

ORIGINAL ARTICLE

Evaluating success of autotransplantation of embedded/impacted third molars harvested using piezosurgery: a pilot study

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Abstract

Objective. To evaluate the success of autogenous transplantation of embedded/impacted third molars harvested using piezosurgery. **Materials and methods.** This prospective pilot study enrolled 20 healthy patients with non-restorable first/second molars and a caries-free retrievable embedded/impacted third molar. Piezosurgery was used for removing inter-radicular bone at the recipient socket as well as for bone removal around the donor teeth. **Results.** After an average follow-up of 16.4 months (SD = 1.9), 18 cases were successful with formation of periodontal ligament around the teeth. One tooth was lost due to infection at 1 month. One patient was lost to follow-up. There was no root resorption or ankylosis in any of the cases. In six donor teeth with complete root formation, root canal treatment was carried out. All the remaining teeth responded positively with vitality testing. **Conclusion.** Piezosurgery is an effective device if embedded/impacted third molars are to be harvested for successful autogenous transplantation.

Key Words: *autotransplant, piezosurgery, rehabilitation, tooth*

Introduction

Autotransplantation of third molars has been used with varying success [1] to replace non-restorable first or second molars. With the advantages of proprioception, continued root development and pulpal regeneration with immature teeth, possible orthodontic movement and being more economical; tooth transplantation when successful is probably one of the best tooth replacement options. The success of the procedure is directly related to the formation of new periodontal ligament (PDL) which in turn depends on how many viable cells are preserved on the donor tooth root [2]. The donor tooth should be extracted with minimal trauma and transplanted with minimal extra-oral time, preserving the PDL to achieve a predictable outcome [3]. While completely erupted third molars can be extracted predictably with minimal trauma to the PDL, retrieving impacted or embedded third molars for the purpose of transplantation is difficult, especially when using rotary surgical drills.

Use of piezosurgery for bone cutting is being increasingly reported in oral and maxillofacial

surgery. It has been used for extracting impacted teeth, implant placement, sinus lift, bone harvesting, cyst removal, ridge expansion, distraction osteogenesis and orthognathic surgery [4,5]. Its advantage lies in its selective cutting capacity wherein only mineralized tissue is cut without damaging the soft tissue [4–6]. Although many studies [7–13] have evaluated success of autogenous tooth transplantation, none have reported the use of piezosurgery for the procedure. With our prospective pilot study we evaluate the success of autogenous third molar transplantation when unerupted or impacted third molars are harvested using piezosurgery.

Materials and methods

Twenty healthy patients reporting to the department of oral and maxillofacial surgery with non-restorable first or second molars and a caries-free retrievable third molar were included in this institutional review board approved study. Informed written consent was obtained from all patients. Exclusion criteria were: completely erupted donor third molars where bone removal is not required for extraction, third molars

with less than 1/3rd root development, severely infected donor or recipient site, inadequate mesio-distal space, alveolar bone loss at the recipient site, untreated periodontal disease, pregnancy and uncontrolled systemic diseases.

Surgical technique

Panoramic radiograph was obtained in all patients pre-operatively to confirm the location and root development of third molars (Figure 1). We used the following criteria for selecting the donor third molar: most suitable mesio-distal dimension so as to fit at the recipient site, maximum root development with open apex and easily retrievable, with minimum damage to adjacent teeth during extraction. The tooth (either maxillary or mandibular) which fulfilled most of these criteria was selected for transplantation. Tooth transplantation was carried out under local anesthesia (lignocaine 2% with adrenaline 1:2lac) by a single surgeon experienced with the procedure. After preparing the oral cavity with 2% chlorhexidine, the non-restorable first or second molar (Figure 2) was extracted atraumatically and inter-radicular bone at the recipient site was removed using piezosurgery tips BS5 and BS6 (Piezotome 2, Satelec, Acteon, New Delhi, India) to create a four-walled socket. Saline-soaked gauze was placed at the recipient site until the third molar was harvested. A mucoperiosteal flap was elevated to expose the donor third molar. Surrounding bone around the third molar was removed using piezosurgery tips BS1, BS5 and BS6 (Figure 3) so as to allow easy extraction by forceps only or by minimum use of elevators restricting it to the crown portion (Figure 4). The third molar was extracted (Figure 5) and placed immediately at the recipient site whenever possible. When modification of the recipient site was required, the donor tooth was preserved in gauze pack dipped in physiologic saline solution until the recipient



Figure 1. Orthopantomogram showing all four embedded 3rd molar and left maxillary 1st molar root stumps. Mandibular right 3rd molar was harvested as it had maximum root development with open apex, adequate mesio-distal dimension and would have caused minimum damage to the 2nd molar during extraction.



Figure 2. Pre-operative clinical picture showing left maxillary 1st molar root piece (mirror image).



Figure 3. Piezosurgery tips—BS1, BS5 and BS6 used in the study.

site was prepared using the same piezosurgery tips. Care was taken not to touch the root surface of the third molar. The third molar was then transferred to the recipient site and mild occlusal pressure was



Figure 4. Mandibular 3rd molar being harvested using piezosurgery.



Figure 5. Harvested mandibular 3rd molar.

applied to achieve stability at the new position. The tooth was stabilized using sutures, tightly adapting the gingiva around the tooth (Figure 6). In case stability was not achieved by sutures and frictional contact with adjacent teeth, the tooth was splinted with adjacent teeth using stainless steel wire and composite resin. Occlusion was checked and any pre-mature occlusal contacts were eliminated. Amoxicillin 500 mg and ketorolac 10 mg 3-times a day for 3 days and chlorhexidine 2% mouthwash 2-times a day for 5 days was prescribed post-operatively. Clindamycin 600 mg was used for penicillin-allergic patients. Patients were instructed to have only a semi-solid diet for 3 weeks. Sutures were removed after 7 days and the splint was removed after a minimum of 2 weeks or after initial stability was achieved. Patients were recalled at 2 weeks, 4 weeks, 2 months, 6 months and 12 months (Figure 7). An intra-oral periapical radiograph [IOPA] was obtained on every follow-up visit to monitor healing and look for root resorption (Figure 8). Electrical pulp testing was carried out after 6 months to check for tooth vitality. In case root development of



Figure 6. Immediate post-operative clinical picture showing donor 3rd molar fixed with sutures.



Figure 7. Follow-up at 18 months showing good clinical outcome.

donor teeth was complete at the time of transplantation, pulpectomy was carried out after 2 weeks followed by obturation at 6 months.

Criteria for success

The autotransplanted tooth was deemed successful if it fulfilled the following criteria [7]:

- (1) The transplanted tooth functioned normally without excessive mobility; however, physiologic mobility was allowed.
- (2) Clinically, no discomfort and a normal periodontal probing.
- (3) Radiographically, no root resorption with the presence of normal periodontal ligament space and lamina dura.

Results

Of 20 patients, one was lost to follow-up after 3 months and was not included in the study. The

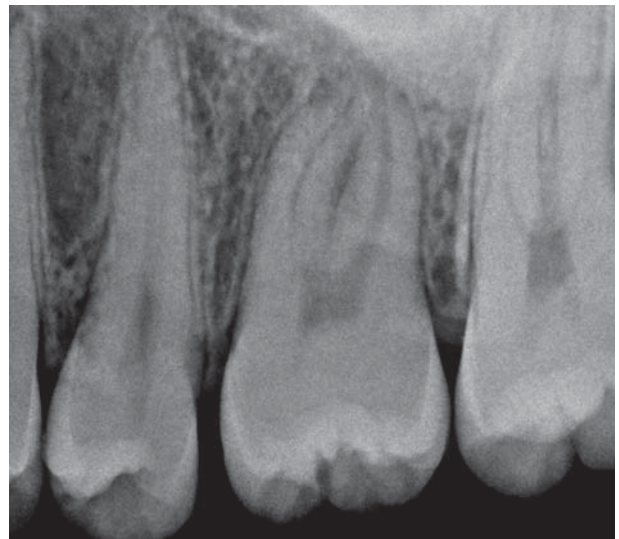


Figure 8. Follow-up IOPA at 18 months showing lamina dura and PDL around the transplanted tooth.

age range of the remaining 19 patients was between 16–25 years, with 10 males and nine females. In 16 patients (84%) first molars and in three patients (14%) second molars were replaced by tooth transplantation. In 14 cases (74%) mandibular third molars were the donor teeth, while in five cases (26%) maxillary third molars were used. Bone removal was necessary to extract donor teeth in all our patients. Data regarding the position of donor teeth and teeth replaced is presented in Table I. The mean extra-oral time of the donor third molars was 2.07 min (SD = 2.17). Following transplantation, third molars were stabilized with sutures only in 12 patients (63%). Additional splinting was necessary in the remaining seven patients (37%). On follow-up, gingival inflammation subsided after 2 weeks and the tooth was firm at its position in all successful cases at 2 months. Periodontal healing was complete at 6 months, with the presence of lamina dura and periodontal ligament space around the roots. Eighteen patients had successful tooth transplantation with good clinical and radiographic outcome at a mean follow-up of 16.4 months (SD = 1.9). In one female patient, the transplanted mandibular third molar ($1/2$ root formation complete at the time of transplantation) was lost due to infection at 1 month. Clinically a buccal draining sinus with lingual swelling



Figure 9. Transplanted third molar at first molar site showing buccal sinus and swelling around the lingual gingiva.

around the transplanted tooth was seen, with absence of new bone around the tooth (Figure 9). When infection did not subside after antibiotics, the tooth was extracted and a small amount of pus was drained from the socket. In six patients root canal treatment was carried out owing to complete root development of the third molar. All the remaining successful cases tested positive for vitality testing at the end of the follow-up period.

Table I. Details of the donor teeth, their position and teeth replaced.

	Number of teeth (%)	
	Maxillary	Mandibular
<i>Teeth replaced</i>		
1 st molars	5 (26%)	11 (58%)
2 nd molars	1 (5%)	2 (11%)
Donor teeth (3 rd molars)	5 (26%)	14 (74%)
<i>Pell and Gregory classification of donor teeth</i>		
Relationship with anterior border of ramus		
Class I		0
Class II		13 (93%)
Class III		1 (7%)
Relationship with occlusal plane		
Class A	0	0
Class B	1 (20%)	12 (86%)
Class C	4 (80%)	2 (14%)
Angulation		
Vertical	4 (80%)	6 (43%)
Mesioangular	1 (20%)	7 (50%)
Distoangular	0	1 (7%)
Relationship with maxillary sinus		
Sinus approximation position	2 (40%)	
No sinus approximation	3 (60%)	

Discussion

Surgical extraction of third molars requires the use of a chisel mallet or rotary surgical drills. Adequate buccal exposure to expose the root surface needs to be carried out. This permits the use of elevators, allowing easy retrieval of the tooth without fracture [14]. The use of rotary surgical drills for this purpose can, however, lead to excessive high temperatures during bone cutting. It can also cause marginal osteonecrosis and impair regeneration and healing [15]. Preserving the PDL of the tooth in such a scenario becomes extremely difficult and, thereby, decreases the possibility of successful transplantation of such a third molar. Kvint et al. [13] have shown that negative prognosis of transplanted teeth is associated with difficult extraction, deviant root anatomy or damage to the periodontium of donor tooth. Such damage usually leads to the two most common complications: root resorption and ankylosis. In one of the largest studies on tooth transplantation, Andreasen et al. [3] noted root resorption in 52 out of 370 transplanted premolars. The authors concluded that trauma to the PDL of the transplant was the reason for root resorption. Tsukiboshi et al. [16], in their description of the healing process of transplanted teeth, have shown that, if the area of root damage of transplanted tooth is small, progenitor cells usually cover the area and new PDL is formed. However, in cases of larger areas

of damage, replacement resorption takes place. The damaged root surface is resorbed followed by bone deposition, thereby ankylosing the tooth. Root resorption usually starts within 1 year of transplantation [3,13] and leads to subsequent loss of the tooth.

This kind of failure and the technique sensitivity precludes clinicians to adopt tooth transplantation as a routine treatment option [17]. To overcome the technical difficulties associated with the procedure, piezosurgery was used in our study to harvest donor third molars. Its utility lies in cutting bone close to important structures like blood vessels, nerves, Schneiderian membrane and dura mater without causing any damage to these soft tissues [4–6,15]. Bone cutting can be performed with minimal increase of temperature, thereby preventing any potential thermal damage. Piezosurgery has been used in periodontal surgical procedures where bone removal has been carried out successfully without damaging the root surface [18]. The aim of our study was to preserve the PDL of the donor tooth utilizing these capabilities of piezosurgery for the purpose of successful tooth transplantation. The use of this ultrasonic device did seem to work in our patients, resulting in a high success rate (95%). The result of our study was higher than that obtained by Kallu et al. [8] (68%), Watanabe et al. [9] (63.1%), Tsukiboshi [2] (82%), Bae et al. [7] (84%) and Akkocaoglu and Kasaboglu [10] (86%). A few recent studies by Yan et al. [11] (94%) and Reich [12] (95%) have shown similar results with the procedure, but without the use of piezosurgery. The difference lies in the need for surgical extraction of third molars in all our enrolled patients, while the above-mentioned studies also included completely erupted third molars which could be extracted non-surgically. Without any case of root resorption or ankylosis, we believe the use of piezosurgery was helpful in preserving the PDL of the donor teeth.

The only tooth lost in our sample was due to infection. The cause probably could have been some remnant infection at the recipient site. While severely infected recipient or donor sites were not included in the study, cases with minor periapical infection at the recipient site were included. In such patients thorough curettage of only the periapical region was done after extraction of the decayed tooth, minimizing the use of the instrument along the socket walls. Such minor infection was the case in only a few patients. Also, no antibiotic prophylaxis was used in our series, which may have prevented failure due to infection. Delayed transplantation, although not considered in our study, is also an option which can be utilized if the recipient site is deemed to be too infected to carry out immediate transplantation.

Recently, 3D computerized tomographic scans and a computer-aided rapid prototyping process has been used to accurately measure the donor and socket site dimensions to facilitate tooth transplantation [19].

However, availability and cost constraints precluded its use in our study. Using a panoramic radiograph along with clinical evaluation, we selected the donor third molar (any of the four third molars) which closely matched the mesio-distal dimension of the recipient site. Also, since post-transplantation root development is not predictable, the donor tooth with maximum developed roots was selected, preferably with an open apex, to take advantage of maximum root length as well as pulp revascularization [2].

Studies have shown immediate transplantation of third molars results in better prognosis than transplanting it in a newly-created socket [2,20,21]. This suggests that, although viable cells on the root surface are critical for success, the importance of progenitor cells on the socket wall should not be overlooked. Instead of using rotary drills to create a 4-walled recipient socket as described in the literature [2,12], piezosurgery tips were used in this study to remove the inter-radicular bone. It has been shown that rotational and torsional power associated with conventional bone drilling is the main cause of soft tissue damage, while on the other hand cellular viability is preserved without any coagulative necrosis with the use of piezosurgery [4]. Thus, the use of this device can be helpful in preserving the progenitor cells on the socket wall, improving the chances of success.

Piezosurgery also works well in terms of surgeon and patient comfort. It provides for precise bone cutting and increased tactile control, as application of excessive force is not needed as in conventional drills [22]. The oscillating tip also drives the irrigation solution through a cavitation phenomenon which allows for better visibility and a clean operating field [23]. Therefore, the surgeon can safely and precisely carry out bone removal around the third molar, with minimal chances of instrument slippage which can damage the tooth root. In contrast to macrovibrations produced by conventional drills, piezosurgery works on the principle of microvibrations. This produces less vibration and noise, minimizing the patient's psychological stress and fear [24]. Studies have also shown that extraction of third molars with piezosurgery is associated with less post-operative pain, swelling and trismus [15]. There are a few limitations of piezosurgery. The unit has its added cost with chances of breakage of surgical tips. The time required is longer due to its slow speed of cutting. Increasing the working pressure can cause transformation of vibrational energy of the device into heat, with subsequent tissue damage [5]. With only a case report in the literature [25], we present the first study evaluating the success of autogenous third molar transplantations using piezosurgery. Piezosurgery was helpful in socket preparation and atraumatic retrieval of third molars which resulted in a high success rate in our study. Further research comparing piezosurgery with conventional drills while transplanting embedded or

impacted third molars with long-term follow-up would provide better evidence in this topic.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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