

Autogenous Transplantation of Maxillary and Mandibular Molars

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Purpose: Autogenous tooth transplantation has been used as a predictable surgical approach to correct malocclusion and replace edentulous areas. This article focuses on the surgical approach and technique for molar transplantation.

Patients and Methods: Thirty-two patients aged between 11 and 25 years underwent 44 autogenous molar transplantations. The procedure involved transplantation of impacted or newly erupted third molars into the extraction sockets of nonrestorable molars and surgical removal and replacement of horizontally impacted molars into their proper vertical alignment. Five basic procedural concepts were applied: 1) atraumatic extraction, avoiding disruption of the root sheath and root buds; 2) apical contouring of bone at the transplantation site and maxillary sinus lift via the Summers osteotome technique, when indicated, for maxillary molars; 3) preparation of a 4-wall bony socket; 4) avoidance of premature occlusal interferences; and 5) stabilization of the tooth with placement of a basket suture.

Results: All 32 patients successfully underwent the planned procedure. To date, 2 patients have had localized infection that resulted in loss of the transplant. The remaining 42 transplants remain asymptomatic and functioning, with a mean follow-up period of 19 months. No infection, ankylosis, loss of the transplant, or root resorption has been noted. In addition, endodontic therapy has not been necessary on any transplanted teeth.

Conclusions: Autogenous tooth transplantation has been discussed and described in the literature previously, with a primary focus on cuspid and bicuspid transplantation. The molar transplant is infrequently discussed in today's literature, possibly because of the preponderance of titanium dental implants. Autogenous molar transplantation is a viable procedure with low morbidity and excellent functional and esthetic outcomes. This report shows the successful transplantation of 42 of 44 molars in 32 patients with a mean follow-up period of 19 months.

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A significant number of patients have premature loss of their first and second molars because of dental caries or dental crowding (or both). Often, these patients are not candidates for replacement of these edentulous areas with titanium dental implants because of their age or simply for financial reasons. As advocates for our patients, we in the dental community should be aware of the benefits of tooth transplantation. Hale¹ described his technique for autogenous transplantation as far back as 1956. In the same year, Miller² described his technique for molar transplantation. Other authors have followed with their experience with molar transplantation, and most re-

cently, Bauss et al³ (2004) reported on the autotransplantation of immature third molars into edentulous and atrophied jaw sections. Autotransplantation has been carried out for many years but with varying success rates.^{1,2,4-14} Consequently, there is a lack of confidence and a lack of understanding regarding this procedure among those in the dental community. The goal of this article is to highlight the evidence-based principles for successful autotransplantation. The author will also describe the surgical technique used for all of the transplantations in this report, with a description of some additional techniques not previously described in the literature on tooth transplantation.

The first documented case reports of autogenous molar transplants appeared in the literature in the 1950s.^{2,5} Hale¹ was the first author to thoroughly describe his technique for autotransplantation. Many authors have followed with different approaches, different locations, and varying degrees of success: Slagsvold and Bjercke⁸ (34 premolars, 100% success rate),

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Alberg (33 maxillary canines, 88% success rate), Pogrel⁹ (416 transplants in various locations, 72% success rate), and Andreasen et al¹⁰⁻¹⁴ (370 premolars, 95%-98% success rates).

One common theme that emerges from these studies is that autotransplantation is a technique-sensitive procedure. For this reason, accurately assessing the merits of a procedure carried out by multiple operators who have varying levels of experience is difficult, as evidenced in the 1987 study of Pogrel,⁹ in which a significantly lower success rate of 72% was noted. Therefore all transplantations reported in this study were executed by a single operator (the author) using the same technique throughout. In addition, a single, clear definition of the term *success* must be applied when evaluating all cases. In this report *success* has been defined as a transplant that remains viable, in stable occlusion, and without evidence of root resorption, infection, or discomfort. The need for endodontic therapy is a question that always comes up in discussions of autotransplantation but often is omitted from analyses of success versus failure. In this study the need for endodontic treatment postoperatively was considered a qualifier for transplant failure. This qualification was selected because a great majority of the patients involved in this study could not afford endodontic therapy and would have chosen extraction when faced with this option.

Patients and Methods

A group of 32 patients (18 female and 14 male patients; age range, 11-25 years [mean, 19 years]) underwent 44 autogenous molar transplantations. Patient selection was based on the presence of 3 basic criteria: 1) a necrotic nonrestorable maxillary or mandibular first or second molar, 2) a caries-free retrievable maxillary or mandibular third molar, and 3) horizontal impaction of the mandibular second molar. No further guidelines were applied regarding medical history, smoking status, or previous dental treatment implemented. Among the subjects of this study were 7 smokers, 2 patients with mild asthma, and 5 patients being treated for depression. Absolute contraindications for patients' involvement in the study were an acutely infected donor or recipient site, inability to follow postoperative instructions, previous radiation or bisphosphonate therapy, and unwillingness or inability to be followed up for radiographic and clinical examination. Age was not considered a contraindication in this study; however, the oldest patient in this study was 25 years old, with the mean age being 19 years. Therefore most of the transplants in this study were open-apex transplants: 37 open apex and 7 closed apex.

All patients were treated on an ambulatory basis at Great Bay Oral Surgery (Somersworth, NH) under intravenous anesthesia (midazolam and fentanyl) (10 patients) or local anesthesia (2% lidocaine [Xylocaine; Benco Dental Supply Co, Wilkes-Barre, PA] with epinephrine, 1:100,000) (22 patients). Panoramic radiographs were used preoperatively to confirm the location and root development of all third molars.

Root length of all transplanted third molars was assessed preoperatively by radiographic examination. The requirement for autotransplantation was one-third root development. The ideal root length was considered to be two-thirds root formation based on the study of Andreasen et al.¹³ Atraumatic surgical removal of the third molar was essential, preserving the root sheath and apical portion of the developing tooth bud. Adequate exposure and preparation of the recipient site were performed with a high-speed Impact Air 45 handpiece (Palisades Dental, Tenafly, NJ) with a 34-mm fissure bur with copious irrigation.

Copious irrigation was used throughout. Removal of the inter-radicular bone at the recipient site was required in every case, as was additional removal of bone beyond the apex to ensure an apical cushion or tension-free zone where the root buds could be positioned without threat of compression. This apical preparation also allowed for the transplant to be positioned at or slightly below the occlusal plane so as to avoid premature occlusal contacts. All transplants were placed into a 4-walled surgically prepared bony socket.

Special consideration was given to 3 transplants to the maxillary first molar position, where pneumatized maxillary sinuses were encountered. In these instances, a Summers osteotome was used to perform a localized sinus lift to once again create a cushion for the transplanted root buds while simultaneously preventing the roots from perforating the sinus membrane with over-preparation with the surgical handpiece. The transplant was then taken directly from its extraction socket to the recipient site to minimize (insofar as possible) extraoral time and trauma to the root sheath. During this transfer, examination of the transplant's root buds was crucial; if the buds were found to be grossly traumatized or missing, another third molar would be harvested and used instead. No transplantations were performed with a transplant that was missing root buds. In this study missing root buds were noted during transfer of the transplant in 3 patients; however, in each of these cases, the author was able to use another impacted third molar that had been designated for removal.

If the transfer from the donor to the recipient site was not an ideal fit on the first attempt and additional preparation of the recipient site was required, then the third molar was sandwiched between 2 gauze

pads soaked in normal saline solution. Attention to avoidance of contact with all surgical instruments and the root sheath was deemed mandatory.^{10,13,15} Premature occlusal contact on the transplanted molar was carefully assessed and eliminated, when present, by further preparation of the recipient site. No occlusal adjustments were performed, and the ideal position was considered to be 1 to 2 mm below the occlusal plane. Stabilization of the transplanted third molar was achieved with a No. 3 silk suture placed in a crossover fashion to prevent up-and-down movement of the transplant. No splinting with composite or wire banding was required. The prepared 4-wall recipient site reinforced lateral forces.

For all transplanted teeth, preoperative antibiotic prophylaxis with 2 g penicillin V potassium, or 600 mg clindamycin in the penicillin-allergic patient, was used. Antibiotic coverage was then carried out for an additional 5 days. All patients were placed on a full liquid diet for 48 hours and then advanced to a pureed diet for 2 weeks. A soft diet was recommended for another 2 weeks. All patients were evaluated at 1 and 2 weeks postoperatively, with suture removal at 2 weeks. Follow-up was then performed at 2-month intervals for the first 6 months and then annually for the next 3 years.

Results

Forty-four autogenous third molar transplantations in 32 patients were taken to completion. Two transplants had to be abandoned intraoperatively because of lack of bone at the recipient site, and three transplants had to be discarded because of trauma to the developing tooth bud. In each of the latter 3 cases, however, an additional third molar was present that was used without complication. Root development on all transplanted molars was a minimum of one third completed. Eighteen female patients (25 transplants) and 14 male patients (17 transplants) have been treated and followed up for 6 months to 4 years postoperatively, with an overall success rate of 95.5% (mean follow-up period, 19 months). Two infections resulting in the loss of 2 transplants occurred. No ankylosis, root resorption, or malocclusion was noted. None of the completed 44 transplants required endodontic therapy.

The mean age of the patients in this study was 19 years. All molar transplants were approached with the same surgical technique, as previously outlined. Individual variations included 3 third molar transplants to the maxillary first molar location that required a localized sinus lift procedure performed through the extraction socket with the Summers osteotome.

Discussion

Reports of autogenous tooth transplantation have appeared in the dental literature since the 1950s. Many of these reports have focused on bicuspid and cuspid transplantation. Molar transplantation has attracted much less attention over the years and, for that reason, is the focus of this article. As dental professionals, we are advocating daily for our patients with the treatment plans that we develop and discuss with them. Until recently, molar transplant was not considered a viable treatment option; dental professionals may have been unaware of this procedure and the benefits afforded to the patient. Now, when a teenage patient walks into the office with a necrotic nonrestorable first molar and impacted developing third molars, we can offer the fundamentally sound option of autogenous molar transplantation in addition to the standard dental implant, crown and bridge, and removable partial denture.

This report illustrates how a technique-sensitive procedure such as autogenous molar transplantation can be performed routinely with excellent results. In this author's experience, 44 molar transplants were performed with a 95.5% success rate in an outpatient office setting. Expert surgical technique is essential for successful autotransplantation. The work of Andreasen et al^{10,11,13-15} and Hale¹ has been fundamental to understanding the delicate nature of the root sheath and developmental age of the transplanted root. These authors show that transplants can be performed with as little as one-third root development, accepting the risk that root development may be halted and therefore compromise stability in certain cases. From these same studies, one can realize that although waiting for near root completion allows for improved results, surgery cannot always be delayed for those additional months or years. These cases also suggest that attention to socket preparation and delicate positioning of the root bud contribute to a successful surgical procedure.

In the current study, no outcome differences are based on gender or age, but it must be pointed out that the oldest patient in this study was 25 years old. Traditionally, apical root closure and increasing age beyond the fully developed root adversely affect the success rate for autotransplantation, and damage to the root sheath increases the chances for root resorption.^{12,14,16}

The mean follow-up period for the patients in this study was 19 months. Although the postoperative follow-up in this study was not uniform, the success rate cannot be ignored. There are studies emerging in the field of autotransplantation now that are showing

postoperative follow-up periods of 17 to 41 years with success rates of 90%¹⁶ and 92%.¹⁷

The benefits of autotransplantation over other treatment options are numerous. The transplanted tooth can regenerate bone, unlike the dental implant, which often requires bone grafting to fulfill all necessary functional and esthetic demands. In our office, autogenous dental transplantation is also about 87% less costly than a dental implant, an obvious benefit to most patients. Autogenous transplantation can also be performed in patients who are not yet fully grown, because the transplant is actively growing and developing with the patient and not passively locked into position as is an endosseous dental implant. The most apparent disadvantage to autogenous transplantation is the limited supply of available donor teeth. However, research may catch up with us here in that, before long, we may be able to harvest multiple donor teeth from a laboratory culture. Autotransplantation may be the groundbreaking work for what is to come next—laboratory-cloned and cryopreserved teeth.

The possibility of growing additional donor teeth in the laboratory is presently being explored. Current studies are investigating the odontogenic potential of bone marrow mesenchymal stem cells for seeding in tooth regeneration.¹⁸ Other studies are working with mouse tooth buds and attempting tooth growth by transplantation of the tooth bud into the mouse mandible with a culture involving bone morphogenetic protein 4.¹⁹ This research examines the possibility of harvesting tooth buds or stem cells and using those materials as the building blocks for new teeth. If this comes to fruition and growing teeth becomes possible, then it will also be necessary to store these teeth until implantation is undertaken. Such storage will most likely involve the process of cryopreservation of donor teeth, which dates back to 1972.²⁰ Some investigators continue to examine cryopreservation of donor teeth.²¹⁻²⁹

That the autogenous transplantation technique may one day be used as the model for transplantation of a laboratory-grown autogenous tooth is amazing. A tooth bank for the anticipated loss and replacement of teeth in any one individual may be the future of implant dentistry.

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