Immediate patient rehabilitation with trabecular metal implants

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KEYWORDS
Guided bone regeneration; Implant success; Single-tooth immediate rehabilitation.

ABSTRACT
Aim: Dental implants have gained widespread use over the last three decades and are now considered as the “gold-standard” option for replacement of missing teeth. However, traditional implant treatment requires prolonged healing times, during which removable rehabilitations may provide esthetics, but rarely function. Immediate implant placement has gained increased attention to shorten the period of implant healing, and under favorable conditions, implants may have immediate function with temporary restorations (1). Immediate rehabilitation, when implants are temporized with immediate occlusal loading, is more commonly used in full-arch cases. Recent evolutions in implant design and materials have allowed for increased success and predictability of single-tooth immediate rehabilitation.

Materials and methods: Literature review and presentation of an alternative method for immediate rehabilitation following tooth extraction. A case using a Trabecular Metal™ (Zimmer Biomet Dental) dental implant and guided bone regeneration to promote immediate patient rehabilitation is also presented.

Results: The patient was successfully treated with immediate replacement of the extracted tooth using TM dental implant and a provisional restoration. Final crown was delivered at 12 weeks. Results have been confirmed for more than 36 months. The patient was extremely satisfied with the final results, that were not only acceptably functional, but also esthetic.

Conclusions: This paper demonstrates that TM dental implants have the potential to provide immediate single-tooth rehabilitation. Future development of this technology and surgical techniques associated with their application may further improve these outcomes.

Introduction
Dental implants have gained widespread use over the last three decades and are now considered as the gold-standard for the replacement of missing teeth (1). However, traditional implant treatment requires prolonged healing times, during which removable rehabilitations may provide esthetics, but rarely function. Immediate implant placement has gained increased attention to shorten the period of implant healing, and under favorable conditions, implants may have immediate function with temporary restorations (1). Immediate rehabilitation, when implants are temporized with immediate occlusal loading, is more commonly used in full-arch cases. Recent evolutions in implant design and materials have allowed for increased success and predictability of single-tooth immediate rehabilitation.

Implantation of metal-based devices in bone was first described by Bothe et al. in the 1940’s, followed by Leventhal et al. in 1951, who described titanium as a potentially biocompatible surgical implantable material. Brånemark et al. later reported that titanium chambers could not easily be retrieved after bone implantation (2). This finding inspired his research group to apply this concept to dental implants with hopes that they would provide rigid fixation to dentures. Titanium or its alloys are regarded as bioinert or biocompatible materials and they are stable in the body owing to the spontaneously formed oxide layer (3). Biomaterial research regarding dental implants have dominantly utilized titanium as a material of choice and both basic and clinical research show that commercially pure titanium and several of other titanium alloys are osteoconductive and promote osseointegration (4). The threaded type implants were further tested in edentulous patients and the clinical outcomes were presented at the Toronto congress in 1982 (5). The 15-year survival presented surprised everyone attending and thereafter, the application of osseointegrated dental implants has become a major alternative to restore full/partial edentulism.

Certain prerequisites have been proposed as essential factors for successful osseointegration (6) and the development and evolution of the dental implants progressed based on these factors. Research on implant surface topography has been of major focus and new surfaces are constantly applied on implants (7) in an attempt to accelerate osseointegration rates. As a result, new implant surfaces are often launched in the market with claims that implant would osseointegrate faster.
Alternative materials have been tested, including tantalum (8,9). Tantalum shares similar properties with titanium, and high porosity similar to bone trabeculation is created when associated with patented processing methods (9, 10). Immediately after placement, the healing chambers will be filled with blood clot which develops toward an osteogenic connective tissue configuration that will ossify through an intramembranous-like pathway. This osteogenic connective tissue is highly vascularized at early implantation times, and allow osteogenic cell migration throughout the healing chamber space. Such vascularization and cell migration pattern allows for woven bone formation simultaneously taking place at the implant surface, osteotomy bone walls, as well as within the center of the healing chamber and results in rapid osseointegration. Shortly after early integration through woven bone formation, lamellar bone will gradually replace the woven bone, resulting in formation of primary osteonic structures.

This alternative process of osseointegration is especially significant during early or immediate loading of dental implants. Conventional dental implants are designed to provide maximum primary stability (fixation) without providing healing chambers for the new bone formation. Primary stability is obtained by the interaction between the outer regions of the threads that engage bone and such initial stability is proportional to the thread design and the amount of mismatch between implant outer thread and osteotomy diameters. Hence, this osseointegration pathway simultaneously presents bone remodeling where engagement between implant and bone occurred, resulting in stability loss that is supposedly compensated by the rapid woven bone formation in the healing chambers formed between threads. This temporary stability loss may prevent osseointegration in the presence of micro-motion (early or immediate loading of dental implants). Hence, immediate rehabilitation or occlusal loading has been limited to cross-arch or splinted cases since occlusal forces are dissipated amongst multiple dental implants.

The aim of this article is to describe, through a case
report, an alternative method for immediate implant rehabilitation using TM implants and guided bone regeneration.

Materials and methods
Trabecular Metal (TM; Zimmer Biomet) is a patented proprietary technology. The material has over 19 years of demonstrated clinical use in a variety of orthopedic applications (11). TM is made of elemental tantalum (atomic number 73), one of the most chemically stable and biologically inert metals used in orthopedic implants (5). This makes it highly biocompatible and corrosion-resistant (12). This is a unique, highly porous biomaterial made from elemental tantalum with structural, functional, and physiological properties similar to that of bone (13). This material features a completely open, engineered and interconnected pore structure to support bone ingrowth and vascularization (13). As a consequence, osseointegration is facilitated and optimized since new bone continues to migrate within this porous structure. TM has a modulus of elasticity similar to that of cancellous bone for more normal physiological loading, which has the potential to reduce stress shielding when used in a monoblock or monolithic application (14). TM also has high coefficient of friction versus cancellous bone for stable initial fixation. TM is a chemically stable and biocompatible material which creates very little adverse biological response (15).

The clinical use of TM includes hip, knee, and shoulder implants; trauma applications; spine implants; bone void fillers and augments; and dental implants. For dental implant application, a hybrid dental implant was created (16). TM dental implant is composed of both titanium and tantalum. Tantalum is present on the body of the implant, with a non-threaded area that provides an excellent environment for secondary implant stability (osseointegration), while the coronal and apical ends of the dental implant are composed of threaded and micro-threaded areas that help primary implant stability and restorative protocols (Figure 1). Based on these unique features, TM dental implants have been developed to overcome known limitations of conventional dental implants, especially related to

Figure 5 Bovine pericardium membrane trimmed and adjusted to cover the bone graft without covering the implant platform

Figure 6 Barrier membrane placement followed by delivery of immediate temporary crown
early or immediate occlusal loading (17). However, these implants may also be used following more conservative protocols for placement and loading. TM dental implants have been found to be clinically effective when immediately temporized out of occlusion within 24 hours of implant placement and definitively restored in occlusion within 14 days of placement in a controlled patient population (18).

Case report
A 46 year old female patient presented with a hopeless mandibular right first molar. Medical history was considered non-contributory. Clinical examination evidenced a draining fistula associated with the mid buccal aspect of tooth #30, associated with a 9 mm probing depth. All other probing depths were within normal limits. The patient reported that she had felt discomfort and occasionally seen bleeding from this area since her dentist placed an intra-radicular post and a new crown on this tooth, less than 6 months before initial examination. Radiographic evaluation revealed that the post had clearly missed the distal root and had penetrated into the furcation area (Figure 2). Post removal and new endodontic treatment with obturation of the perforation with MTA and possible periodontal regeneration was suggested, but the patient chose to have the tooth extracted and replaced with a dental implant. Drainage was stimulated and the patient was prescribed Amoxicillin 500mg every 8 hours for 7 days before extraction. Patient was extremely concerned about esthetics and did not want to be edentulous during the implant healing period. Immediate implant placement with immediate temporization was therefore suggested. Following local anesthesia, minimally traumatic exodontia techniques were applied, which included crown removal and subsequent sectioning at the mid aspect of the tooth in a buccal-lingual direction. Periotomes were used to elevate both roots with minimal trauma to the socket walls. Roots were removed with root tip extraction forceps. After careful extraction, socket inspection and degranulation, implant osteotomy was prepared following the manufacturer’s recommendations, aiming for an ideal restorative position. A 6x11.5mm TM dental implant was uneventfully placed with an insertion torque of 40 Ncm and 72 ISQ (Figure 3). The patient’s tooth crown was hollowed, retro-filled, and used as temporary crown. The implant mount of the TM implant, that can be used as impression coping or temporary abutment, was used to create the provisional restoration. The mount, while still attached to the implant, was bonded to the patient’s crown intra-orally. After bonding, the crown and temporary abutment were removed, rinsed and dried extra-orally. Additional flowable composite resin was used to contour the provisional screw-retained restoration and the remaining portion of the temporary abutment was adjusted. A Tutoplast processed, cancellous bone allograft (Puros, ZimmerBiomet) was used to fill the spaces between the TM implant and the walls of the socket (Figure 4). The implant cover screw was used to prevent bone graft particles from becoming trapped inside the implant abutment connection. A Tutoplast processed bovine pericardium long-lasting absorbable barrier membrane was trimmed to the size of the implant shoulder and used to cover the bone graft, without interfering with the implant-abutment junction (Figure 5). The provisional restoration was delivered, and torqued to 30 Ncm. Flaps were repositioned and secured with 4.0 Vicryl sutures (Ethicon) (Figure 6). Occlusion was adjusted to avoid interferences during lateral and protrusive movements (Figure 7). The patient was prescribed Amoxicillin 500mg every 8 hours for another 7 days, and Ibuprofen 600mg every 6 hours for 5 days. The patient was seen at 2 weeks for suture removal. Adequate wound healing was observed. The patient returned at 10 weeks, when the provisional restoration
was removed and final impressions were taken. Positive and reverse torque tests to 30 Ncm were used, in conjunction with RFA analysis. ISQ value recorded was 76. At 12 weeks, the final abutment (Figure 8) and PFM crown (Figure 9) were delivered. The patient was extremely satisfied with treatment, and was placed on a 3-month maintenance interval. The implant has been in function for over 36 months with optimal crestal bone levels and absence of any signs or symptoms of peri-implant disease (Figure 10).

Conclusion
This paper demonstrates that TM dental implants have the potential to provide immediate single-tooth rehabilitation. Future development of this technology and surgical techniques associated with their application may further improve these outcomes.

References