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ORIGINAL ARTICLE

Comparison of clinical parameters and environmental noise levels between regular surgery and piezosurgery for extraction of impacted third molars

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Background/Purpose: Impacted third molars can be extracted by regular surgery or piezosurgery. The aim of this study was to compare clinical parameters and device-produced noise levels between regular surgery and piezosurgery for the extraction of impacted third molars.

Methods: Twenty patients (18 women and 2 men, 17–29 years of age) with bilateral symmetrical impacted mandibular or maxillary third molars of the same level were included in this randomized crossover clinical trial. The 40 impacted third molars were divided into a control group ($n = 20$), in which the third molar was extracted by regular surgery using a high-speed handpiece and an elevator, and an experimental group ($n = 20$), in which the third molar was extracted by piezosurgery using a high-speed handpiece and a piezotome. The clinical parameters were evaluated by a self-reported questionnaire. The noise levels produced by the high-speed handpiece and piezotome were measured and compared between the experimental and control groups.

Results: Patients in the experimental group had a better feeling about tooth extraction and force delivery during extraction and less facial swelling than patients in the control group. However, there were no significant differences in noise-related disturbance, extraction period, degree of facial swelling, pain score, pain duration, any noise levels produced by the devices under different circumstances during tooth extraction between the control and experimental groups.

Conflicts of interest: All contributing authors declare no conflicts of interest.

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Conclusion: The piezosurgery device produced noise levels similar to or lower than those of the high-speed drilling device. However, piezosurgery provides advantages of increased patient comfort during extraction of impacted third molars.

Introduction

An ultrasonic scaler is a piece of dental equipment used for scaling procedures. It produces noise that can impair dentists' hearing, particularly at 4000 Hz.[1] A dental clinic contains several sources of noise, for example, micromotor handpieces and air-turbine handpieces, which create maximum water spray and air pressure, produce noise levels of 76–82 dB when drilling. Power suction and saliva suction tubes produce 77 dB and 75 dB noise levels, respectively. An ultrasonic scaler is associated with 83 dB noise when operating.[2] An ultrasonic bone surgery device can do precise surgical tasks, such as performing a split-crest procedure in a narrow ridge for a dental implant placement, with reduced damage to the soft tissue and reduced risk of bone thermonecrosis.[3,4] Previous studies have used various piezosurgical techniques to perform Lefort I osteotomy, calvarial bone grafting, mandibular sagittal splits, and surgical approaches to orbital or skull-base bone.[5,6] Wallace et al[7] compared a piezosurgical technique with a conventional approach for maxillary sinus lifting, and observed reduced membrane perforation when using the piezosurgery device compared with the conventional device (7% vs. 30%, respectively).

The advantages of piezosurgery include gentle vibration, reduced noise levels, and potentially increased patient comfort during surgical procedures. However, piezosurgery is reported to be time-consuming.[8] Sivolella et al[9] compared piezosurgical and conventional surgical techniques for extraction of the bilateral symmetrical impacted mandibular third molars. One third molar was extracted by piezosurgery and the other was extracted by conventional rotatory osteotomy. They found no significant differences in clinical parameters including bleeding, mouth opening range, wound dehiscence, locoregional lymphadenopathy, pain on palpation at the extraction site, and persistent edema between the two groups.[9] Gao et al[10] compared piezosurgery with chisel osteotomy for extraction of impacted mandibular third molars; they found that the piezosurgical group took significantly shorter surgical time and had fewer complications compared with the chisel osteotomy group.

In this randomized crossover clinical study, 20 patients with bilateral symmetrical impacted mandibular or maxillary third molars of the same level were enrolled. The 40 impacted third molars were divided into a control group ($n = 20$), in which the third molar was extracted by regular surgery using a high-speed handpiece and an elevator, and an experimental group ($n = 20$), in which the third molar was extracted by piezosurgery using a high-speed handpiece and a piezotome. The purpose of this study was to compare clinical parameters and device-produced noise levels between regular surgery and piezosurgery for extraction of impacted third molars.

Materials and methods

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board of the National Taiwan University Hospital. Twenty patients (18 women and 2 men, 17–29 years of age) without any systemic diseases and requiring extraction of the bilateral symmetrical impacted mandibular or maxillary third molars were enrolled in this randomized crossover clinical trial. Those patients with any systemic diseases such as diabetes mellitus, hypertension, immunocompromised status, etc., and female patients who were pregnant were excluded. Moreover, patients without third molars or bilateral symmetrical impacted mandibular or maxillary third molars were also excluded.

At the first visit, all 20 patients were examined using panoramic radiography and their age and sex were recorded. Bilateral symmetrical impacted mandibular or maxillary third molars of the same level were selected for extraction. The 40 impacted third molars of the 20 patients were divided into a control group ($n = 20$), in which the third molar was extracted by regular surgery using a Stryker high-speed handpiece (Kalamazoo, Michigan, US) and an elevator, and an experimental group ($n = 20$), in which the third molar was extracted by piezosurgery using a Stryker high-speed handpiece and a piezotome at either the second visit or third visit. For extraction of third molars, the crowns were firstly removed using a Stryker high-speed handpiece with a carbide round bur, then the residual roots were removed by insertion of either an elevator (control group) or a piezotome tip (experimental group) into the periodontal ligament (PDL) space of the third molar.

Noise levels were measured using a precision sound level meter (Audio Analyzer, TES-1358; TES Electrical Electronic Corp., Taipei, Taiwan). All noises were recorded and calculated (in dB) as the maximum sound (L_{max}) and the average sound (L_{av}). The sound level meters employed the LA(eq) mode (equivalent to continuous sound level in a specific time interval), which is similar to human hearing. For each measurement, the meter was set at a distance of 15 cm away from the principal noise source to simulate the auditory position of the patient. Prior to surgery, the background noise levels and the noise levels of the suction machine turned on were recorded. During flap reflection for extraction of the impacted third molar, the noise levels produced by suction of saliva were also collected. The noise levels were measured when the devices for tooth extraction were initially turned on (without cutting), when the carbide round bur was cutting at the cementoenamel

junction, and when the piezotome tip was wedging into the PDL space of the third molar.

After the recording of the noise levels of the devices, the patients' subjective experiences about the tooth extraction and postextraction clinical parameters were evaluated using a self-reported questionnaire immediately after tooth extraction surgery and on a daily basis post-surgery for a week. All data from the control and experimental groups were collected and then compared by statistical analyses.

Results

Patient comfort

In this study, we evaluated several clinical parameters of patient comfort, such as the feeling of tooth extraction, the feeling of force delivery during surgery, disturbance related to noise from the surgical device, and the duration of surgery. Clinical parameters were assessed by using a self-reported questionnaire for each patient immediately after tooth extraction surgery.

Feeling of tooth extraction

In the control group, 25% of patients felt comfortable during the tooth extraction procedure, 65% described the experience as bearable, and 10% described the experience as terrible. In the experimental group, 40% of patients felt comfortable during the tooth extraction procedure, 60% described the experience as bearable, and none described the experience as terrible. Patients in the experimental group had a better feeling about tooth extraction than patients in the control group ($p < 0.05$, Table 1).

Feeling of force delivery during surgery

In the control group, 15% of patients felt comfortable with the force delivery during surgery, 20% described the force as bearable, and 65% described the force as heavy. In the experimental group, 20% of patients felt comfortable with the force delivery during surgery, 50% described the force as bearable, and 30% described the force as heavy. Patients in the experimental group had a better feeling about force delivery during surgery than patients in the control group ($p < 0.05$, Table 1).

Disturbance related to noise from the surgical device

In the control group, 35% of patients felt comfortable with the noise during surgery, 50% described the noise as bearable, and 15% described the noise as unbearable. In the experimental group, 30% of patients felt comfortable with the noise during surgery, 60% described the noise as bearable, and 10% described the noise as unbearable. There was no significant difference between the two groups (Table 1).

Table 1 Comparison of the clinical parameters between patients in the experimental group and patients in the control group.

	Control group	Experimental group	*p*
Feeling of tooth extraction			
Comfortable	25	40	<0.05
Bearable	65	60	
Terrible	10	0	
Feeling of force delivery during surgery			
Comfortable	15	20	<0.05
Bearable	20	50	
Heavy	65	30	
Disturbance related to noise			
Comfortable	35	30	NS
Bearable	50	60	
Unbearable	15	10	
Extraction period			
Adequate	75	80	NS
Slightly longer	25	20	
Facial swelling			
None	6.25	25	<0.01
Mild	31.25	25	
Moderate	37.5	40	
Severe	25	2	
Facial swelling duration, d	3.7 ± 1.9	3.6 ± 1.9	NS
Pain score (visual analog scale)	4.1 ± 2.5	4.1 ± 2.3	NS
Pain duration, d	2.2 ± 1.2	2.2 ± 1.2	NS

Data are presented as % or mean ± SD.
Control group = third molar extraction by regular surgery using a high-speed handpiece and an elevator; experimental group = third molar extraction by piezosurgery using a high-speed handpiece and a piezotome; NS = not significant.

Extraction period

In the control group, 75% of patients felt adequate about the extraction period and 25% considered the extraction period being slightly longer. In the experimental group, 80% of patients felt adequate about the extraction period and 20% considered the extraction period being slightly longer. There was no significant difference between the two groups (Table 1).

We also evaluated several postextraction clinical parameters, such as the degree of facial swelling, the duration of facial swelling, the degree of pain, and the duration of pain. A self-reported questionnaire was used to investigate these postextraction clinical parameters 1 week after tooth extraction.

Degree of facial swelling

In the control group, 6.25% of patients had no facial swelling, 31.25% had mild swelling, 37.5% had moderate

swelling, and 25% had severe swelling. In the experimental group, 25% of patients had no facial swelling, 25% had mild swelling, 40% had moderate swelling, and 2% had severe swelling. Patients in the experimental group had less facial swelling than patients in the control group ($p < 0.01$, Table 1).

Duration of facial swelling

Patients in the control group experienced a slightly longer duration of facial swelling than patients in the experimental group (3.7 days vs. 3.6 days), although the difference was not statistically significant.

Degree of pain

The degree of pain experienced by patients was evaluated by a Visual Analog Scale. There was no significant difference in the pain score between patients in the control group (4.1) and patients in the experimental group (4.1).

Duration of pain

Equal duration of pain was experienced by patients in the control group (2.2 days) and in the experimental group (2.2 days), and no difference was found between the two groups (Table 1).

We also evaluated the clinical parameters such as degree of pain, degree of facial swelling, and mouth opening range by using a patient self-reported questionnaire, provided on a daily basis postsurgery for a week. For measurement of degree of pain, Score 0 represented no pain, Score 1 bearable pain, and Score 2 unbearable pain. For assessment of degree of facial swelling, Score 0 represented no swelling, Score 1 bearable swelling, and Score 2 unbearable swelling. For evaluation of mouth opening range, Score 0 represented normal mouth opening, Score 1 mouth opening of three-finger width, Score 2 mouth opening of two-finger width, Score 3 mouth opening of one-finger width, and Score 4 trismus without any mouth opening.

Pain

There was no significant difference in the pain score between the experimental and control groups. However, patients in the experimental group felt less pain than patients in the control group on the operation day and on the first postoperation day (Fig. 1).

Facial swelling

There was no significant difference in the facial swelling score between the experimental and control groups. However, patients in the experimental group had less facial swelling than patients in the control group on the operation day and on the first postoperation day (Fig. 2).

Mouth opening

There was no significant difference in the mouth opening score between the experimental and control groups. However, patients in the experimental group had more mouth opening limitation than patients in the control group on the second postoperation day (Fig. 3).

Environment noise levels

Table 2 shows the noise levels produced by the suction machine, high-speed handpiece, and the piezotome. The measured noise levels included those produced in the background, when the suction machine was turned on but doing nothing, when the suction machine was suctioning the saliva, when the high-speed handpiece was turned on but doing nothing, when the high-speed round bur was cutting at the cementoenamel junction, when the piezotome was turned on but doing nothing, and when the

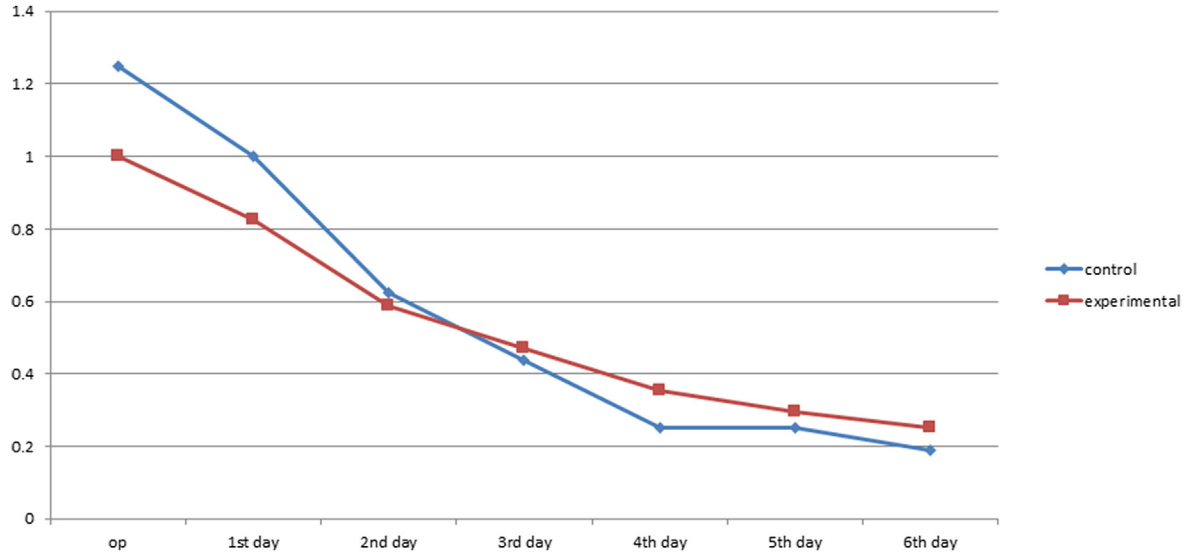

Figure 1 There was no significant difference in the pain score between the experimental and control groups. However, patients in the experimental group felt less pain than patients in the control group on the operation day and on the first postoperation day.

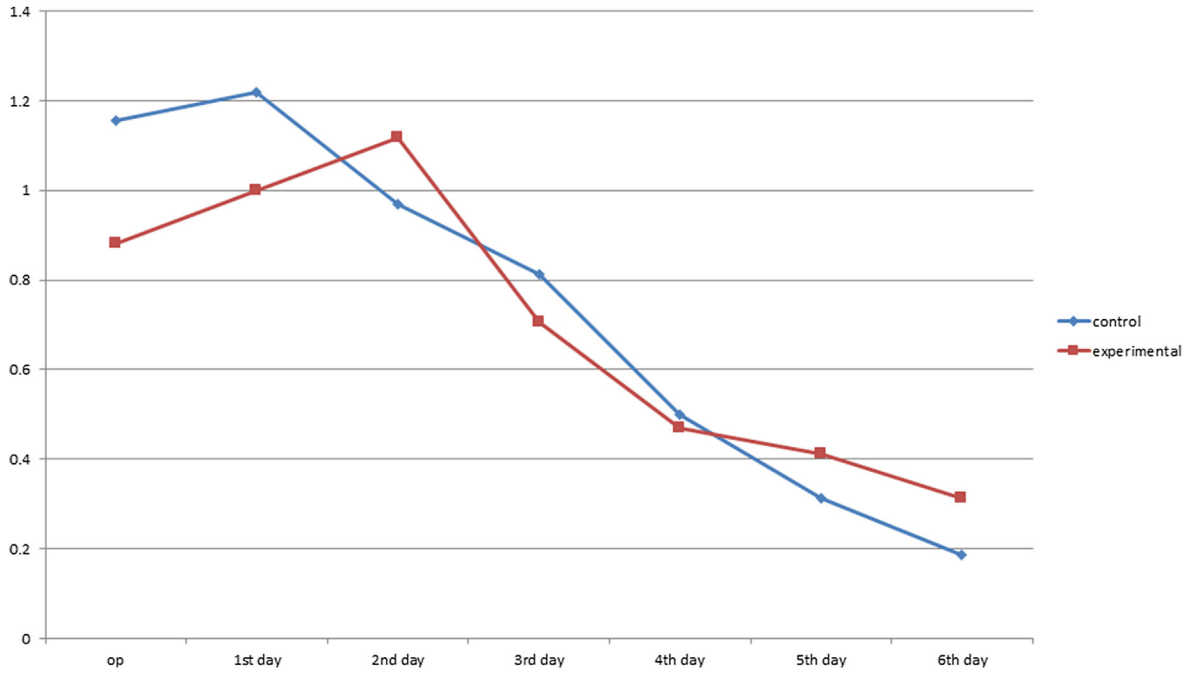

Figure 2 There was no significant difference in the facial swelling score between the experimental and control groups. However, patients in the experimental group had less facial swelling than patients in the control group on the operation day and on the first postoperation day.

piezotome tip was wedging into the PDL space. In general, L_{av} ranged from 60.5 dB to 80.8 dB and L_{max} varied from 68.5 dB to 87.2 dB. However, there were no significant differences in noise levels produced by the devices under different circumstances during third molar extraction between the experimental and control groups (Table 2).

Discussion

A dental clinic is associated with high levels of environmental noise, with hearing loss being an occupational risk for dentists. Different ranges of noise levels are produced by different machines or equipment. Different brands of equipment are also associated with different ranges of

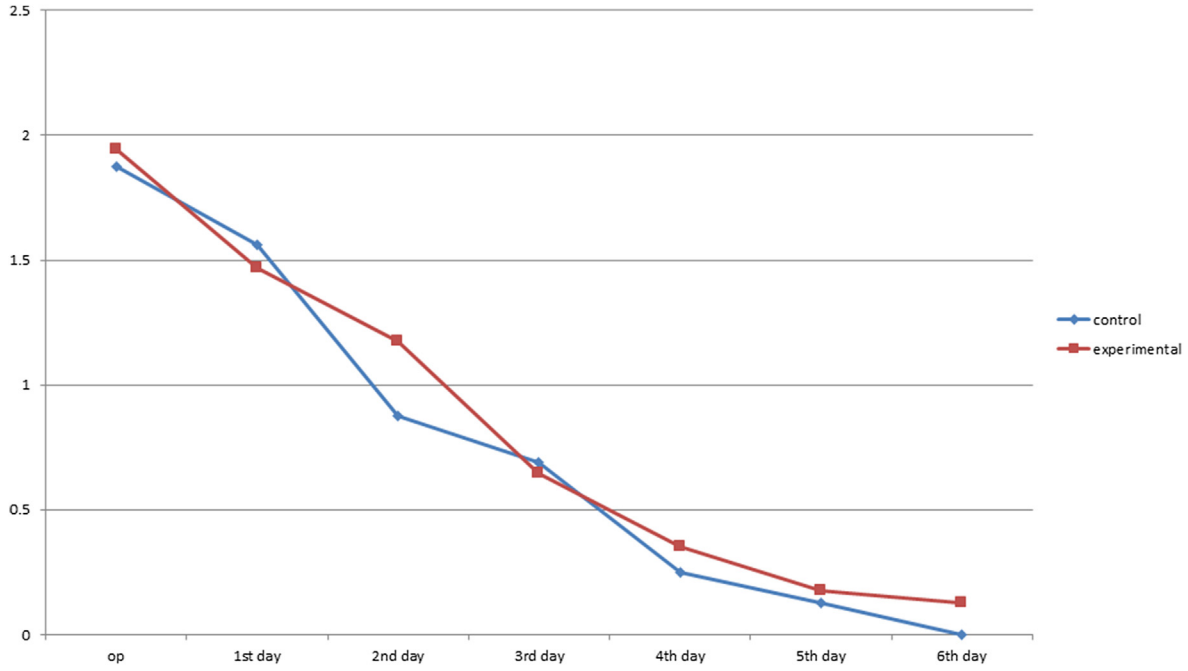

Figure 3 There was no significant difference in the mouth opening score between the experimental and control groups. However, patients in the experimental group had more mouth opening limitation than patients in the control group on the second postoperation day.

Table 2 Noise levels produced by the devices under different circumstances during third molar extraction.

Situation	Mode (dB)	Control	Experiment
Background	L_{max}	70.7 ± 5.5	68.5 ± 6.2
	L_{av}	61.1 ± 3.2	60.5 ± 3.4
Suction machine turning on only	L_{max}	70.5 ± 4.1	69.5 ± 3.6
	L_{av}	64.0 ± 1.9	64.6 ± 2.7
Suction of saliva	L_{max}	78.8 ± 6.6	77.6 ± 15.3
	L_{av}	67.5 ± 6.5	71 ± 7.5
High-speed handpiece turning on only	L_{max}	82.4 ± 5.8	80.7 ± 4.8
	L_{av}	77.9 ± 4.0	75.9 ± 5.0
High-speed bur cutting at the cementoenamel junction	L_{max}	88.1 ± 5.0	87.2 ± 4.6
	L_{av}	80.8 ± 5.3	80.2 ± 5.1
Piezotome turning on only	L_{max}	69.9 ± 0.9	71.8 ± 6.8
	L_{av}	68.0 ± 0.1	68.7 ± 5.5
Piezotome tip wedging into the periodontal ligment space	L_{max}	NA	86.6 ± 5.6
	L_{av}	NA	78.9 ± 4.9

Data are presented as mean ± SD.
Control group = third molar extraction by regular surgery using a high-speed handpiece and an elevator; experimental group = third molar extraction by piezosurgery using a high-speed handpiece and a piezotome; L_{av} = the average sound level; L_{max} = the maximum sound level; NA = not applicable.

noise levels. Studies have suggested that the risk of damage to dentists' hearing might be lower when using brand-new equipment compared with using older equipment.[11]

The purpose of this study was to investigate environmental noise levels and patient comfort when removing impacted third molars by using a traditional high-speed drilling device plus an elevator, or a traditional high-speed drilling device combined with a piezosurgical device. Although there were no significant differences in noise levels produced by the devices under different situations during third molar extraction between the experimental and control groups, our results indicate that the noise levels measured when the high-speed drilling device was performing cutting activities were higher than those measured when the device was turned on only. In the experimental group, the maximum difference in values (cutting vs. turned on only) was 6.5 dB and the average difference in values was 4.3 dB. In the experimental group, when the piezosurgical device was wedging into the PDL space, the noise levels were higher than those when the device was turned on only. The maximum difference in values (wedging vs. turned on only) was 14.8 dB and the average difference in values was 10.2 dB. Sampaio et al[11] reported average values of 6 dB in similar conditions. When turned on only, the noise levels of the piezosurgical device (maximum and average values) were lower than those of the high-speed drilling device. When the piezosurgical device was wedging into the PDL space, the noise levels (maximum and average values) were also lower than those produced by the high-speed drilling device during cutting activities. Our results also indicate that the maximum noise levels generated by suction of saliva during flap reflection (77.6—78.8 dB) were higher than those deriving from the background (68.5—70.7 dB) and when the suction machine was turned on only (69.5—70.5 dB).

Our study demonstrated that patients in the experimental group had a significantly better feeling on tooth extraction and force delivery during surgery than patients in the control group. These findings indicate significantly higher levels of patient comfort in the experimental group than in the control group. These results may be due to the use of a wedging procedure for tooth extraction in the experimental group, in which the piezosurgical device delivered continuous and gentle vibrations in the PDL space to extract the residual roots. On the contrary, in the control group the dentist's hand force was used for operating a traditional elevator to extract the residual roots. Therefore, the patients may feel heavy force during the tooth extraction procedure.

This study found significantly less facial swelling in patients in the experimental group than in patients in the control group. This result indicates that piezosurgery causes lesser damage to the soft tissue, because a piezosurgical device delivers gentle vibrations to the surgical area with minimal damage to the soft tissue. In contrast, the high-speed drilling device may cause overheating or accidental soft tissue damage when drilling.

Analyses of the data from the self-reported questionnaires revealed that patients in the experimental group had less pain and less facial swelling than patients in the control group on the operation day and on the first postoperation day. Although there were no significant differences in the pain and facial swelling scores from the 2nd to the 6th postoperation day, our findings suggest that piezosurgery may cause less initial injury to the PDL tissue than the elevator (Figs. 1 and 2), leading to mild pain and mild facial swelling in the initial 2 days after tooth extraction.

Although the piezosurgery device is considered to create noise disturbance to the patients and dental workers, our results indicate that the piezosurgery device produced slightly lower noise levels than the high-speed handpiece when both devices were turned on only. When the piezosurgery tip was wedging into the PDL space, it also generated slightly lower noise levels than the high-speed round bur cutting at the cementoenamel junction. We also found that patients in the experimental group had a better feeling about tooth extraction and force delivery during tooth extraction and less facial swelling than patients in the control group. We conclude that although the piezosurgery device produces noise levels similar to or lower than those of the high-speed drilling device, piezosurgery provides advantages of increased patient comfort during extraction of impacted third molars.

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