	36.5±4.44	50.6±7.43	<0.001*

**Independent samples t-test*

Table 3: Stratification of post-op pain with respect to gender and age in two study groups

Variables			**Group A Conventional (n=35)**	***p*-value**	**Group B Piezoelectric (n=35)**	***p*-value**
Gender	**Male**	Post-op D1 pain	5.1±1.1	0.004	4.2±0.6	0.288
	Female		6.0±0.6		4.5±0.9	
	Male	Post-op D7 pain	3.6±0.7	0.93	3.0±0.8	0.065
	Female		3.7±0.8		3.4±0.5	
Age groups (years)	**18-24**	Post-op D1 pain	5.7±0.9	0.879	4.2±0.8	0.315
	25-31		5.8±0.8		4.5±0.7	
	18-24	Post-op D7 pain	3.7±0.8	0.490	3.0±0.5	0.004
	25-31		3.5±0.7		3.6±0.5	

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DISCUSSION

As clinicians, it is our priority to promote optimal therapeutic outcomes while preserving the integrity and viability of the surrounding anatomical structures. It is this balance of trauma and healing that has initiated ongoing efforts to use piezoelectric surgery, which is now considered an emerging method with promising results.

Piezosurgical and conventional rotary techniques are both commonly used methods for extracting impacted third molars. The piezosurgical technique involves using ultrasonic vibrations to create precise cuts in bone tissue without damaging surrounding soft tissue, nerves, or blood vessels. The tip of the device can be shaped and angled to allow for precise cutting in hard-to-reach areas, such as around the roots of teeth or in narrow spaces.

The main advantage of piezosurgery for the maxillofacial surgeon is the provision of a clear surgical field, precise bone sectioning through micrometric sensitivity, avoiding damage to adjacent vital structures and hard tissues, more comfortable surgery for the patient due to the absence of macro vibrations, it can also aid in easy and effective harvesting of autogenous grafts intra or extra orally, enhance faster tissue repair more than rotary instruments over a short period.[15] Besides so many advantages some drawbacks are also associated with piezosurgery such as the cost of the device- a financial burden, with longer duration of surgeries, not suitable for patients having pacemakers, and special expertise required for surgeons to proceed surgery with such device.

The rotary technique, on the other hand, involves using a slow-speed rotary handpiece to cut through the bone and remove the tooth. This technique is generally faster than piezosurgery, which can make it a more practical option for cases where time is a concern. However, the rotary technique can be more traumatic to surrounding tissues than piezosurgery. The increased rotation of the instrument can generate heat and cause vibrations that can damage nearby soft tissue, nerves, or blood vessels. This can lead to more postoperative pain, swelling, and discomfort, and it may increase the risk of complications such as infection or nerve damage.

The current study includes mesioangular impacted mandibular third molars, similar to the findings of a survey by Goyal et al[11], who used the same molar class in their study. Participants in Group A had their extractions done using the rotational osteotomy approach, whereas patients in Group B had their extractions done using the traditional piezoelectric osteotomy technique.

The study's mean age (years) was 30.60±7.39, with a gender distribution of 13 (26.0) male and 37 (74.0) female subjects. There were almost no dropouts from the selected respondents, which might be ascribed to their increased level of education as well as adherence to their surgery, and also access to social media, which enables follow-up and communication with the patients simpler.

We have concluded in our research that the piezosurgery site's average operation time (50.6±7.43) was longer than the control site's (36.5±4.44), these results are consistent with Arakji H et al[9] (17.60±2.95) in control site and (28.50±3.57) minutes. The results of meta-analyses by Liu et al.[12], Al-Moraissi et al.[13], and Jiang et al.[8] obtained a difference of 4.6 minutes between the two techniques, whereas the difference observed in our trial was 14 minutes.

Bhati et al[14] discovered that piezoelectric surgeries improve short-term wound healing, and other studies have shown that it provides the benefit of significantly reduced pain after mastoidectomy. These findings, when combined with ours, highlight the distinct advantages of piezoelectric devices as safe and minimally invasive tools.

In this study, the average recorded pain score at the experimental site was (3.28±0.62), which was significantly lower than the control site's (3.68±0.79). In previous studies, Liu et al[12] discovered a significant variation among pain scores using a similar visual analogue scale, and they all believed that the region where the impacted mandibular wisdom tooth is treated with piezo surgery had little discomfort after surgery. Piersanti et al[15] conducted research comparing the postoperative outcomes of piezo surgery and traditional rotational surgery in extracting mandibular third molars and found that piezo surgery is a novel substitute method to surgically remove impacted third molars.

In this study, the pain scores obtained using a visual analogue scale on the first post-op day were (5.80±0.86) for the conventional group and (4.40±0.81) for the piezo

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group. In contrast, on the seventh post-operative day, the control site in the piezo group (3.28±0.62) shows improved healing and demonstrates higher patient comfort when compared to the conventional group (3.68±0.79). Another study by Movantani et al[16] also observed a significant difference among the pain scores measured through the visual analogue scale on a second post-op day where the conventional group shows (6.09±2.08) and the piezo group VAS was (5.97±2.14), as compared to the sixth post-op day the conventional group VAS scores were (1.27±1.87) and (0.882±1.69) in the piezo group. Sulphi et al.[10] also found significant variations in pain scores between the two groups, with piezo surgery causing less post-operative pain.

These findings are consistent with those of meta-analysis research carried out by Jiang et al., which included seven studies in its analysis. The primary goal of the study was to compare the methods of piezosurgery and rotary osteotomy. Their meta-analysis demonstrates that although patients underwent piezosurgery for a longer period, they encountered less postoperative discomfort.[8]

Our study has a few practical limitations, including a smaller sample size, and the use of pain as the main outcome, which has a subjective measurement, therefore the results can present bias related to reading and interpretation of the VAS. There was a lack of double blinding for obvious reasons, and the results should be evaluated over a longer period.

We suggest changing the primary outcome to an objective measurable variable such as swelling, which has a similar impact on the postoperative characterization, with the expectation that large, international, well-conducted, randomized controlled trials would be required in the long run to obtain more conclusive results.

CONCLUSION

In conclusion, this study showed that piezo-electric surgery is more reliable, effective, and valuable than traditional rotary systems for surgically removing impacted mandibular third molars. Piezoelectric surgery reduces postoperative swelling, pain, and trismus significantly. Despite the technical requirements and high equipment costs, the inherent benefits of the technique make its clinical applicability advantageous, particularly in cases where the integrity of the noble anatomical structures is the most important risk. It is suggested that for patients undergoing complicated surgical extraction of impacted lower third molars, this may be the preferred modality.

DISCLAIMER

None to declare.

CONFLICT OF INTEREST

There is no conflict of interest among the authors.

ETHICAL STATEMENT

Ethical approval was provided by the Ethical Review Committee at Foundation University Medical College, Foundation University, Islamabad (Ref. No: FF/FUMC/215-Phy/18).

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