Observational Study

Medicine®

OPEN

Flapless boning to increase space by piezosurgery

A novel mini-invasive strategy for teeth extraction. A retrospective study

Yu Cai, MD, Rui Sun, MD, Ji-Hong Zhao, MD*

Abstract

This study aimed to investigate the application of piezosurgery-associated flapless surgery for increasing bone space during teeth extraction and evaluate its success rate, postoperative outcomes, and incidence of major complications.

From January 2014 to December 2016, patients who experienced teeth extraction via piezosurgery-associated flapless surgery were enrolled in this study. The positions, diagnosis, dental medical history, and radiographic examination of teeth were recorded before the treatment. During the surgery, the fracture or displacement of root, injuries of soft tissue, and fractures of the alveolar process were noted.

A total of 140 patients fulfilled the eligibility criteria in the present study. All these teeth were classified into 4 groups based on diagnosis: residual roots that underwent root canal therapy (28 cases), teeth with root fracture (37 cases), teeth extraction because of orthodontics needed (31 cases), and the vertically impacted lower third molar (44 cases). The radiographic presentation revealed about 50% ankylosed teeth. No root fracture and root displacement emerged, and all roots were removed intact. Moreover, fracture of the alveolar process did not occur. Two cases with buccal mucosal injury were noted, which were because of heat injuries caused by the basement of the tip while cool water was used out.

This study introduced a novel mini-invasive strategy for increasing space during teeth extraction. The advantage of this piezosurgery-associated flapless surgery included maximal preservation of the alveolar bone, minimal injury to soft tissues, and prevention of root fracture during the surgery. Furthermore, the cool water used during the surgery must be carefully checked before the procedure.

Abbreviation: RCT = root canal therapy.

Keywords: flapless, increase space, piezosurgery, teeth extraction

1. Introduction

Surgical tooth extraction, which is one of the most common oral manipulations, is difficult for clinicians to practice, especially for removing ankylosed teeth. In general, spaces between the alveolar bone and roots need to be created to eliminate the area of adhesion while removing ankylosed teeth. Traditional methods used to increase space include tapping the elevator by a hammer or deboning around the teeth by a traditional rotary handpiece. Tapping the elevator by a hammer may cause fracture of the alveolar bone, damage the temporomandibular joint, and produce psychological fear in the patient. Meanwhile, deboning by a traditional rotary handpiece involves raising the full-thickness mucoperiosteal flap to prevent soft tissue injury. All these methods may be invasive, which is disadvantageous for teeth socket healing and subsequent implantations. Therefore, more effective and less invasive therapeutic modalities for increasing spaces are urgently needed.

Flapless surgery was first introduced in implant dentistry with the advantages of alleviate post-treatment side effects, accelerate healing, and avoid bone resorption caused by the elevation of the full-thickness flap. Piezosurgery-associated flapless surgery is currently popular in dental clinics because of its higher successful rates, faster healing, and minimal inflammation by piezoelectric bone cuts as compared with traditional methods.[1] Piezosurgery, as a new minimally invasive osteotomy instrument, has been widely applied in oral and maxillofacial surgery, such as impacted tooth extraction,[2] bone crafting harvesting,[3] inferior alveolar nerve transposition,[4] and maxillary sinus floor elevation. As the obvious merit of soft tissue-sparing, piezosurgery is characterized by its clinical efficiency and favorable osseous repair and remodelling. However, piezosurgery-associated flapless surgery for increasing bone space in teeth extraction has not been reported in the literature.

Therefore, a retrospective study was performed to investigate the application and effect of piezosurgery-associated flapless surgery for increasing bone space in teeth extraction. This study aimed to evaluate the success rate, postoperative outcomes, and incidence of major complications.

Editor: Li Wu Zheng.

This study was supported by grant 81102054, 81671008 and 81741082 from National Natural Science Foundation of China.

The authors report no conflicts of interest.

Department of Oral and Maxillofacial Surgery, School and Hospital of Stomatology, Wuhan University, Wuhan, P. R. China.

* Correspondence: Ji-Hong Zhao, Department of Oral and Maxillofacial Surgery, School and Hospital of Stomatology, Wuhan University, 237 LuoYu Road, Wuhan 430079, P. R. China (e-mail: jhzhao988@whu.edu.cn).

Medicine (2018) 97:27(e11398)

Received: 29 January 2018 / Accepted: 13 June 2018

http://dx.doi.org/10.1097/MD.0000000000011398

2. Patients and methods

2.1. Inclusion criteria

From January 2014 to December 2016, patients who underwent teeth extraction by piezosurgery-associated flapless surgery at the Department of Oral and Maxillofacial Surgery, Hospital of Stomatology, Wuhan University, were enrolled into present study. Furthermore, the patients' dental medical history and results of radiographic examinations revealed that teeth needed to be removed and space should be increased for the extraction.

2.2. Exclusion criteria

1. During the surgery, the mucoperiosteal flap was reflected.
2. During the surgery, tapping by a hammer or the traditional rotary handpiece was used.

2.3. Approach and technique

During the extraction, piezosurgery was initially used to increase the space between the teeth and alveolar bone. Subsequently, elevators, dental forceps, or root forceps were used to remove the teeth. Finally, the wound was cleaned by dental curettes and rinsed by 0.9% sodium chloride physiological solution. All the cases showed no indication for suture and were oppressed for 1 hour by sterile gauze to attain hemostasis.

The narrow, smooth tip of the piezosurgery device was chosen (Fig. 1). During the surgery, the tip was inserted along the roots into the apical areas. The exact operative procedures are shown in Figures 2 to 5.

2.4. Control group

The ankylosed teeth removed by the traditional method were used as the control. The cases which experienced raising the mucoperiosteal flap during the surgery were also excluded.

2.5. Measurements

The age, sex, location, diagnosis, dental medical history, and radiographic examination of the teeth were recorded before the surgery. The occurrence of root fracture or root displacement during the surgery was also recorded. After the surgery, the injuries of soft tissue and fractures of the alveolar process were examined. Informed consent was obtained from all patients. This study was approved by the review board of the Wuhan University Medical Ethics Committee.

Ankylosis was assessed by radiographic examination, which showed that the dark continuous lines between the root and alveolar bone were missing; these lines represented periodontal ligament (Fig. 2A and Fig. 3A).[5] New root fracture that occurred during surgery was examined by the integrity of the removed root. Root displacement was defined as the whole root moving to a deeper space, including the subperiosteum, maxillary sinus, and mandibular canal. Soft tissue injuries included the undesired mucosal lacerations caused by surgery. Fractures of the alveolar process were diagnosed by the movable bone around the tooth socket via probing after the surgery.

Figure 1. A piezosurgery tip was used for space creation, and its surface was smooth.

2.6. Data analysis

Data analysis was performed using the standard data package included with GraphPad Prism 6.0 (GraphPad Software, Inc., La Jolla, CA). Parametric data and demographic data (such as age, sex, success rate, and complication rate) were analyzed using descriptive statistics. Pearson χ^2 test was used to compare the difference of complications between the piezosurgery-associated flapless surgery group and control group. P value $<.05$ was considered as significant.

3. Results

From January 2014 to December 2016, a total of 140 patients, who underwent teeth extraction through piezosurgery-associated flapless surgery, fulfilled the eligibility criteria in this study. There were 84 males (60%) and 56 females (40%) in this series, whose ages ranged from 14 years to 76 years, with a median age of 45 years.

Diagnosis of the teeth and purpose of the extraction revealed that all these teeth could be classified into 4 groups (Table 1): residual root that underwent root canal therapy (RCT) (28 cases, 20%), teeth with root fracture (37 cases, 26.4%), teeth extraction because of orthodontics needed (31 cases, 22.1%), and vertically impacted lower third molar (44 cases, 31.5%). The radiographical presentation showed about 50% ankylosed teeth (Table 2).

During the surgery, no new root fractures and root displacement emerged, and all roots were removed intact. After the surgery, the alveolar process and soft tissue were carefully examined, and no fracture of the alveolar process was found. Two cases (1.4%) with buccal mucosal injury were noted, which were heat injuries caused by the basement of the tip while cool water was used out (Table 3 and Fig. 6). No other complications associated with this method were observed.

Furthermore, the incidence of complications was compared between the piezosurgery-associated flapless surgery and the traditional method for removing the ankylosed teeth. And the incidence of complications by the piezosurgery-associated flapless surgery is significantly lower than the traditional method (Table 4).

4. Discussion

Tooth ankylosis refers to the anatomical fusion of the mineralized root surface (including dentin and cementum) with alveolar

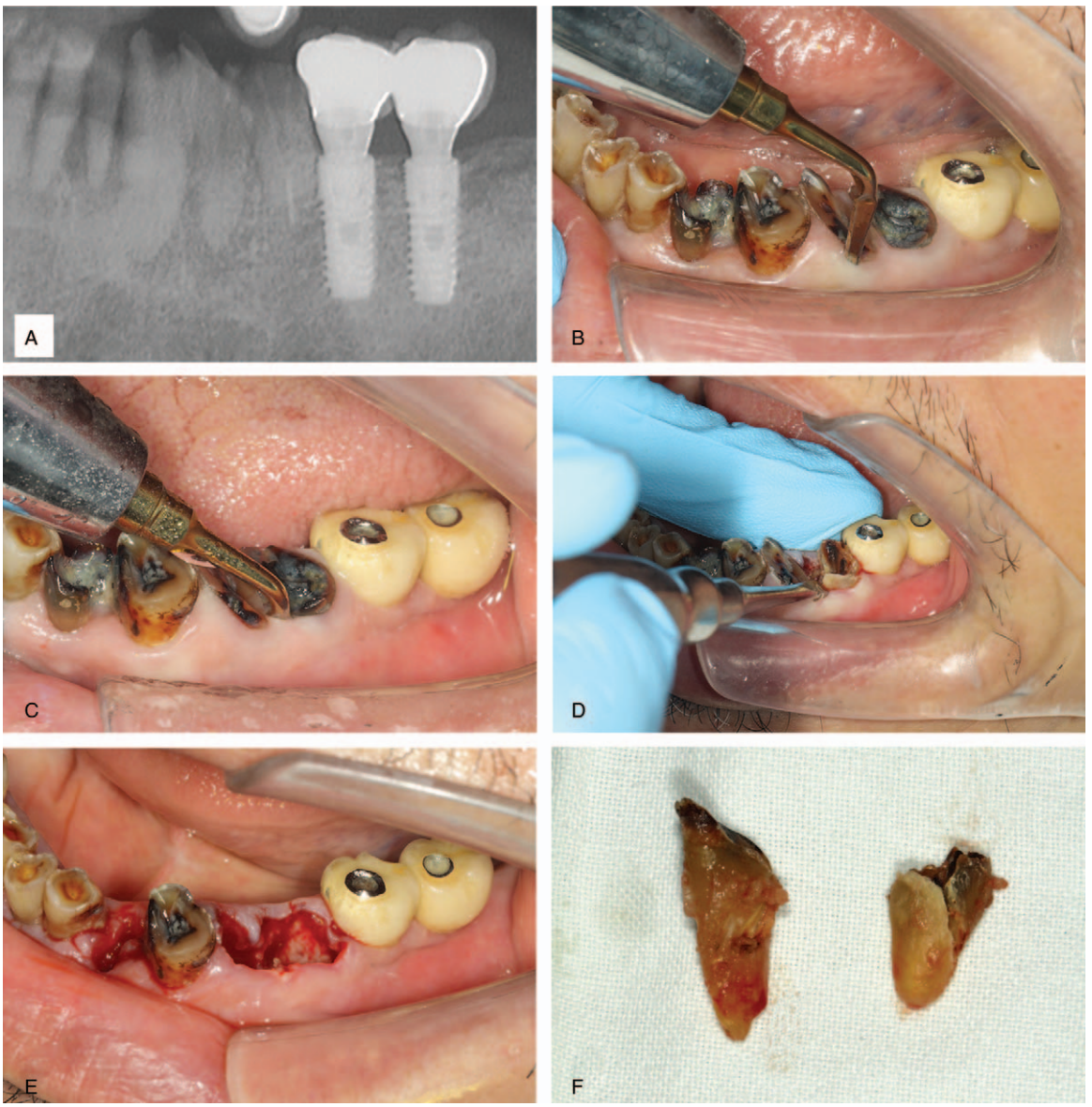

Figure 2. Extraction of residual root that experienced root canal therapy. (A) The panoramic radiograph showed that teeth #34 and #35 were useless residual roots, and tooth #35 underwent root canal therapy. Meanwhile, the periodontal spaces of teeth #34 and #35 were missing, and the boundaries between teeth #34 and #35 and the alveolar bone were hard to identify. Tooth #35 was quite close to tooth implant #36. (B) Piezosurgery was applied to create the extraction space of teeth #34 and #35. (C) The tip was inserted into the alveolar process and stuck to the root. (D) After space was created, teeth #34 and #35 were easily removed by an elevator. (E) No alveolar bone fracture and soft tissue injury occurred during the surgery. (F) The removed teeth were intact.

bone.[5] Radiographic examination showed that the dark continuous lines between the root and alveolar bone, which represent periodontal ligament, were missing. When removing these teeth, it is difficult to find a space to insert an elevator, and the root may break if forceps are used. Traditional methods to increase space between the teeth and bone present some limitations, such as excessive bone cutting, bone fracture, bone necrosis, and soft tissue injuries.[6] Given the principle of minimally invasive surgery, piezosurgery has been widely applied in teeth extraction for maximally protecting adjacent hard and soft tissues, and all the reported literature confirmed the minimal damage and favorable tissue repair associated with piezosurgery.[7] In the present research, piezosurgery-associated flapless surgery was used for increasing space to remove ankylosed teeth. No fracture of the alveolar process occurred during the surgery. Meanwhile, 2 cases exhibited buccal mucosa injury, which were not because of mechanical damage by piezosurgery but the result of thermal damage from the basement of the tip while cool water was used out. Therefore, this operative mistake must be addressed in the future, and the cool water must be monitored during the surgery.

Root fracture is one of the most common complications during the surgery, especially when removing ankylosed teeth and teeth that experienced RCT. Teeth become frangible after RCT as a result of several endodontic treatment procedures, such as access preparation, instrumentation, and irrigation with sodium hypochlorite.[8] Unlike ankylosed teeth, an elevator could be easily inserted into the space between the root and alveolar bone while removing teeth after RCT. However, root fracture often occurs as a result of the reduction in fracture resistance. In these

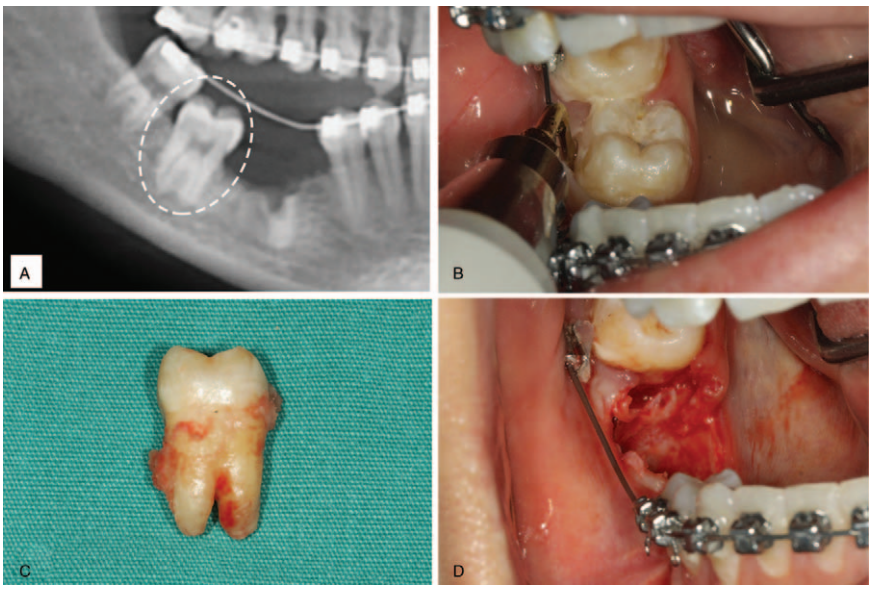

Figure 3. Extraction of ankylosis teeth. (A) Tooth #47 should be removed based on orthodontic needs because this tooth failed to orthodontic traction. The radiographical examination showed that the dark continuous lines between tooth #47 and the alveolar bone, which represents periodontal ligament, were missing. (B) Piezosurgery was used to create space on the buccal, lingual, mesial, and partial distal aspects of tooth #47, and the tooth was removed by forceps. (C) The removed teeth were intact. (D) No alveolar bone fracture and soft tissue injury occurred during the surgery.

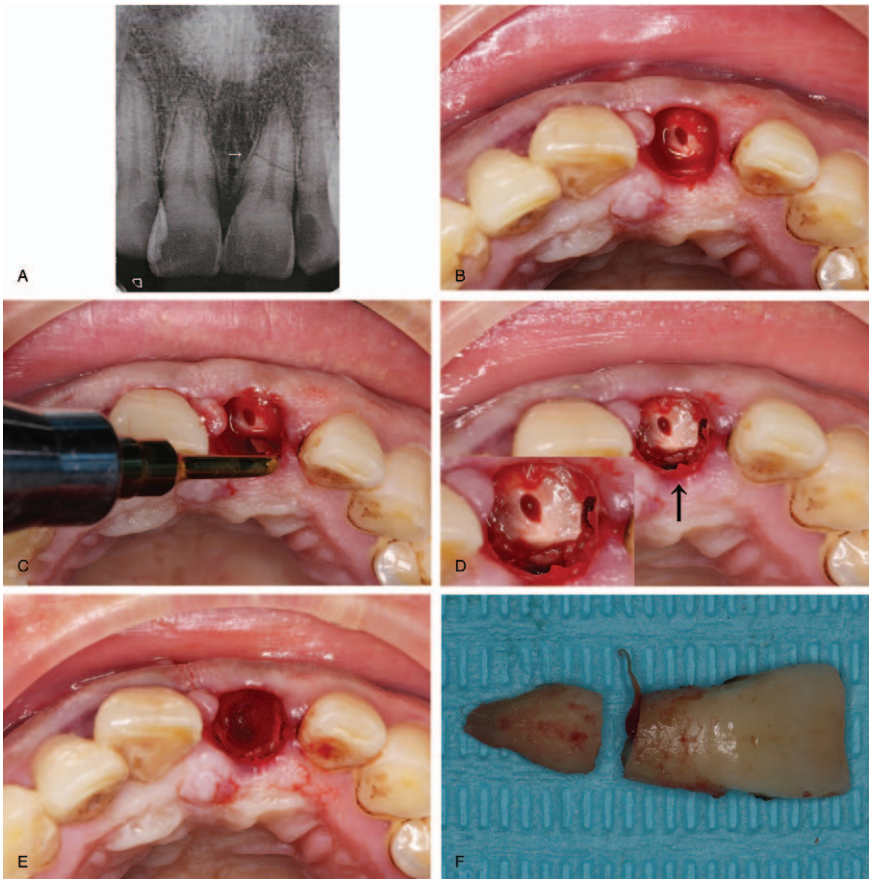

Figure 4. Extraction of root fracture tooth. (A) Radiologic examination showed that the fracture line was located at the middle third of the root on tooth #21. (B) The clinical manifestation was present after the crown part of tooth #21 was removed. (C) Piezosurgery was used to create space on the palatal, mesial, and distal aspects of the root. (D) Clinical manifestation after space creation. Elevator asserted palatal-ward force slightly. (E) Tooth socket after extraction. (F) Tooth #21 after extraction.

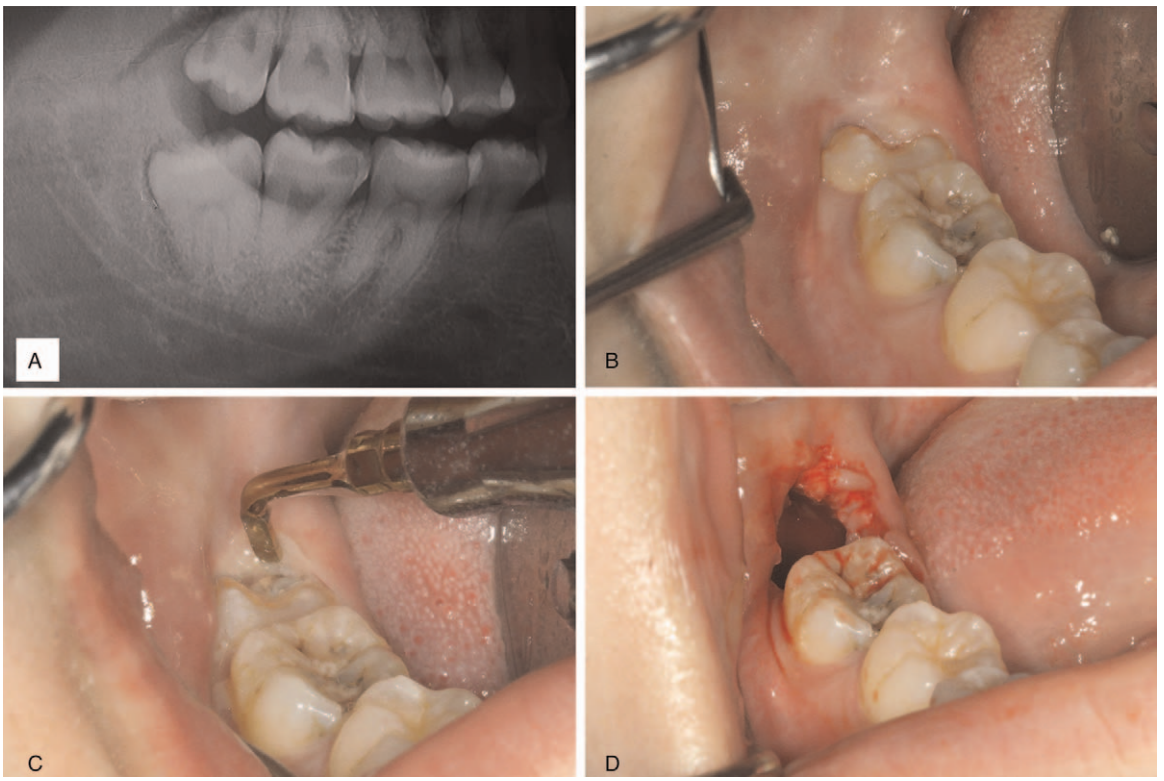

Figure 5. Extraction of vertically impacted third molar. (A) The panoramic radiograph showed that the resistance of tooth #48 came from the distal bone of the crown. (B) Clinical examination showed that tooth #48 was vertical impaction and about half of the crown was covered by the gingiva. (C) The resistance of the tooth luxation included the soft tissue and bone tissue covering the distal aspect of the crown. Bone resistance was eliminated by piezosurgery without flap reflection, and the gingiva covering the crown was separated by a detacher. (D) Tooth socket after extraction.

Table 1

The location and diagnosis of the removed teeth.

	Anterior		Premolar		Molar		
Diagnosis	**Upper**	**Down**	**Upper**	**Down**	**Upper**	**Down**	**Total**
Residual root experienced RCT	8	7	3	10	0	0	28 (20%)
Root fracture	25	2	5	5	0	0	37 (26.4%)
Orthodontics Needed	0	0	15	14	0	2	31 (22.1%)
Vertical impacted third molar	0	0	0	0	0	44	44 (31.5%)
Total							140

RCT = root canal therapy.

cases, identifying whether the whole tooth has been removed can be difficult because the tooth becomes fragments after extraction, and another radiological examination is sometimes needed. Therefore, in this study, root fractures during the surgery were investigated, and the results showed that no root fracture occurred in these piezosurgery-associated flapless surgery. The use of piezosurgery to increase space for the extracted teeth is a preferred technique to preserve the integrity of roots.

The main purpose of flapless boning by piezosurgery is to preserve the implantation site and relieve patient discomfort. The

Table 2

The position and diagnosis of the removed teeth.

	Ankylosed		
Diagnosis	**Yes**	**No**	**Total**
Residual root experienced RCT	27	1	28
Root fracture	0	37	37
Orthodontics needed	25	6	31
Vertical impacted third molar	19	25	44
Total	71 (50.7%)	69 (49.3%)	140

RCT = root canal therapy.

Table 3

Complications happened during the piezosurgery-associated flapless surgery.

Complications	**Number**
Soft tissue injury	2 (1.4%)
Fracture of alveolar bone	0
Fracture of root	0
Displacement of root	0

Table 4

The difference of complications between the piezosurgery-associated flapless surgery and traditional method for removing ankylosed teeth.

Group	Number of total cases	Number of cases happened complications			
		Soft tissue injury	Fracture of alveolar bone	Fracture of root	Displacement of root
Piezosurgery	71	2	0	0	0
Traditional	59	38	33	45	12
χ^2		$P<.0001$	$P<.0001$	$P<.0001$	$P<.0001$

periosteum is a continuous osteogenic and fibroblastic membrane of the cortical bone, which is related to the blood supply and osteogenesis of cortical bone.[9] The partial blood supply to the buccal plate of the alveolar bone is disrupted by elevating the full-thickness flap during teeth extraction. Classic studies have reported that the amount of resorption of the buccal alveolar bone crest ranges from 0.47 to 0.7 mm following full-thickness flap elevation.[10] Furthermore, Araujo and Lindhe[11] demonstrated that full-thickness flap elevation has detrimental effects on the adjacent tooth, such as connective tissue loss and resorption of the alveolar bone crest of adjacent tooth. Therefore, an increasing number of clinicians advocate the application of the flapless technique, which can prevent disruptions of the periosteum, blood supply, gingival architecture, and source of osteoprogenitor cells.[12,13] Additionally, patients treated by the flapless approach experience minimal discomfort and pain, with a reduced healing time.[14,15]

The flapless approach combined with piezosurgery has been applied to oral surgery for years. Brugnami et al[1] used piezosurgery to perform split crest surgery without flap reflection for implant installation. Patel[16] utilized the flapless approach to perform debridement of osteonecrosis of the jaw related to either bisphosphonates or radiation by piezosurgery. Dibart et al[17] and Ruso et al[13] performed alveolar decortication via piezosurgery with the flapless approach. In the present study, a new application of piezosurgery-associated flapless surgery was introduced to increase space during tooth extraction.

5. Conclusions

This study introduced a novel mini-invasive strategy for increasing space during teeth extraction. The advantages of the proposed piezosurgery-associated flapless surgery included maximal preservation of the alveolar bone, minimal injury to soft tissue, and prevention of the fracture of root and alveolar process during the surgery. Except for the ankylosed teeth and frangible teeth, this flapless approach was also applied to extract the vertically impacted third molar in this study.

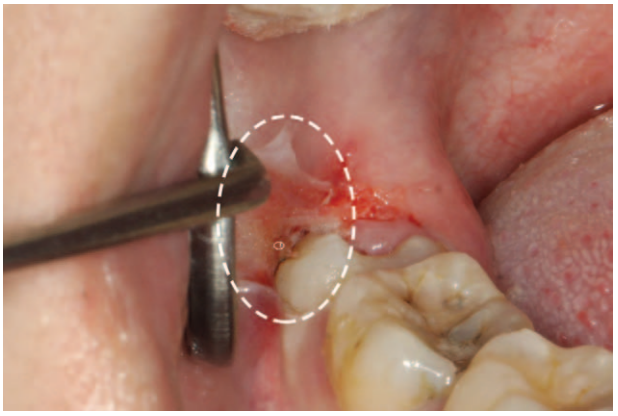

Figure 6. Buccal mucosal injury occurred. The injury was baecause scalding by the basement of the tip while cool water was used out.

Author contributions

Conceptualization: Ji-Hong Zhao.
Data curation: Yu Cai, Rui Sun.
Funding acquisition: Yu Cai.
Investigation: Yu Cai, Rui Sun, Ji-Hong Zhao.
Software: Rui Sun.
Supervision: Ji-Hong Zhao.
Writing – original draft: Yu Cai.
Writing – review & editing: Ji-Hong Zhao.

References

[1] Brugnami F, Caiazzo A, Mehra P. Piezosurgery-assisted, flapless split crest surgery for implant site preparation. J Maxillofac Oral Surg 2014;13:67–72.
[2] Piersanti L, Dilorenzo M, Monaco G, et al. Piezosurgery or conventional rotatory instruments for inferior third molar extractions? J Maxillofac Surg 2014;72:1647–52.
[3] Ylikontiola LP, Sandor GK. Autotransplantation donor tooth site harvesting using piezosurgery. Ann Maxillofac Surg 2016;6:75–7.
[4] Yoshimura H, Ohba S, Aiki M, et al. Piezosurgery-assisted transposition of the inferior alveolar nerve in a patient with osteoradionecrosis: a case report with a neurosensory assessment and a review of the literature. J Oral Maxillofac Surg Med Pathol 2014;26:472–6.
[5] Takahashi TT, Moriyama K. Orthodontic treatment of a traumatically intruded tooth with ankylosis by traction after surgical luxation. Am J Orthod Dentofacial Orthop 2005;127:233.
[6] Hamza H. Computer-assisted technique for surgical tooth extraction. Int J Dent 2016;2016:7484159.
[7] Jiang Q, Qiu Y, Yang C, et al. Piezoelectric versus conventional rotary techniques for impacted third molar extraction: a meta-analysis of randomized controlled trials. Medicine 2015;94:e1685.
[8] Schäfer E, Zandbiglari T, Schäfer J. Influence of resin-based adhesive root canal fillings on the resistance to fracture of endodontically treated roots: an in vitro preliminary study. Oral Surg Oral Med Oral Pathol Oral Radiol Endodontol 2007;103:274–9.
[9] Allen MR, Hock JM, Burr DB. Periosteum: biology, regulation, and response to osteoporosis therapies. Bone 2004;35:1003–12.
[10] Coomes AM, Mealey BL, Huynh-Ba G, et al. Buccal bone formation after flapless extraction: a randomized, controlled clinical trial comparing recombinant human bone morphogenetic protein 2/absorbable collagen carrier and collagen sponge alone. J Periodontol 2014;85:525–35.
[11] Araujo MG, Lindhe J. Ridge alterations following tooth extraction with and without flap elevation: an experimental study in the dog. Clinical oral implants research 2009;20:545–9.
[12] Ribeiro FV, Hirata DY, Reis AF, et al. Open-flap versus flapless esthetic crown lengthening: 12-month clinical outcomes of a randomized controlled clinical trial. J Periodontol 2014;85:536–44.

[13] Ruso S, Campbell PM, Rossmann J, et al. Bone response to buccal tooth movements-with and without flapless alveolar decortication. Eur J Orthod 2014;36:613–23.
[14] Cannizzaro G, Leone M, Esposito M. Immediate functional loading of implants placed with flapless surgery in the edentulous maxilla: 1-year follow-up of a single cohort study. Int J Oral Maxillofac Implants 2007;98:87–95.
[15] Margonar R, Queiroz TP, Marcantonio E, et al. A CAD/CAM flapless surgical technique and immediate prosthesis: a clinical report. J Osseointegration 2011;3:35–9.
[16] Patel V, Patel D, McGurk M. Flapless piezoelectric surgery in the management of jaw necrosis - a case series. Oral Surgery 2016;10:228–34.
[17] Dibart S, Sebaoun JD, Surmenian J. Piezocision: a minimally invasive, periodontally accelerated orthodontic tooth movement procedure. Compend Contin Educ Dent 2009;30:342–4.