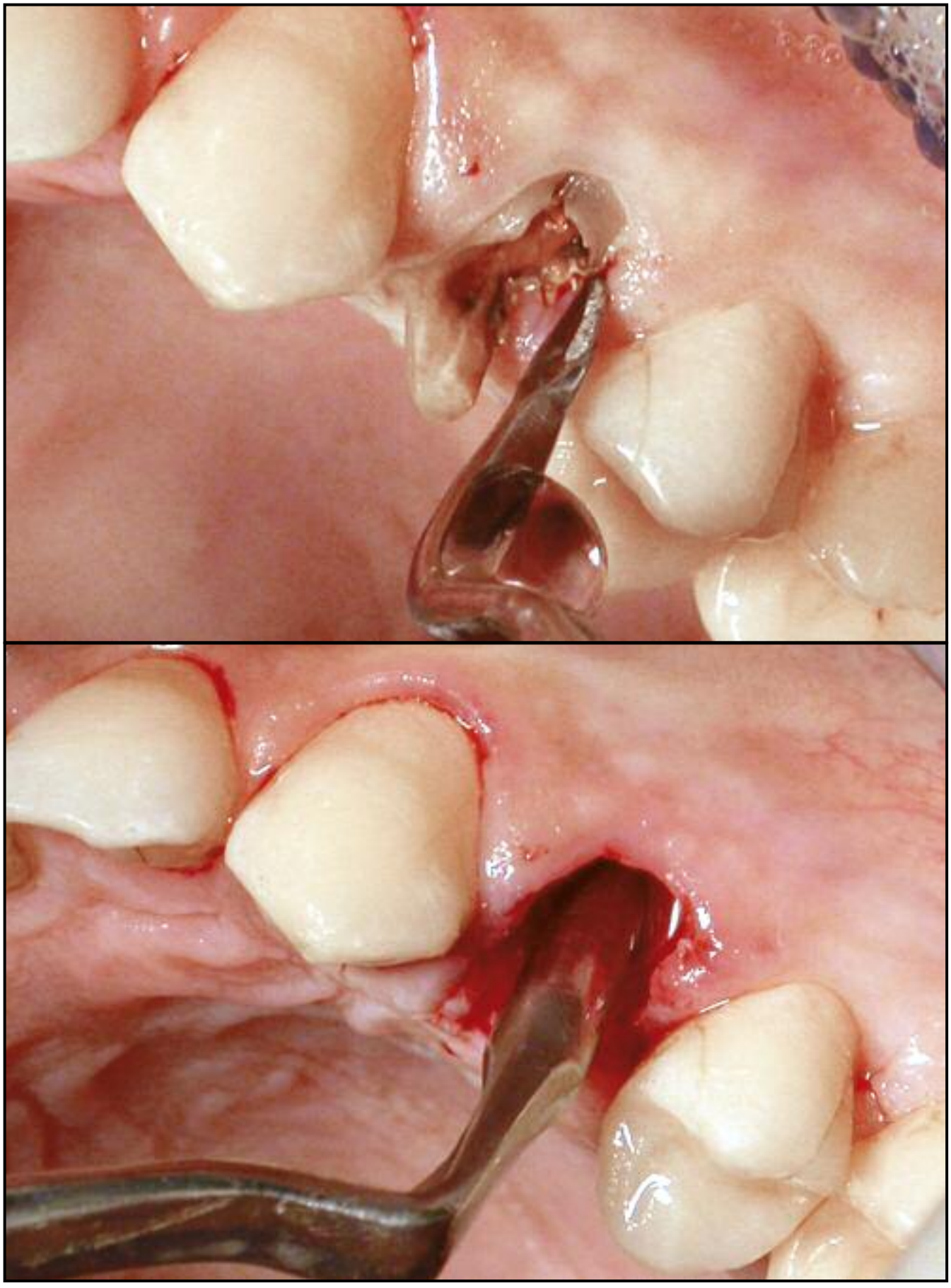

Atraumatic Tooth Extraction and Immediate Implant Placement with Piezosurgery: Evaluation of 40 Sites After at Least 1 Year of Loading

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This paper presents ultrasonic surgery (ie, Piezosurgery) as a new, relevant, and predictable method for performing atraumatic tooth extraction and subsequent implant site preparation. Forty noninfected teeth or roots were extracted in 23 patients and replaced immediately with implants. Extraction consisted of cutting the fibers of the periodontal ligament with vibrating tips of up to 10 mm in depth; the teeth or roots were mobilized afterward with an elevator. All teeth/roots were removed without fracture. Implant osteotomies were performed using conical tips of increasing diameters. During implant placement, notching of the apical third of the palatal wall or the interradicular bridge was performed without complication due to uncontrolled movements of the instrument. After a mean healing period of 2.4 months, all implants were osseointegrated and have been successfully loaded for at least 12 months. By implementing Piezosurgery, extraction can be atraumatic and implant placement can be predictable and undemanding compared to the use of burs, which can lead to instruments slipping during the procedure. (Int J Periodontics Restorative Dent 2010;30:355–363.)

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Immediate implant placement was introduced more than 15 years ago.[1] The procedure consists of placing implants into fresh extraction sockets immediately after tooth extraction. It has been documented in various animal[2,3] and clinical studies.[4,5] This protocol claims to reduce horizontal bone loss[6] and maintain the presence of the papilla.[7]

Clinicians have stressed that tooth extraction prior to implant placement must be atraumatic; however, the method of achieving this has never been addressed in detail.[3] Tooth extraction has been performed in the same manner for several decades, with either forceps or newly developed instruments.[8] In both protocols, tooth mobilization is achieved by forcefully tearing the Sharpey fibers away from the bundle bone. Extraction is obtained after exerting either twisting movements with a forceps or a vertical force with newer extraction devices.[8] Vigorously tearing the periodontal ligament (PDL) fibers leads to alteration of the bundle bone surrounding the socket, as well as blood vessel disruption. Any alternative approach to this severing action should be welcomed,

for it should reduce the trauma caused by extraction and foster socket healing.[8]

Ultrasonic surgery, also known as Piezosurgery, has been introduced recently in the field of oral surgery.[9–11] Instruments involved in Piezosurgery are versatile because their novel vibrating tips lead to new therapeutic applications, eg, ulcer debridement in the diabetic patient,[12] gingival cutting without bleeding,[13] tooth extraction, and implant osteotomy preparation. Vibrating syndesmotomes are among these recently developed tips for tooth and root extraction. They are brought through the gingival sulcus into the space occupied by the PDL between the root and socket to cut the PDL fibers surrounding the tooth socket up to or greater than 10 mm. Thus, when the roots or teeth are mobilized after severing the most apical fibers, the coronal portion of the socket has not been submitted to a violent "rip." At this stage, a nearly atraumatic extraction can be achieved.

Preparation of the implant osteotomy has been performed classically using burs and drills of various shapes to conform to the implant's geometry. In the anterior portion of the maxilla, the buccal wall is peculiarly thin and undergoes resorption readily.[2,14,15] To limit resorption of the buccal wall, it is recommended to leave at least 2 mm between the implant and the vestibular edge of the buccal wall.[16] Consequently, it is advocated to shift the implant axis away from the root axis palatally by 5 degrees.[16,17] To obtain this shift, it is necessary to drill into the palatal wall of the socket at its apical third.[16–18] At this location, a round bur is first applied against the cortical bone to create a notch in the palatal wall; afterward, the notch is enlarged using drills of increasing diameters until the implant will fit in the socket.

However, clinical practice shows that rotating burs applied against the palatal wall often result in movement or slipping in the socket. Adequate notching at the desired location is rather difficult to achieve. Often, the clear channel that is needed before using the pilot drill is lacking; the implant axis is often incorrect and requires rectification. When the latter is not attained, the implant neck emerges too vestibularly in the socket, which may lead to resorption of the buccal wall.[16,19]

In line with the versatility of Piezosurgery instruments, new tips have been developed to prepare the implant bed in extraction sockets. However, little is known about their ability to prepare the implant osteotomy in a predictable way and allow for implant osseointegration. Still, suspicion of bone overheating with use of the vibrating tips remains.[20]

The aim of the present paper is to investigate the reliability of Piezosurgery when implants are immediately placed in extraction sockets. To assess the predictability of this method, osseointegration of the implants was evaluated after at least 1 year of loading.

Fig 1 *Vibrating tips used to cut the PDL fibers. From left to right: arrowlike tip, syndesmotome with teeth perpendicular and parallel to the handpiece long axis, left- and right-angled syndesmotomes without teeth (45 degrees), and large syndesmotome with teeth.*

Fig 2 *Vibrating osteotomy tips used in extraction sockets. From left to right: two cylindric pilot tips and four conical tips of increasing diameter.*

Method and materials

Piezosurgery instrument

The UBS device (Resista) was used for the Piezosurgery. It works in the 20- to 32-KHz range and its maximum ultrasound power is 90 W.[11,12] The tips used with this instrument are made of titanium alloy.

Extraction tips

Six different tips (Fig 1) were available for adaptation to various clinical situations. The first tip is arrowlike and sharp on both sides; it was used to penetrate the PDL at the coronal aspect of the socket and start sectioning the PDL fibers. To section the PDL fibers deeper in the apical direction, four syndesmotomes were used. Two of them were straight, with teeth, and their cutting directions were parallel and perpendicular to the long axis of the tip. The other two were angled at 45 degrees (one to the right and one to the left) to better adapt to the socket's geometry. The last tip, which also had teeth, was indicated for removal of ankylosed teeth.

Implant osteotomy preparation tips

Six different tips were also available to prepare the socket for the implant osteotomy: two pilot cylindric tips and four conical ones (Fig 2), corresponding to the various implant diameters. All were laser-marked at 8, 10, 13, and 15 mm. The pilot drills had diameters of 1.8 and 2.2 mm; the conical drills at the 13-mm laser marking had diameters of 2.8, 3.2, 3.8, and 4.5 mm to place 3.75-, 4.2-, and 5-mm-diameter implants. The working surface was located solely at the apical extremity to prevent alteration of the thin buccal wall during preparation of the implant bed. The conical shape of the vibrating tips allowed mechanical bone condensation of the osteotomy site beyond the socket envelope.

Table 1 **Distribution of the extracted teeth according to the mandible and maxilla***

6	3	2	1	3	3	2	1	3	3
15	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**
				Tooth location					
45	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**
3	1	2	1	–	1	1	–	2	2

*FDI tooth-numbering system.

Patient demographics

Patients were treated with the present protocol in a prospective open-ended study initiated in January 2006. The present paper reports on all implants that had been loaded for at least 1 year. Forty implants were placed in 23 patients (16 women, 7 men; age range: 37 to 77 years).

The following inclusion criteria were used: extracted teeth could not show any signs of periodontal disease or infection at the apex and the buccal wall could not be resorbed. Extracted teeth consisted of 27 from the maxilla and 13 from the mandible. Of the maxillary extracted teeth, 12 were located in the anterior maxilla (canine to canine), 15 were premolars, and 9 were biradicular (Table 1). Reasons for extraction included fracture of endodontically treated teeth/roots (8 in 8 patients), lack of biomechanical functionality to support a prosthetic crown (22 in 14 patients), and extraction after orthodontic treatment performed to gain vertical bone (10 in 3 patients). A total of 12 roots and 28 teeth were extracted. Among them, 9 showed complete ankylosis and 8 showed partial ankylosis.

Implants (Leader) were 3.75 mm (n = 8) and 4.5 mm (n = 12) in diameter and 10 mm (n = 5), 11.5 mm (n = 16), and 13 mm (n = 19) in length.

Fig 3 *Extraction procedure with the vibrating tips.*

Figs 3a and 3b *The arrowlike tip was placed in the PDL on* (right) *the distal side and* (left) *the mesial side of the damaged tooth.*

Fig 3c *An elevator (Claude Bernard syndesmotome) was used to lift the premolar.*

Fig 3d *The tooth was removed in one piece with tweezers after elevation with the manual syndesmotome.*

Surgical procedure

Extraction was performed using the extraction kit tips (Fig 1). The arrowlike tip was brought into the sulcus over a 4- to 5-mm depth, without first separating the gingiva from the tooth, around the entire tooth circumference. There was no evident bleeding while progressing in the apical direction (Figs 3a and 3b). Then, the straight or angled syndesmotomes were used to cut the PDL fibers deeper (up to 10 mm or more). After sectioning of the PDL fibers, the tooth was mobilized with a Claude Bernard syndesmotome (Fig 3c) and removed from the socket with tweezers (Fig 3d). At ankylosed teeth, the vibrating syndesmotomes with teeth were used to detach the root from the surrounding attached bone.

To place the implants in the extraction sites, the osteotomy tips were used. The pilot tip was placed against the palatal wall to notch the socket at its apical third. Angulation of the tip took into account a palatal shift of approximately 5 degrees away from the tooth axis (Fig 4a). Upon activation of the pilot tip, the notch was created with the correct angulation without any slipping of the instrument. No effort was required to maintain the selected angulation at the chosen spot. With the same tip, the notch was extended into a 3- to 5-mm-deep channel, apical to the alveolus apex. Enlargement of the osteotomy took place with tips of increasing diameter (Fig 4b). Beyond the extraction socket, the osteotomy was conical in shape, similar to that obtained with Summers osteotomes.

Implants were then placed according to a single-stage procedure (Fig 4c). Different healing procedures were allowed: 6 implants were immediately loaded, 24 were early loaded between 1 week and 3 months, and 10 were loaded within 3 to 6 months because of patient delay. At healing, implant mobility was tested and the classic steps for prosthetic rehabilitation were undertaken.

Follow-up and success criteria

Implants were followed up at the end of the corresponding healing period, at 3, 6, and 12 months after loading (Figs 4d and 4e), and then for the purposes of this study. The success criteria included: *(1)* extraction without tooth/root fracture, *(2)* effective placement and primary stability of the implant, *(3)* implant stability at each follow-up appointment, *(4)* absence of pain or any subjective sensation, *(5)* absence of recurrent peri-implant infection, and *(6)* absence of continuous radiolucency around the implant.

Results

Extraction was performed by cutting the PDL fibers before tooth mobilization. Endodontically treated brittle teeth or roots (n = 28) that would have otherwise fractured were removed in one piece without fracture. The ankylosed teeth were also taken out in one piece without the need for invasive surgery.

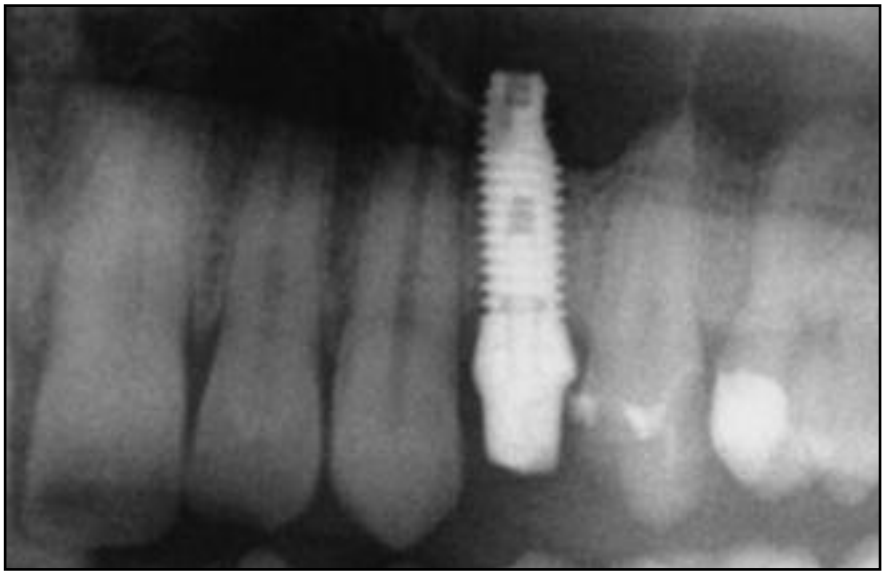
Notching of the apical third of the palatal cortical wall during implant placement in the anterior maxilla and preparing the thin interradicular bridge of biradicular teeth were uncomplicated and without any slipping of the Piezosurgery device. The pilot tip notching the cortical bone was deepened further beyond the alveolus apex to attain the final length and the appropriate implant axis. Enlarging this opening with the increased diameter tips was effortless. Implant placement was performed without any complication. Healing was uneventful and all implants osseointegrated. All 40 implants have been currently loaded for at least 1 year; 28 implants have been loaded for more than 18 months and 3 for more than 2 years.

Fig 4 *Osteotomy site preparation and implant placement.*

Fig 4a *Introduction of the pilot tip into the extraction socket. Note the apical working area in contact with the apical third of the palatal wall with the correct angulation (away from the tooth axis).*

Fig 4b *Conical tips of increasing diameter were then used. These tips simultaneously prepare and mechanically condense the osteotomy site.*

Fig 4c (right) *The implant was placed in the extraction socket. Note the space left between the implant and the cortical wall (> 2 mm).*



Figs 4d and 4e *One-year follow-up radiograph and clinical view of the implant with its provisional crown.*

Discussion

Atraumatic extraction is recommended to provide the best healing conditions for the extraction socket, regardless of whether an implant is placed immediately or not. Despite all efforts, trauma to the bundle bone of the socket cannot be avoided while severing the collagen fibers and the blood vessels of the PDL. Recently, Babbush[8] stated that no significant innovation has impacted the way tooth extractions have been performed over the last 30 years. In that study, a new extraction device exerting a vertical force was tested; this new method claimed to be atraumatic. It may be that this method is less traumatic than the classic method of twisting with forceps, since the latter probably induces microfractures to the buccal wall, but it is likely that the present procedure of cutting the fibers and vessels of the PDL instead of severing them is even less traumatic. Comparative experimental data on the effect of severing versus cutting the elements of the PDL on socket healing would be interesting.

Bleeding was limited during extraction. This was not surprising since Blus and Szmukler-Moncler[13] previously reported that cutting the gingiva with a similar tip did not lead to bleeding, a result of temporary occlusion of the capillaries. This extraction method is particularly relevant and atraumatic when caried teeth or roots are too brittle to be extracted without fracturing into several small fragments. The PDL fibers are sectioned with the arrowlike and the syndesmotome tips; afterward, the weak tooth or root can be lifted without damage. Ankylosed teeth can be also separated from the attached bone in one piece. Invasive surgical procedures that subsequently require bone and soft tissue grafting before implant placement[4,21] can be therefore avoided.

Preparing implant osteotomies in fresh extraction sockets led to the following advantages: *(1)* notching of the apical third of the palatal wall at the exact location and with the desired orientation was easy and effortless since there was no slipping of the instrument; *(2)* the working surface was restricted to the apical extremity to avoid damage to the buccal wall; *(3)* bleeding was limited and therefore visual access to the surgical field was not restricted; *(4)* in the premolar area of the mandible, injury to the mandibular nerve was not a concern; and *(5)* mechanical bone condensation at the osteotomy site was obtained to increase primary stability[22] and speed up osseointegration.[23] Preparing the implant osteotomy was as fast as that with rotatary drills; the only inconvenience of this method was the time required to screw on the tips.

Some authors suggest the possibility of tissue overheating during use of the vibrating tips of piezoelectric devices.[20] However, this study shows that thermonecrosis is not a relevant threat during bone preparation since all implants have been successfully loaded for at least 1 year. In addition, implants placed in split-crest procedures prepared by Piezosurgery led to 96.5% success rates,[10] comparable to the success rates obtained using other methods. Finally, studies comparing bone cutting with rotatary instruments versus vibrating tips have shown that Piezosurgery tips provide a cleaner bone cut[24] and better conditions for bone healing.[25,26]

Conclusion

Extraction and osteotomy site preparation with Piezosurgery showed several advantages over the classic methods of tooth extraction and implant bed preparation with rotating instruments. Those most relevant were the possibility of extracting brittle teeth or roots in one piece, removing ankylosed teeth without invasive surgery, avoiding instrument slipping while preparing the notches for implant placement, and achieving mechanical bone condensation while preparing the osteotomy.

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Disclosure

Drs Blus and Szmukler-Moncler are consultants for Resista, the manufacturer of the UBS device.

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