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The Immediate Placement of Endosseous Dental Implants in Fresh Extraction Sites

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Nearly 40 years ago, the advent of implant dentistry changed our ideas about tooth replacement therapy for our patients. Brånemark discovered that fully edentulous patients could be dentally rehabilitated using machined screws made of commercially pure titanium, which osseointegrated to the jawbone, enabling the attachment of a fixed prosthesis [1]. Since then, endosseous dental implants of various shapes and surface textures have been used in partially edentulous patients, achieving a measured rate of success of 96.7% at 8 years [2]. To achieve this safe, predictable, and cost-effective mechanism of rehabilitation, Brånemark and coworkers developed a list of clinical recommendations regarding treatment protocols. According to one of the recommendations, a waiting time of 12 months was necessary following tooth extraction before an endosseous dental implant could be installed [3]. The rationale for this reasoning was to allow resolution of any hard or soft tissue pathology in a proposed recipient site.

Several investigations have evaluated the effects of tooth extraction on the dimensional changes observed with both the hard and soft tissue. These changes in the healing extraction sockets have been evaluated by means of cephalometric analysis [4,5], study cast assessments [6–8], subtraction radiography [9], and direct measurements made at surgical reentry [10–13]. Diagnostic casts have the ability to evaluate morphologic changes in the bone and overlying mucosa in a noninvasive fashion. During the first 4 months of healing, according to observations and measurements, the buccal-lingual ridge undergoes a reduction of approximately 5 to 7 mm [5,10] with a 2- to 4.5-mm loss of vertical bone height [9,11]. Several studies have observed greater apico-coronal changes when comparing multiple adjacent

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extraction sites to single sites [7,10,11]. Most recently, Schroop and colleagues measured dimensional changes intraoperatively in 46 healing sockets in 46 patients, confined to only the premolars and molars in both arches. They reported a reduction in buccolingual width of nearly 50% over an observation period of 12 months. They noted that two thirds of the change occurred within the first 3 months following tooth extraction, with greatest changes observed in the molar sites.

Noting that this postextraction resorption could adversely affect the availability of bone for implant placement, clinicians began to insert dental implants immediately following tooth extraction. The first reported case was described by Schulte in 1976 using a polycrystalline aluminum surface [14]. Since then, numerous clinical case reports have been published, and, at various times, review papers have appeared to update this surgical technique with contemporary findings [15–18].

Advantages and disadvantages

In nearly all cases, investigators report many advantages for immediate placement. These include a reduction of surgical procedures [19], a reduction in treatment time [20], preservation of alveolar bone [21–23], maintenance of ideal soft tissue contours [24], better implant placement [25], simplification of the prosthetic design [19], and an improvement in the patients' psychological outlook for dental treatment [26].

Potential disadvantages of immediate placement include the possibility of infection [27–29], lack of soft tissue closure [30], thin tissue biotypes with consequent risk of recession [31], and an incongruity between the socket wall and the endosseous implant shape [32].

Site classification

To assist the clinician in properly evaluating patients for immediate dental implant placement, several investigators have developed a classification system for the timing of implant placement following tooth extraction [7,17,18,30,33]. Terms such as *immediate*, *recent*, *delayed*, *late*, and *mature* have been used in the literature in describing timing for implant placement following an extraction. Wilson and Weber's description concerns soft tissue healing and the predictability of guided bone regeneration. Mayfield's classification focuses on intervals expressed as time before installation of an implant. Most recently, Chen and colleagues [18] published a report classifying implant placement based on morphological, dimensional, and histologic changes that occur following tooth loss with regards to the term *immediate* (Table 1). Several papers defined *immediate* as occurring on the day when the tooth was extracted, while others include the time frame of 0 to 15 days and 0 to 7 days.

Table 1
Protocols for implant placement in extraction sockets and their advantages and disadvantages

Classification	Definition	Advantages	Disadvantages
Type 1	Implant placement immediately following tooth extraction and as part of the same surgical procedure	Reduced number of surgical procedures Reduced overall treatment time Optimal availability of existing bone	Site morphology may complicate optimal placement and anchorage Thin tissue biotype may compromise optimal outcome Potential lack of keratinized mucosa for flap adaptation Adjunctive surgical procedures may be required Procedure is technique-sensitive
Type 2	Complete soft tissue coverage of the socket (typically 4–8 wks)	Increased soft tissue area and volume facilitates soft tissue flap management Resolution of local pathology can be assessed	Site morphology may complicate optimal placement and anchorage Treatment time is increased Socket walls exhibit varying amounts of resorption Adjunctive surgical procedures may be required Procedure is technique-sensitive
Type 3	Substantial clinical or radiographic bone fill of the socket (typically 12–16 wks)	Substantial bone fill of the socket facilitates implant placement Mature soft tissues facilitate flap management	Treatment time is increased Adjunctive surgical procedures may be required Socket walls exhibit varying amounts of resorption
Type 4	Healed site (typically >16 wks)	Clinically healed ridge Mature soft tissues facilitate flap management	Treatment time is increased Adjunctive surgical procedures may be required Large variations are present in available bone volume

From Hammerle CH, Chen ST, Wilson TG, et al. Consensus statements and recommended clinical procedures regarding the placement of implants in extraction sockets. Int J Oral Maxillofac Implants 2004:19(Suppl):27; with permission.

Fig. 1. Preoperative presentation of tooth #8 with internal resorption.

Histology and clinical trials

Many preclinical and human clinical studies have been published regarding immediate implant placement [15–18]. Variables addressed in the studies include implant numbers, implant types, submerged versus nonsubmerged healing, the use of membranes or grafting materials, tooth positions, and follow-up periods. Furthermore, the results of these studies range from pure clinical and radiographic assessments to histologic findings.

Most reports on immediate implant placement describe small periimplant osseous defects resulting in a gap measurable from the wall of the extraction socket to the surface of the implant [19,34]. This defect type has been defined as the horizontal defect dimension (HDD) or ''jumping distance'' [35]. Reentry and histologic studies have shown that these small defects heal with significant bone fill regardless of the placement practices or

Fig. 2. Preoperative radiograph of tooth #8 with internal resorption.

Fig. 3. Buccal view of full-thickness flap and beveled vertical releasing incisions.

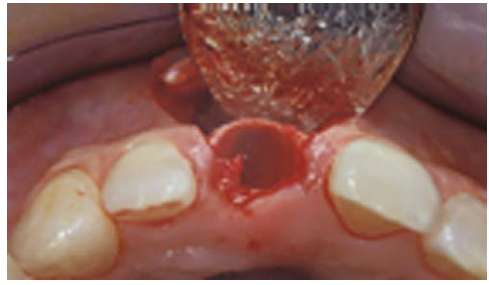

Fig. 4. Completion of degranulation following periotome extraction.

Fig. 5. Occlusal–cervical and mesial–distal orientation determined with a 2.8-mm gauge.

Fig. 6. Buccal–lingual and mesial–distal orientation determined with a 2.8-mm gauge.

Fig. 7. Buccal view of implant placement.

Fig. 8. Occlusal view of implant placement showing buccal HDD.

Fig. 9. Buccal view of healing cap insertion and placement of autogenous bone graft.

augmentation methods chosen. Several studies have shown that when the HDD was found to be 2 mm or less in width, no augmentation or membrane was required [35–39]. However, studies illustrating dehiscence or fenestration defects have been shown to benefit from the use of barrier membranes and bone grafting [7, 40–42]. One study observed favorable results in dehiscence defects treated with a resorbable collagen barrier and anorganic bovine bone material. This finding is of particular importance when addressing sites with local bony pathology. Often in such cases, at least one of the socket walls has been traumatized or lost due to infection. Studies have shown a high degree of success in treating dehiscences with a wide variety of methods and materials, including expanded polytetrafluoroethylene membranes and freeze-dried demineralized bone allograft, resorbable collagen membranes and anorganic bovine bone [43], or autogenous bone grafts alone. However, the use of a nonresorbable membrane increases the likelihood of postsurgical infection and requires secondary surgery to retrieve

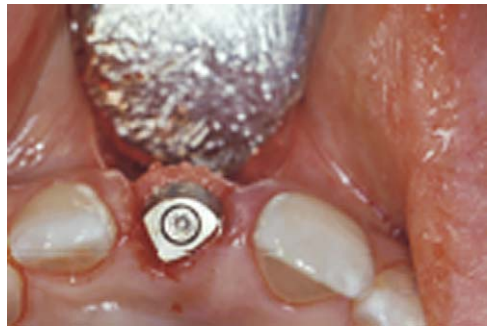

Fig. 10. Occlusal view of autogenous bone graft into the HDD.

Fig. 11. Buccal view of flap closure.

the membrane [17,44,45]. Furthermore, studies have shown less than ideal bone fill when a nonresorbable membrane becomes prematurely exposed [42,46,47].

The International Team for Implantology consensus paper discussing immediate implant placement identified 18 studies having a follow-up period ranging from 1 to 4 years [18]. All but 4 of the studies involved a submerged placement protocol. The implants under study had varied surfaces: machined, titanium plasma-sprayed, hydroxyapatite-coated, grit-blasted, and acid-etched. The cumulative survival rate (CSR) for immediately placed implants ranged from 89.3% to 100%. Implants having a roughened surface as opposed to a smooth machined surface were shown to have a higher CSR.

Indications

Clinical indications for replacing teeth with immediate implants include retained deciduous teeth, vertically and horizontally fractured teeth, teeth lost to nonrestorable dental caries, periodontal disease, endodontic failure, and poor esthetics [16]. These situations generally offer the clinician the ability to obtain primary mechanical stability with immediate implant

Fig. 12. Occlusal view of flap closure.

Fig. 13. Buccal view of soft tissue healing at 12 weeks.

placement by engaging either pristine bone 3 to 5 mm beyond the apex of the affected tooth or engaging the lateral walls of the socket [19]. These criteria generally limit the procedure to single-rooted teeth unless a wide volume of inter-raducular bone exists in molar areas. Generally, immediate implants are not inserted into the root sockets of molars due to poor positioning for ideal prosthetics, as well as poor bone quality [48].

Treatment protocol

Figure 1 presents the preoperative view of tooth #8, shown radiographically (Fig. 2) to exhibit internal resorption. Following administration of local anesthesia, a 15 blade is used to create a sulcular incision along the buccal aspect of the planned implant site, and a vertical releasing incision to spare the adjacent papillae (Fig. 3). The vertical releasing incision must be beveled 45° to insure ideal flap closure and to prevent the formation of scar tissue. A full-thickness flap is elevated and extended beyond the anticipated apical extension of the preplanned implant length. This method permits careful evaluation of any pathology present at the periapical region of the tooth to be extracted. The tooth in question is then extracted using a method involving minimal trauma to the bone and surrounding soft

Fig. 14. Occlusal view of soft tissue healing at 12 weeks.

Fig. 15. Fabrication of acrylic screw-retained provisional crown.

tissues. Generally, this extraction is accomplished using a periotome directed along the proximal and buccal surfaces of the tooth root, taking care to avoid fracturing the thin buccal plate noted in cases of a type one gingival/bone phenotype. A forceps of anatomic design can be used to rotate the tooth root in a clockwise–counterclockwise fashion to retrieve the root from the alveolus. Should difficulty arise with this method, the tooth in question should be sectioned vertically with a surgical length carbide bur. Following extraction, the socket is then thoroughly degranulated with curettes and diamond rotary instrumentation to remove all remnants of the periodontal ligament and granulation tissue (Fig. 4). Depth gauges of

Fig. 16. Buccal view of acrylic screw-retained provisional crown.

Fig. 17. Insertion of acrylic screw-retained provisional crown.

various diameters are inserted to ascertain the socket architecture before the initiation of the osteotomy. If primary stability of the implant cannot be achieved by increasing the length or width of the socket as ascertained by inserting the final diameter depth gauge, then no attempt should be made with immediate placement and a delayed type two or type three protocol should be followed (see Table 1).

Initiation of the osteotomy should be performed in standard fashion with the initial penetration point for the anterior maxillary teeth approximately 2 mm coronal to the extraction apex and along the palatal wall. This position should ensure that the buccal aspect of the implant does not rest against the buccal plate resulting in compression necrosis. The initial bur penetration point for maxillary premolars and all mandibular single-rooted teeth is directed toward the exact apex of the extraction socket. When preparing the depth of the osteotomy, be aware of the position of the anticipated restorative platform, as it should be located ideally as expected in a delayed or late placement method (Figs. 5 and 6). No attempt should be made to purposely plan the implant restorative platform deeper than 2 to 3 mm apical to the cementoenamel junction of the final restoration (Figs. 7 and 8).

Fig. 18. Soft tissue sculpting following placement of provisional crown.

Fig. 19. Postrestoration photograph at 1 year.

Following implant insertion, an appropriate healing cap is selected depending on the desire for a submerged, semisubmerged, or nonsubmerged healing approach. Should an HDD greater than 2 mm exist or a dehiscence be present, osseous grafting and the use of a membrane is required (Figs. 9 and 10). Many times, autogenous bone grafting material can be obtained along the buccal plate, lateral to the implant site, using an osseous bone scraper/collector. Additionally, should increased soft tissue volume be needed, a connective tissue graft should be placed before flap closure. The soft tissue phenotype will dictate the method of flap closure. A type one soft tissue phenotype benefits from a fully submerged or semisubmerged technique, while a type two soft tissue phenotype may be addressed with a semisubmerged or nonsubmerged approach (Figs. 11 and 12). Suture material of 5-0 or smaller and with a minimal wicking effect should be chosen to tie the interrupted

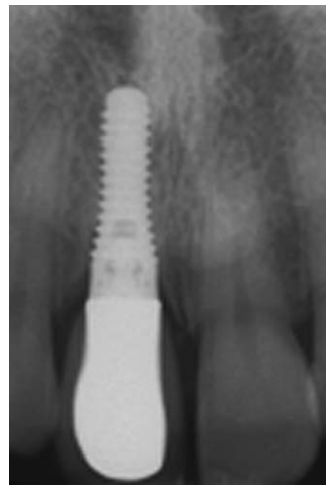

Fig. 20. Postrestoration radiograph at 1 year.

sutures, with the first suture placed to properly position the coronal margin of the flap in the desired location. Suture removal can be accomplished in 7 to 10 days (Figs. 13 and 14) with the insertion of a fixed, screw-retained acrylic provisional restoration at 12 weeks postsurgery (Figs. 15, 16, and 17), and the definitive restoration delivered following the completion of soft tissue sculpting (Figs. 18, 19, and 20).

Summary

The goal of dental implant treatment is to provide safe, predictable, and cost-effective tooth replacement therapy to patients. Treatment methods for these patients should be supported by evidence-based, peer-reviewed literature. Initially, endosseous dental implants were placed into an edentulous site following a sufficient period of socket healing. The caveat of this statement, though, is that only four longitudinal studies with mean follow-up periods between 3 and 5 years have been reported in the literature, despite numerous case reports with findings up to 12 months in length. Currently, the literature notes a nonrandomized pattern of techniques related to immediate placement protocols pertaining to timing of placement as well as augmentation techniques.

Continued publications discussing bone remodeling, limits of the HDD, esthetic outcomes related to gingival phenotypes, and flapless surgeries are needed to advance this concept of immediately placed dental implants forward for the next 10 years.

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