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CLINICAL OUTCOMES FOLLOWING ENDODONTIC MICROSURGERY USING PIEZOSURGERY OF MANDIBULAR MOLARS. A CLINICAL STUDY

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ABSTRACT

Objective: This study evaluated the effect of Piezosurgery and Trephine bur-assisted cavity preparation techniques on post-operative sequelae including pain, swelling, tenderness to palpation and percussion following guided endodontic microsurgeries. **Patients and Methods:** Twenty-eight male patients between 18 and 45 years old have mandibular first molar teeth need endodontic microsurgery due to failed non-surgical treatment or re-treatment. The selected patients were randomly divided into two groups (n=14) according to the type of cutting tools during bony cavity preparation and root end resections. Group I: Piezosurgery assisted cavity preparation. Group II: Trephine Bur assisted cavity preparation. An apical curettage was performed and the over-extended objects such as separated instruments or gutta percha were removed. The postoperative pain and swelling assessment were recorded for five days every 24, 48, 72, 96, and 120 hours postoperatively. The tenderness to palpation and percussion were examined by the operator 3, 6 and 12 months. **Results**: At the postoperative pain assessment, there was no statistically significant difference between groups. At the postoperative swelling assessment, there was a statistically significant difference between the swelling scores of group I and group II at 72 and 96 hours p= 0.049, 0.043 respectively. The tenderness to percussion and palpation were comparable between the tested groups at 3, 6 and 12 months, there was no statistically significant difference between groups. **Conclusion:** Piezosurgery-assisted cavity preparation technique improve the postoperative swelling but did not affect the postoperative pain and tenderness to palpation and percussion.

KEYWORDS: Endodontic Microsurgery, Piezosurgery, Trephine bur.

INTRODUCTION

The outcome of endodontic surgery depends on several factors such as the site, size and extent of the bony cavities in addition to the techniques used for the osteotomy and root end-resection [1,2]. The concept of guided endodontic microsurgery has been extensively investigated in recent years for minimally invasive, precise, and efficient osteotomy and root end resection [3] using either conventional tools such as surgical cutting burs or/and relatively recently cutting devices such as piezosurgery, trephine bur, and laser. The extent and technique used for the osteotomy influences the degree of postoperative complications such as pain and swelling [4]. Also, increase the cutting temperatures above 47 °C during surgical procedures, even for intermittent periods, lead to irreversible osteonecrosis that has negatively impacts on the post-operative recovery time and complications [5]. The study aimed to evaluate the effect of Piezosurgery and Trephine bur as cutting

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tools on the post-operative sequelae including pain, swelling, tenderness to palpation and percussion following endodontic microsurgeries.

PATIENTS AND METHODS

This a randomized clinical trial was approved by the Ethics Committee of the Faculty of Dental Medicine, Al Azhar University Cairo, Egypt for Research on Human Subjects Number **722/1224.**

Sample Size Calculation: According to the power analysis of the study the minimum sample size was 10 patients in each of 2 groups which has an 80 % power to detect a difference between means of 0.099 with a significance level (alpha) of 0.05 (two-tailed).

Inclusion criteria:

Twenty-eight healthy male patients aged between 18 and 45 years old were selected from the outpatient clinic of the Endodontic Department, Faculty of Dental Medicine, Al Azhar University, Cairo, Egypt to be included in the study. The selected patients have no general medical contraindications for oral surgical procedures (Scores 1–2) according to the classification of the American Society of Anesthesiologists (ASA) [6].

Mandibular first molar teeth were selected according to specific inclusion criteria including:

1. Teeth presented with failed non-surgical treatment or re-treatment. Failure is due to iatrogenic errors at the apical 3mm of the mesial root canal including canal ledging, zipping and transportation, root perforation, separated instrument and canal calcification.
2. Teeth presented with normal pocket depth ranging from 1 to 3mm, up to grade II tooth mobility.
3. Teeth presented without periapical radiolucency (Class A) or with periapical radiolucency not more than 1 mm in diameter both mesiodistally and buccolingually (Class B) according to the preoperative endodontic microsurgical classification of teeth [7].
4. Teeth presented with non-fused mesial and distal roots and the mesial roots range from 10 to 15mm. in length, Type III root canal configuration (Two canals run separately from orifice to apex)[8]. The root canal curvature angle was measured using the Weine technique[9] to be not less than 160° in both directions buccolingually and mesiodistally.

The selected patients have signed a written informed consent after exploring all steps of the study. The iatrogenic errors at the apical 3mm of the mesial root canals were categorized and managed as follows: On the 1st visit, The working length and width were measured at the level of the coronal extent of the iatrogenic errors at the mesial root and measured at 0.5 mm from the radiographic apex at the distal root by digital periapical radiographs. The canals were instrumented using rotary files system protaper next (Dentsply Maillefer, Switzerland) to a file size # X4 using a brushing motion filling technique accompanied with 5% sodium hypochlorite irrigation and orthograde MTA (TehnoDent., Russia) was mixed with normal saline and applied using MTA applicator (MAP One, Switzerland) into the mesial canals and compacted using different size pluggers to a level 6 mm. from the radiographic apex. On the 2nd visit, all canals were irrigated, dried and obturated using vertical compaction technique followed by restoration of the teeth using bonded composite restoration (Polofil Nht. Voco. Germany). A surgical stent was virtually designed and fabricated to locate the appropriate osteotomy site, the mesial root apex of the mandibular first molars precisely and the 3 mm apical resection level of the root ends and the lesion area (In case of 1 mm. periapical lesion).

The selected patients were divided into two groups (n = 14) according to the type of cutting tools during bony cavity preparation and root end resections:

Group I: Piezosurgery assisted cavity preparation and root end resection.

Group II: Trephine Bur assisted cavity preparation and root end resection.

The preoperative pain assessment of selected patients was done by the operator according to a scale modified from the verbal descriptor scale (VDS) described by Mathias Haefli [10]. The VDS consists of a scoring system translated into Arabic, which describes a list of adjectives describing the different levels of pain from (none) to (Worst pain). The operator marked the adjective which fits the pain intensity according to the patient's own words. The odd numbers represent the intermediate pain intensity among the main pain levels. Patients with a score level (0-6) were included in the study (Table 1).

TABLE (1) Showing the levels of pain assessment.

Score	Pain intensity	Description
0	**No pain**	Tooth felt normal
2	**Mild pain**	Low pain intensity **+** no need for analgesics
4	**Moderate pain**	Higher pain intensity than mild pain level (tolerable) **+** may need non-steroidal anti-inflammatory drugs (NSAID) analgesics.
6	**Strong pain**	Strong pain intensity that disrupts sleep **+** need (NSAID) analgesics
8	**Severe pain**	Severe pain intensity disrupts normal activity (eating, walking, sports activity, etc.) And/or sleep **+** no effect of (NSAID) administration
10	**Worst pain**	Severe pain that disrupts normal activity and/ or sleep **+** general symptom manifestation including fever and weakness **+** need antibiotics and narcotic analgesics.

The preoperative swelling assessment of selected patients was done by the operator according to a swelling assessment scale. The swelling assessment scale consists of a scoring system describes a list of adjectives describing the different level of swelling from (none) to (severe) [11]. Patients with a score level (0) were only included in the study (Table 2).

TABLE (2) Showing levels of swelling assessment.

Score	Status	Criteria
Score 0	**None**	No swilling.
Score 1	**Mild**	Intraoral swelling confined to the surgical field.
Score 2	**Moderate**	Extraoral swelling confined to the surgical field.
Score 3	**Severe**	Extraoral swelling spreading beyond the surgical field.

The periodontal status assessment tests [12] including palpation and percussion were performed by the operator on four teeth in each side including the test tooth and the control tooth respectively. The test tooth and its adjacent teeth were first examined followed by the control tooth and its adjacent teeth. The teeth were tested in a non-controlled randomized order. The patient's responses to apical palpation and percussion of the tested teeth were registered according to the following criteria and the patients with a score level (0) were only included in the study. (Table 3).

TABLE (3) showing periodontal status assessment.

Score	Status	Criteria
Score 0	**None**	A non-affirmative answer to the question whether pain was felt, (No reaction)
Score 1	**Mild**	An affirmative answer to the question whether pain was felt. (Discomfort)
Score 2	**Severe**	An affirmative answer to the question whether pain was felt. The patient flinched when examined

Surgical Intervention:

All steps of the non-surgical/surgical endodontic management were carried out under varying degrees of magnification (8X–16X) using a dental operating microscope (S2350, Zumax Medical Co. China). Inferior alveolar nerve anesthesia technique accompanied by long buccal nerve block anesthesia was performed using two carpules of local anesthesia solutions lidocaine 4% adrenaline 1:80.000 (Septodent, Lignospan, France). A submarginal flap with one vertical releasing incision was performed using a carbon steel surgical scalpel blade no. 15c (Swann Morton, Sheffield S6 2BJ, England). A full-thickness flap was reflected, and the surgical guide was fitted in its position, retracting the soft tissue flap and check. The osteotomy and root end resection were performed in an intermittent liner motion. For Group I: A piezosurgery assisted cavity preparation was performed using a **IM4A** Piezosurgery tip mounted in the handpiece of a Piezosurgery device (PIEZOSURGERY® touch, Mectron, Carasco, Italy) at an operating frequency in the range of 24 to 36 kHz with power ratings 55 W. For Group II: A trephine bur assisted cavity preparation was performed using a **TPB-4** trephine bur mounted in 20:1 contra angled handpiece of an implant motor (ImplaNX, Micro-NX, Republic of Korea) at an operating speed of 1200-1500 RPM / Torque 20 N. The resected root end and bone fragments were removed. An apical curettage was performed and the over-extended objects such as separated instruments or Gutta Percha were reached and removed. The osteotomy site was copiously irrigated using normal saline. An interrupted suturing technique was performed using a 4-0 poly-tetra-fluoroethylene coated monofilament suture (PTFE) and 3/8 circle reverse cutting needle (Maxima, Henry Schein, NY, USA).

Immediate post-operative CBCT scans were taken (Figure 1), and post-operative instructions were given as follows; Compression with ice was performed by patients in the surgical zone for the first (4 – 6 hours) postoperatively. The patients were instructed to rinse their mouth twice daily with chlorhexidine 0.2% mouth rinse for 1 week and a soft diet was advised during the postoperative period. The patients returned after 96 hours postoperatively for suture removal. The patients been have prescribed an oral analgesic (ibuprofen 600 mg) as needed and instructed to not take the analgesic before asking/send to the operator and no postoperative antibiotic therapy was prescribed.

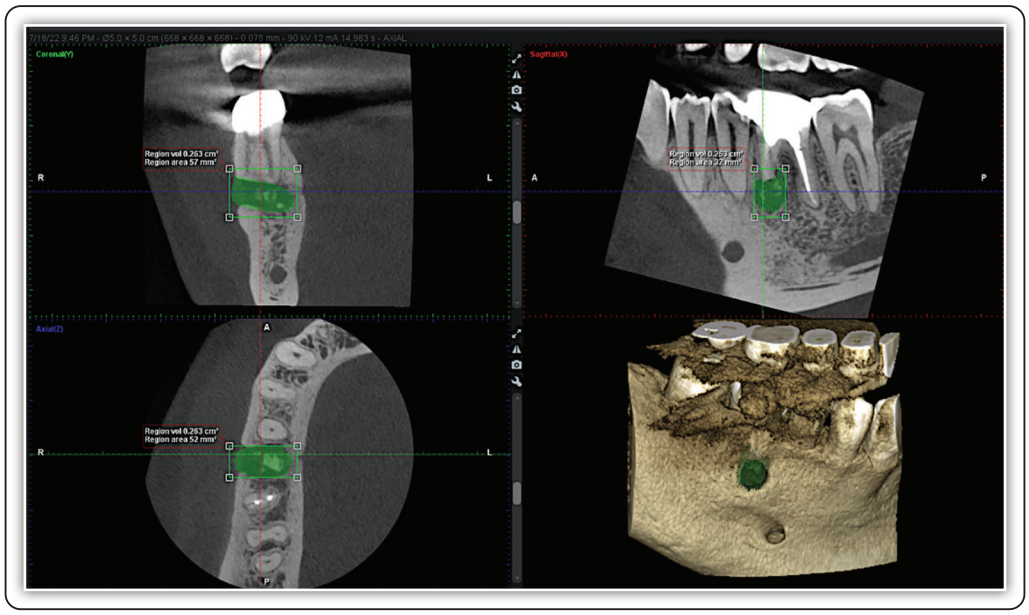

FIG (1) Immediate post-operative CBCT scans

Postoperative Evaluation:

1. The primary outcome of this study is the assessment of postoperative pain using the modified verbal descriptor scale (VDS). The postoperative pain assessment was done for five days for each patient every 24, 48, 72, 96, and 120 hours postoperatively. Patients were initially instructed to use the VDS and the description of each level of pain intensity was explained in detail (Score 0-10).
2. Postoperative swelling degree was recorded by the patient for five days every 24, 48, 72, 96 and 120 hours postoperatively using the swelling assessment scale (Score 0-3).
3. Postoperative palpation test: The patients were examined by the operator 3, 6, 12 months postoperatively according to the previously mentioned criteria. The alveolar ridge on both sides of the alveolar process at the apices of the teeth was palpated with the thumb and the index finger and the patient's responses to apical palpation of the tested teeth were registered (Score 0-2).
4. Postoperative Percussion test: The patients were examined by the operator 3, 6, 12 months postoperatively according to the previously mentioned criteria. The cusps of each tooth were percussioned three times with the shaft of a straight probe and the patient's responses to apical percussion of the tested teeth were registered (Score 0-2).

Statistical analysis:

Data was collected, tabulated, and statistically analyzed. Data management and statistical analysis were performed using the Statistical Package for Social Sciences (SPSS) version. 27. Numerical data were summarized using median and range Data were explored for normality by checking the data distribution and using Kolmogorov-Smirnov and Shapiro-Wilk tests. Comparisons between the 4 groups were done by Kruskal Wallis test followed by Dunn post hoc test. All p-values are two-sided. P-values <0.05 were considered significant.

RESULTS

1) The postoperative pain assessment score:

A. All the pain scores were comparable between the tested groups in different time points (Table 4).

- **At 24 h**, there was no statistically significant difference between the median and range of the pain scores of Groups I and II (p= 0.353).
- **At 48 h,** there was no statistically significant difference between the median and range of the pain scores of Groups I and II (p= 0.436).
- **At 72 h,** there was no statistically significant difference between the median and range of the pain scores of Groups I and II (p= 0.684).
- **At 96 h,** there was no statistically significant difference between the median and range of the pain scores of Groups I and II (p= 1.000).
- **At 120 h,** there was no statistically significant difference between the median and range of the pain scores of Groups I and II (p= 1.000).

B. Comparing median pain score over time in each single group was statistically significant (p<0.001)

TABLE (4) Median and range of pain scores at different time points in the tested groups

	Group I	Group II	P value
	Median (range)	Median (range)	
	Pain		
24 H	0(0-2)	1(0-4)	0.353
48 H	2(0-4)	3(0-6)	0.436
72 H	3(0-4)	2(0-6)	0.684
96 H	2(0-4)	2(0-4)	1.000
120 H	0(0-2)	0(0-2)	1.000

P<0.05 is statistically significant, analysis done by Kruskal Wallis test

2) The swelling assessment scale: All the swelling scores were comparable between the tested groups at different time points (Table 5).

- **At 24 h,** there was no statistically significant difference between the median and range of the swelling scores of Groups I, and II (p= 0.631).
- **At 48 h,** there was no statistically significant difference between the median and range of the swelling scores of Groups I and II (p= 0.353).
- **At 72 h,** there was Statistically significant difference between the median and range of the swelling scores of Groups I and II (p= **0.049).**
- **At 96 h,** t there was Statistically significant difference between the median and range of the swelling scores of Groups I and II (p= **0.043**).
- **At 120 h,** there was no statistically significant difference between the median and range of the swelling scores of Groups I and II (p= 0.143).

TABLE (5) Median and range of swelling score at different time points in the tested groups

	Group I	Group II	P value
	Median (range)	Median (range)	
Swelling			
24 H	1(0-2)	1(0-1)	0.631
48 H	1(0-2)	1(1-3)	0.353
72 H	1(0-2)	2(1-2)	0.049
96 H	0(0-1)	1(0-2)	0.043
120 H	0(0-1)	1(0-1)	0.143

P<0.05 is statistically significant, a: Similar lower case are statistically significant, analysis done by Kruskal Wallis test

3) Postoperative palpation test (Table 6):

- **At 3 m,** there was no statistically significant difference between the median and range of the postoperative palpation scores of Groups I, and II (p= 0.739).
- **At 6 m,** there was no statistically significant difference between the median and range of the postoperative palpation scores of Groups I and II (p= 0.739).
- **At 12 m,** there was no statistically significant difference between the median and range of the postoperative palpation scores of Groups I and II (p= 1,000).

TABLE (6) Median and range of postoperative palpation scores at different time points in the tested groups

	Group I	Group II	P value
	Median (range)	Median (range)	
Swelling			
3 Months	0(0-1)	0(0-1)	0.739
6 Months	0(0-0)	0(0-1)	0.739
12 months	0(0-0)	0(0-0)	1.000

P<0.05 is statistically significant, a: Similar lower case are statistically significant, analysis done by Kruskal Wallis test

4) Postoperative Percussion test (Table 7):

5) At 3 m, there was no statistically significant difference between the median and range of the postoperative percussion scores of Groups I, and II (p= 0.773).

6) At 6 m, there was no statistically significant difference between the median and range of the postoperative percussion scores of Groups I and II (p= 0.391).

7) At 12 m, there was no statistically significant difference between the median and range of the postoperative percussion scores of Groups I and II (p= 1,000).

TABLE (7) Median and range of postoperative percussion scores at different time points in the tested groups

	Group I	Group II	P value
	Median (range)	Median (range)	
	Swelling		
3 Months	0(0-1)	0(0-1)	0.773
6 Months	0(0-0)	0(0-1)	0.391
12 months	0(0-0)	0(0-0)	1.000

P<0.05 is statistically significant, a: Similar lower case are statistically significant, analysis done by Kruskal Wallis test

DISCUSSION

The concept of guided endodontic microsurgery has been extensively investigated in recent years for minimally invasive, precise, and efficient osteotomy and root end resection [2] using either conventional tools such as surgical cutting burs or/and relatively recently cutting devices such as piezosurgery, trephine bur, and laser [3].

This is a randomized clinical trial was done to evaluate the effect of piezosurgery and trephine bur as cutting tools on the post operative clinical outcomes following endodontic microsurgery. Regarding patient selection, out of fifty-two healthy male patients, twenty-eight patients were selected to be included in the study. The selected patients have no general medical contraindications for oral surgical procedures (Scores 1–2) as patients with various systemic complications that affect the post operative clinical outcomes and healing[13]. The patients were 18 and 45 years old for standardization purposes as the post operative pain is affected by age and healing process and remodeling occur to a lesser degree (the collagen formed is qualitatively different)[14]. Van Dijk et al, concluded that the postoperative pain after endodontic surgeries decreases with increasing age [15]. Only males were included in our study for standardization purposes as female patients in the menstruation period have functional impairment of the coagulation system (increased bleeding tendency) and periodic changing levels of serotonin and noradrenaline leading to increased pain prevalence (increase postoperative pain and swelling) [16,17].

Mandibular first molar teeth were selected in this study because they are the most commonly endodontically treated posterior teeth, and are more susceptible to iatrogenic errors including fracture instruments, ledging, and apical transportation even in the straight canals [18]. Ungerechts et al. [19] investigated the incidence of instrument fracture, they concluded that 39.5% of the separated instruments were in the mesiobuccal canals of the first mandibular molars and 76.5% of these instruments were located apically. Ali et al.[20] investigated that the post operative pain related to mandibular molars (6%) was significantly higher than maxillary molars (2.2%). The selected patients have signed written informed consent with a detailed explanation of the study and its potential risks because of the sensitivity to vital structures including the inferior alveolar nerve and mental canals. Informed consent is both an ethical and legal obligation to inform well enough to allow them to make a balanced decision and without written informed consent with a detailed explanation of the study is considered malpractice [21].

All steps of the non-surgical and surgical endodontic management were carried out under magnification for better visibility and accessibility. Setzer et al.[22] evaluated the effect of DOM, loupes, or no visualization aids on the prognosis of endodontic microsurgery, the success rate of endodontic microsurgeries using DOM was significantly greater than with loupes and without magnification. Up till now, there is no standardized procedure for successful separated instrument removal using ultrasonic [23] so far, the management through bypassing the separated instruments and

ledges was selected for standardization purposes and to avoid the complications such as excessive loss of dentin, root perforation, and temperature rise on external root surface as a result of ultrasonic use. MTA was used as root end filling (orthograde) for its regenerative behavior on periradicular tissues, biocompatibility, excellent sealing ability as well as its mechanical properties as an apical sealing material [24]. Regarding the technique of application of MTA, the orthograde technique was selected for ease and to avoid the adverse effect of the ultrasonic preparation including cracks and fractures on the root dentin [25]. Andelin et al. [26] concluded that there is no discernible leakage in teeth with resected MTA (orthograde MTA) or in those with MTA placed as a retrograde root-end filling material. Based on these results it appears that the resection of set MTA does not affect its sealing ability.

The surgical guide was fabricated to act as a stopper to standard the osteotomy parameter (diameter/depth) and to improve accuracy during the endodontic microsurgery by precise locating the appropriate osteotomy site and performing less sensitive technique to anatomically vital structures such as inferior dental nerve and mental nerve [3]. Also, the surgical guide itself acts as a soft tissue retractor, helping to avoid iatrogenic soft tissue damage. Pinsky et al. [27] confirmed that greater accuracy and consistency were achieved during endodontic surgery with surgical guidance without damaging vital structures.

A submarginal flap with one vertical releasing incision was selected to minimize gingival recession as the soft tissue attachment level and crestal bone is not exposed [28] and to minimize edema which is proportional to time and amount of tissue reflected. Research [29] evaluated edema following different types of flaps and concluded that edema was more significant in intrasulcular incisions than the submarginal incisions. The piezosurgery and trephine burs were selected in this study for many reasons. Piezosurgery creates an effective osteotomy with minimal trauma to soft tissue and important structures such as nerves, vessels, and mucosa in contrast to conventional surgical burs[30]. Piezosurgery reduces damage to osteocytes and permits the survival of bony cells during the harvesting of bone (reduces the risk of postoperative necrosis) [5]. Trephine bur is an easy and safe cutting instrument, that creates an effective osteotomy with more accurate (more regular) preparations in comparison with the other techniques [31], available in different diameters and lengths. The research in this field is lacking but the few published papers discussed the trephine burs. Postoperative pain and swelling are the most common complications after endodontic surgery. The magnitude of pain and swelling secondary to any surgical procedure is directly related to the amount of tissue damage [32].

In the present study, the postoperative pain assessment scores of groups I and II were statistically non-significant differences. This can be explained by several causes including, Firstly, regarding to the cutting tools used for the osteotomy and root end resection, the post operative pain is related to the trauma that resulted from the rotational speed during the drilling and consequence heat generation. Matthews and Hirsch [33] found a directly proportional relationship between drilling speed and heat production when comparing speed ranges from 345 rpm to 2,900 rpm. In this study, the trephine bur was mounted in an implant motor at 1200-1500 RPM / Torque 20 N which considered low speed range [34] which led to less amount of heat was generated. Secondly, the internal irrigation was used during the osteotomy procedure which have effect to decrease heat generation and decrease the post operative pain. These factors made the trephine bur have a similar effect as the piezosurgery that have the least traumatic effect and best post operative pain results. This result is agreed with research comparing the post operative pain between piezosurgery and rotary instruments [35].

In the present study, there was a statistically significant difference between the swelling scores of group I and II at 72 and 96h. This can be explained by the fact that Piezosurgery creates an effective osteotomy with minimal trauma to soft tissue, nerves, vessels, and mucosa in contrast to surgical burs [30]. In addition to the difficulty during the osteotomy procedure using the contra angle of the implant motor which exerts excessive force for retraction of the check and soft tissue which may be the main cause of edema and swelling.

Regarding postoperative tenderness to palpation and percussion, there was statistically non-significant differences between the piezosurgery and trephine bur groups. This can be explained that the palpation and percussion examination tests were for evaluate the gingival tissue and periodontal ligaments status for infection or inflammation and most of the cases have no tenderness palpation and percussion at the different evaluation times. This result is agreed with research comparing the post operative tenderness to palpation and percussion after endodontic microsurgery [11].

CONCLUSION

Within the limitations of this study, the following conclusions could be drawn: Piezosurgery-assisted cavity preparation technique improve the postoperative swelling scores but did not affect the postoperative pain scores and tenderness to palpation and percussion scores.

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