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Review Article

A One-Drill System for Predictable Osteotomy and Immediate Implant Placement

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Abstract

For nearly 40 years, dental implants have had high success rates as artificial tooth roots in alveolar bone. However, creating an osteotomy and inserting a dental implant has traditionally involved a series of multiple drills, lengthy surgical time, and patient frustration. Fortunately, a high-efficiency, fluted, step-drill (OneDrill®, OsseoFuse®) specifically designed for dental implant placement in crestal bone, leading to a shortened procedural time, is available. This enables dentists to eliminate the need for changing drills numerous times and therefore lessening the possibility of surgical contamination and error, and raise the predictability of implant treatment success. By combining all the components and functions of traditional multiple-sequence drills into one-including site marking, drill guiding, increasing diameter width, and a stopper to avoid excessive osteotomy depth-the OneDrill® represents a revolutionary approach for completing immediate osteotomies and implant placement that achieves predictable primary stability. This article reviews the mechanisms and function of the OneDrill® and presents two clinical cases to demonstrate its utility.

Keywords: *One Drill Implant; Primary Stability; Step Locking; Immediate Implants; Implant Osteotomy; Dental Implant; Single Drill Osteotomy; Immediate Provisionalization*

Introduction

Since their introduction nearly 40 years ago, dental implants constructed of titanium or other biocompatible materials have had high success rates as artificial tooth roots in alveolar bone [1-8]. By supporting single and/or multiple unit restorations, dental implants and their prostheses have enabled patients to achieve a bite force, occlusal stability, and comfort that approximate those of natural dentition. Contributing to the ongoing success of this treatment modality, there have been continual improvements to dental implant, bone, and tissue grafting materials, as well as the technologies and techniques utilized for placement [6-9].

Simultaneously, placement armamentarium and dental implant design, combined with modifications to surgical protocol (e.g. immediate placement following extraction; immediate loading), have allowed clinicians to realize enhanced predictability and accuracy when providing implant treatments in order to achieve long-term function, life-like esthetics, and greater patient acceptance.

Historically, however, placing dental implants, which is the cornerstone of such treatment, has consisted of inserting the dental implant into the alveolar bone to ultimately support a fixed single or fixed and/or removable multiple-unit prosthesis. Once osseointegration has been established, an abutment is installed onto the implant, after which the restoration is attached to the abutment to complete the dental implant-restoration plan.

The traditional method of inserting a dental implant involves first locating and exposing the implant surgical site, then using a large round bur to smooth and flatten the occlusal surface of the crest of the alveolar ridge in order to prepare the implant site. Subsequently, a pilot hole is drilled, after which a series of multiple drills with different and widening diameters is used to gradually expand the pilot hole until the width and depth approximate, but remain slightly smaller than, the diameter and length of the selected implant (Figure 1).

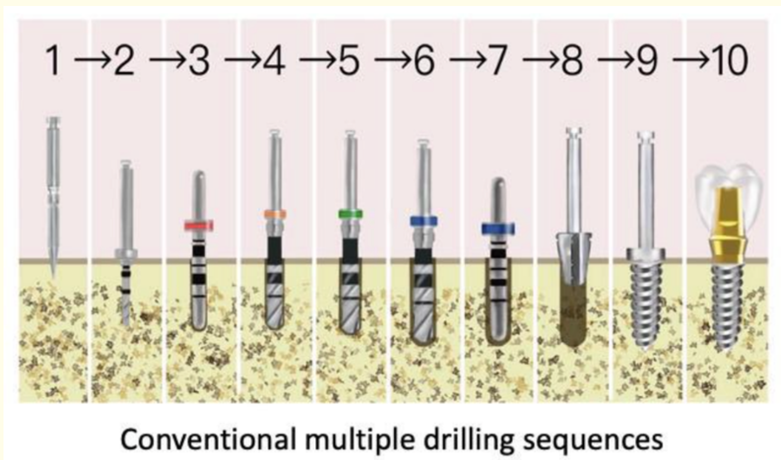

Figure 1: *Traditional implant placement procedures require the use of multiple drills in order to place one implant.*

After drilling the osteotomy, a countersink drill is then used to widen the cortical bone to the same diameter as the selected implant, and a tap is then used to create a thread within the site to passively allow entry of the dental implant into the crestal bone. Overall, this dental implant placement method could require around 3 - 10 drills for placing just one implant.

Despite shortened overall implant treatment procedures, such as immediate placement following extraction and immediate loading, the repeated drilling associated with this traditional implant placement protocol increases not only the risk of damaging important anatomical structures, but also the risk of infection due to long surgical time. Some manufacturers have introduced various types of streamlined drilling systems, perhaps in response to the high cost of drills that could become burdensome to clinicians, or perhaps to help shorten the time required to place a single implant. These have included a variety of dental implant drills, each with a unique design and features that are intended to facilitate the osteotomy operation and reduce procedural time and associated steps.

However, there are several limitations and drawbacks to some of these options. First, some (e.g. fixed-diameter pilot drill) require stationary rings to be moved or changed in order to modify drilling capabilities, which can be time consuming; these components also may not be clearly visible (e.g. bleeding during osteotomy), which could cause the dentist to inadvertently drill too deep, potentially damaging viable anatomical structures and increasing morbidity.

Additionally, although literature citations offer conflicting perspectives, some single-drill dental implant devices have been associated with generating a high temperature, particularly when there are no grooves in the drill to allow water to enter the osteotomy to cool it down [10-12]. This could cause cell damage and/or patient discomfort. This article will demonstrate how the OneDrill® system performs equally in safety and functionality compared to the traditional method with multiple drills.

A predictable one-drill alternative

A high-efficiency alternative to the traditional multiple drill method is a fluted, side-cutting drill (OneDrill®, OsseoFuse®) specifically designed for rapid dental implant placement in crestal bone leading to a shortened operation time (e.g. as little as 50 seconds per implant site according to a flapless protocol) [13]. Structured to eliminate the need for changing drills multiple times, prevent error, and raise the predictability of implant treatment success, the OneDrill® is comprised of an initial drill and drill guide at the distal end; and a series of different diameter active drill body sections that extend upward from the initial drill bur to the base of the stopper in stepped increments of increasing diameter (i.e. from smallest diameter to largest); a stopper positioned at the base of the latch engagement which are color coded to match the diameter of the selected implant and a latch engagement configured for quick connection to a dental handpiece (Figure 2).

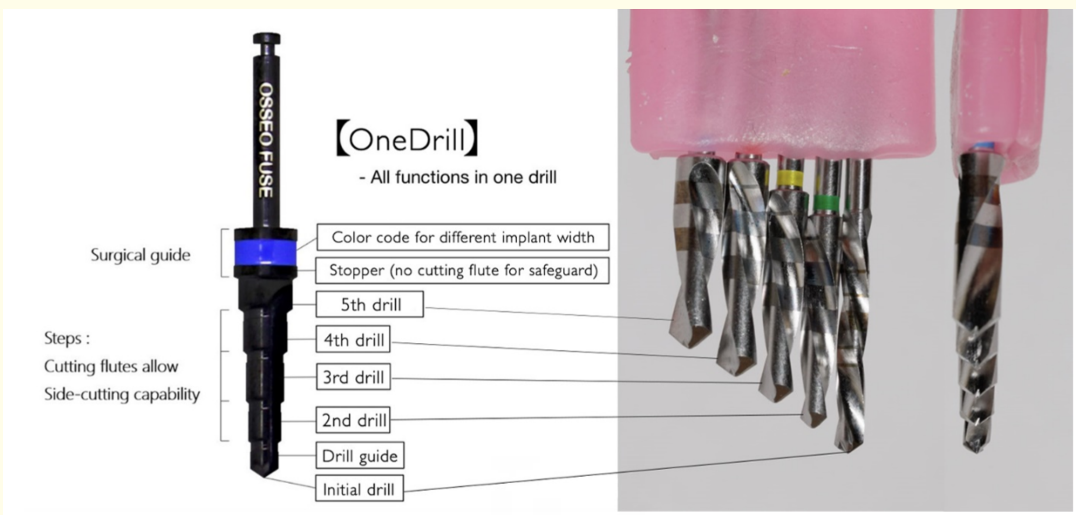

Figure 2: *The OsseoFuse OneDrill® combines the functions of multiple drills into a single drill for use in completing a dental implant osteotomy from start to finish with one drill, including self-tapping.*

As a result, rather than clinicians needing to repeatedly change the drill throughout the implant procedure to slowly widen the osteotomy diameter, a single OneDrill® contains all the drill diameters needed for the selected implant in one drill. Once the size of the implant that is needed is determined, a corresponding OneDrill® can be selected to complete the osteotomy from start to finish; therefore, the number of drills required to perform an osteotomy is reduced to 1 (Figure 3).

The initial drill and drill guide facilitate location marking, in addition to preventing any skipping or digressive motion; the drill's safeguard design (i.e. stopper) also prevents the surgeon from drilling too deep and damaging any important anatomical structures. By observing the silhouette of the OneDrill®, each step increases in diameter from the tip to the base of the drill. This mimics the multiple drills in the traditional method without the need to switch to another drill. Consequently, the initial drill and drill guide pass through the

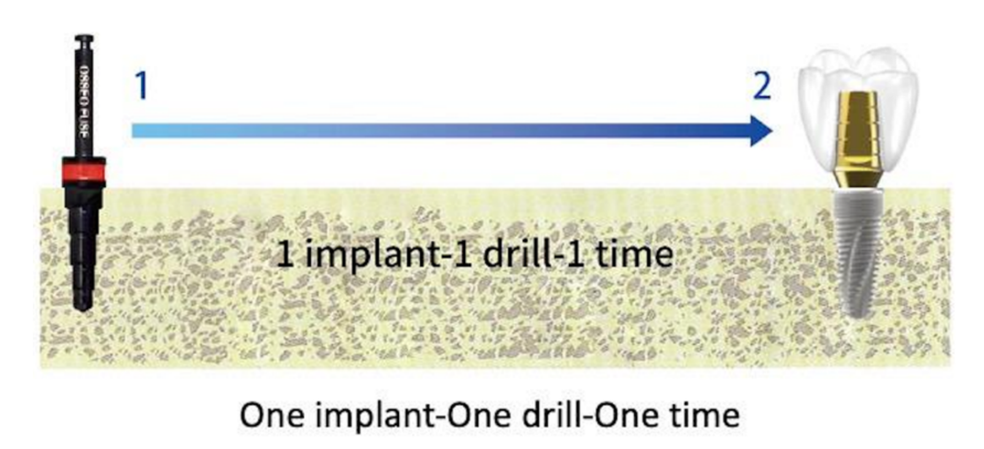

Figure 3: *Compared to traditional techniques, the OneDrill® requires only a single drill for performing the osteotomy, after which implant placement can follow immediately thereafter.*

cortex, continuing along its downward path. Now the first "step" of the OneDrill® functions as the second drill, with an increased diameter equal to the second drill in traditional method, the same applying for the next and subsequent "steps" along its trajectory. This concept prevents the generation of heat, unnecessary trauma, and ensures a safe osteotomy site.

Angulation may change during osteotomy and adjustments are possible with the traditional sequential drill method by swapping out for a drill with a larger diameter, there are limitations on the number of degrees that can be changed. The OneDrill® can achieve a greater amount of angulation change since the design of the side-cut on the drill provides the capability of a lateral cutting function. This allows a higher amount of redirection of the osteotomy with a single drill.

As the OneDrill® proceeds through the osteotomy site, it essentially shapes the osteotomy bone into multiple steps of over-drilled and under-drilled areas due to the "step" shaped design and tapered body. These bony "steps" are the basis for "step-locking", the foundation for establishing primary stability with immediately placed threaded implants (Figure 4).

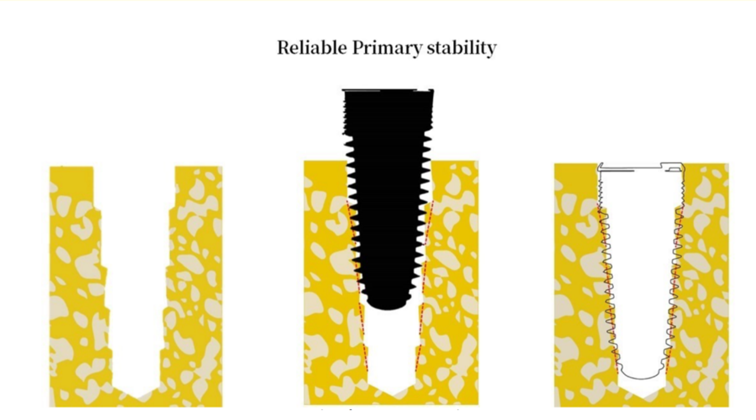

Figure 4: *The OneDrill® system shapes the osteotomy into multiple bony steps (left). These bony steps enable threaded implants to achieve predictable primary stability when the implant threads "lock" into the bony steps (middle). Note that step-locking occurs in those osteotomy areas that are under-drilled (right).*

The design of a dental implant consists of an inner body (main shape of the implant) and outer body (thread design of the implant). The inner body of the implant fixture, when placed, does not compress the under-drilled areas of bone (Figure 5). Step-locking occurs when the sharp, active threads and side cutting grooves present on the outer body portion of the implant (e.g. OsseoFuse HexaPlus™ dental implants) shave off a portion of the under-drilled autogenic bone during insertion. Insertion and torquing motion of the implant force the shaved-off, under-drilled autogenic bone powder up and into the over-drilled areas, thereby "step-locking" the implant into its optimal stability (Figure 6), and reducing compression of the bone in the under-drilled areas, resulting in pressure release.

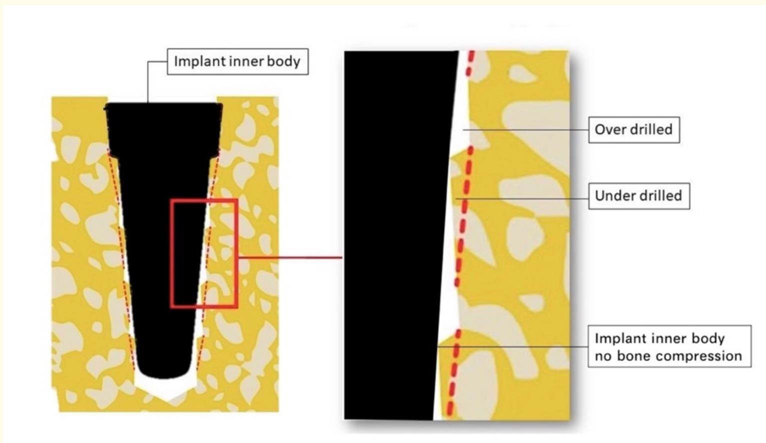

Figure 5: *Alternate illustration highlighting the completion of an OneDrill® osteotomy and the resulting "steps" in the bone created from over-drilled and under-drilled areas at each step. The inner body of the implant fixture-when placed-should not compress the under-drilled areas of bone.*

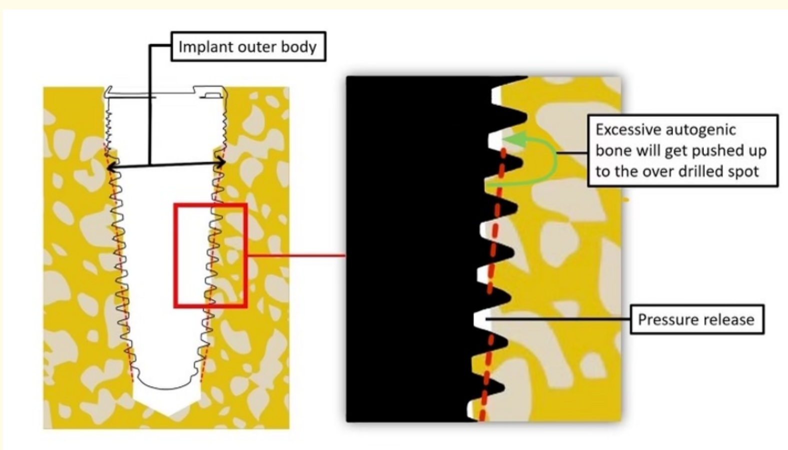

Figure 6: *Sharp, active threads with side cutting ability on the outer body portion of the implant shave off the under-drilled autogenic osteotomy bone during insertion, which is then forced and pushed up into the over-drilled osteotomy areas, thereby "step-locking" the implant into its optimal stability.*

Also contributing to step-locking and predictable primary implant stability is the way the implant side threads, cutting grooves, and cutting flutes complement and integrate with the OneDrill® unique osteotomy design. In fact, the side cutting flutes function like sharp threads to mechanically lock any bone in close contact with it, while the deep side grooves serve as a reservoir for the autogenic bone (Figure 7). In addition, the implant is generally a self-tapping implant which eliminates the need for the final drill (Figure 8).

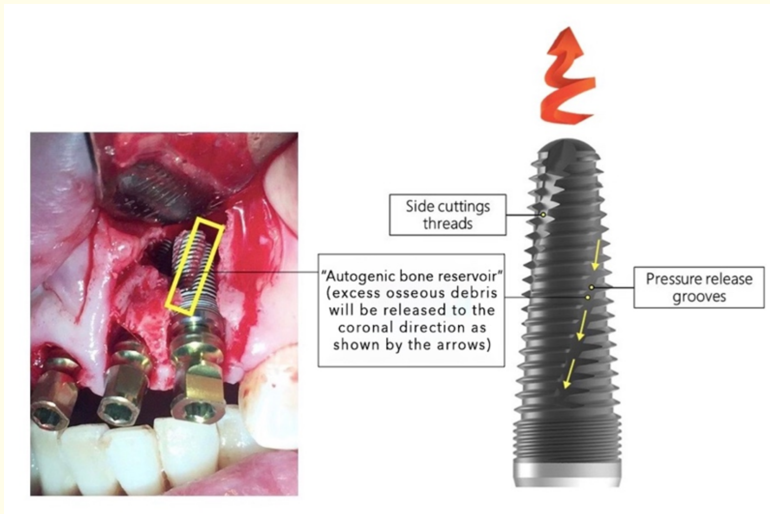

Figure 7: *The side cutting flutes of the dental implant (OsseoFuse® HexaPlus™) function similar to sharp knife threads that mechanically lock any bone in close contact with it, while the deep side grooves (yellow square) serve as a reservoir for the autogenic bone.*

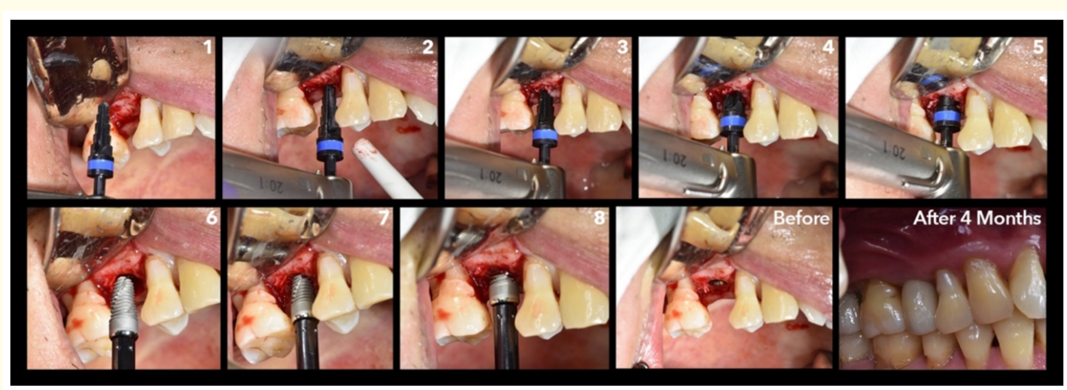

Figure 8: *Incorporating the OsseoFuse OneDrill® system enables clinicians to predictably and confidently place implants immediately following extraction, yet with shortened surgical chair-time and greater confidence. Without the need to change from a variety of drills with increasing diameters, patients benefit from less risk of postoperative infection, discomfort, and prolonged chair-time.*

Case Presentation #1

An 18-year-old male high school student presented after fracturing teeth #8, #9, and #10 in a motorcycle accident over the preceding weekend (Figure 9). A thorough examination was performed, including radiographs (Figure 10) and medical history and no indication that would contraindicate treatment.

Figure 9: *Close-up preoperative view of the trauma and injuries sustained to teeth #8, #9, and #10 as a result of a motorcycle accident.*

Figure 10: *Preoperative panoramic radiograph revealing extensive damage to teeth #8, #9, and #10, which were determined to be unsalvageable.*

All three affected anterior teeth were determined to be unsalvageable, but the patient was adamant about restoring those teeth to their ideal esthetics and function so that he could attend school as usual the following week. It was mutually agreed that the affected teeth would be extracted, and three titanium dental implants (e.g. OsseoFuse HexaPlus™ dental implants) would be immediately placed using the OneDrill® system. The selected implants have not only demonstrated a > 97% success rate, but they would also contribute to primary stability by maximizing the "step-locking" function of the OneDrill's osteotomy design [7].

Local anesthesia was administered. Care was taken to atraumatically remove the fractured tooth roots and clean out all residual root fragments and debris from the socket, and the healthy bone was detected using a periodontal probe.

The proper size of the selected implants was chosen, after which the corresponding size of the appropriate OneDrill® was also selected (e.g. 3.75 mm x 14.5 mm). Each osteotomy was immediately created, placing the corresponding implant, with the step-locking function enabling the implants to reach their optimal torque.

Once primary stability was achieved, only a minimal amount of xenograft material (Bio-Oss®, Geistlich Pharma North America, Inc.) was necessary to fill any remaining areas. Two interrupted, chromic gut sutures were placed for the purpose of achieving hemostasis. Provisional abutments were placed, and the patient was provided with immediate provisional restorations for #8, #9, and #10 (Luxatemp, DMG) (Figure 11).

Figure 11: *Atraumatic tooth extraction of #8, #9, and #10; OneDrill® osteotomy; immediate implant placement with primary stability achieved; and immediate provisionalization were all achieved at the initial presentation appointment.*

An immediate postoperative radiograph was taken (Figure 12), and the patient was dismissed with an immediate implant and acceptable fixed provisional treatment that enabled him to resume his daily routine. In addition, the flapless nature of the osteotomy and implant placement technique would enhance patient recovery as well as reduce the likelihood of morbidity and complications. After four months of healing (Figure 13), the patient returned for a final impression, and the definitive implant supported restorations were delivered the following week (Figure 14).

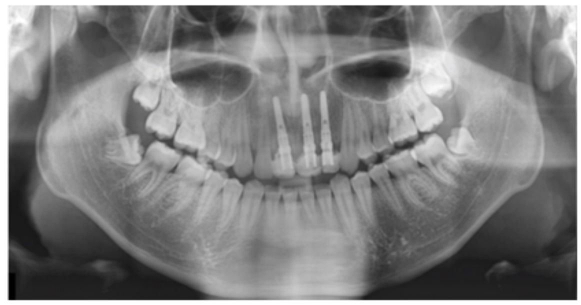

Figure 12: *Immediate postoperative panoramic radiograph of the implants that were immediately placed into fresh extraction sites with osteotomies created using the OneDrill® system.*

Figure 13: *Panoramic radiograph taken after five months of healing showing excellent integration.*

Figure 14: *The definitive restorations were delivered five months after implant placement.*

Case Presentation #2

A 38-year-old woman presented with a chief complaint of discomfort in her teeth that had previously undergone endodontic treatment, specifically teeth #7 through #10 (Figure 15). A thorough examination was performed, including radiographs and medical history. She was in overall good health, and nothing was found to contraindicate treatment.

Figure 15: *Close-up preoperative view of a patient who complained of discomfort in teeth #8 through #11, which had previously undergone endodontic treatment. The restorations on these teeth were broken and loose.*

The examination revealed that these teeth were affected by endo-periodontal lesions with some vertical root fractures on teeth #7, #8, and #9 (Figure 16). Additionally, the full-coverage crown and bridge restorations on these teeth were broken and presented mobility. After discussing these clinical findings with the patient, she agreed that she wanted these teeth replaced with four implants.

Figure 16: *Preoperative radiograph revealing failed endodontic treatment and broken posts-and-cores.*

Local anesthesia was administered. Care was taken to atraumatically extract teeth #7 through #10 with forceps. A curette was used to remove the granulomatous tissue, some of which (i.e. infectious tissue) had fenestrated through the buccal plate (Figure 17).

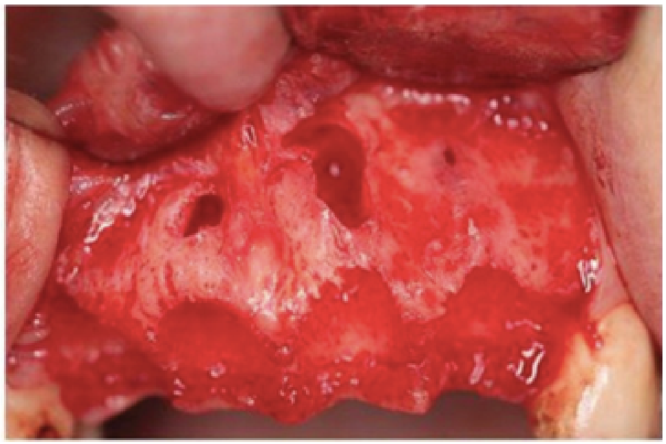

Figure 17: *View of the four fresh extraction sites cleaned of all granulomatous tissue.*

The proper size of the selected implants was chosen (e.g. 3.75 mm x 14.5 mm), after which the corresponding size of the appropriate OneDrill® was used to immediately perform an osteotomy in each socket. The chosen implants (e.g. OsseoFuse HexaPlus™ dental implants) were immediately placed and torqued to achieve primary stability (Figure 18).

Figure 18: *View of the immediately placed OsseoFuse HexaPlus™ dental implants at #8 through #11.*

Xenograft material (Bio-Oss®) was necessary to fill residual gaps remaining in the extraction sockets, as well as recessed buccal areas resulting from the fenestrations. Provisional abutments were placed, and the patient was provided with immediate provisional crown restorations for #7 through #10 (Luxatemp, DMG) that would restore esthetics, function, and preserve the gingival architecture all in the same visit (Figure 19).

Figure 19: *Immediate postoperative view of the provisionalized implants that were immediately placed into fresh extraction sites using the OneDrill® system.*

An immediate postoperative radiograph was taken (Figure 20), and the patient was dismissed. The patient returned in less than five months of healing for the definitive restorations, which have, as of this date, been providing exceptional function for more than 3 years (Figure 21).

Figure 20: *Immediate postoperative radiograph showing ideal placement and depth of the immediately placed implants.*

Figure 21: *Close-up clinical view three years after placement of the definitive restorations.*

Discussion

Advancements in dental implant armamentarium, materials, and techniques are helping clinicians optimize the treatments in which they provide to their patients by enhancing the predictability and efficiency. Single-drill systems and immediately placed implants are among the evolving devices and associated protocols that enable dentists to shorten dental implant treatment time, reducing the duration and discomfort associated with surgery, and achieve long-term stability. The introduction of the OneDrill® system represents a further refinement of this promising approach to immediate implant site preparation [7].

To date, several studies have been added to the dental literature over the past few years that suggest dentists' and patients' satisfaction with the clinical outcomes of treatments when various single-drill systems for immediate implant site preparation have been used [12,14]. Single-drill osteotomies are less invasive, have been shown to promote osseointegration, and have demonstrated higher levels of accuracy with or without the use of a surgical guide [14]. In fact, one report even noted that when experienced clinicians were performing single-drill compared to multiple-drill procedures, improved accuracy was observed without the use of a surgical guide [14].

With its initial drill tip and built-in stopper, the OneDrill® system minimizes potential angulation mistakes, and provides what functions as a safeguard. The stopper (safeguard) prevents the drill from accidentally over-penetrating into the bone and possibly injuring vital nerves and tissues. The OneDrill® demonstrated to be ideally paired with a surgical guide to prevent all potential mistakes with angulation and overpenetration simultaneously.

Fortunately, the design and structure of the OneDrill® not only accounts for drilling efficiency and implant stability, but also maintained the cellular integrity of the surrounding tissues by less heat generation during osteotomy. To account for heat generation, traditional multiple drill techniques use many drills with increasing diameter. Although the OneDrill® creates the desired final osteotomy using only one drill without skipping any steps of the traditional approach, the "stepped" nature of its design allows the OneDrill® to proceed in depth progressively without generating any additional heat. The staggered incremental increase in diameter on the OneDrill® mimics the increase in diameter concept used in the multiple drill system. Interestingly, the research suggests that a single-drill procedure could eliminate the thermal consequences typically associated with multiple sequential drilling [10]. Another study also concluded that using a single-drill protocol did not generate greater heat during implant site preparation compared to the traditional approaches using multiple drills of sequentially increasing diameter and, therefore, considered more safe [11]. The final osteotomy from the OneDrill® is identical to the multiple drill system, but with less trauma, less heat generation, "step-locking" and angulation change capabilities, being completed in a fraction of the time.

Of course, immediate and long-term stability of the implant complex affects the ultimate success of the treatment. Therefore, the characteristics and design of the osteotomies created by single-drill systems and the design of the implant itself also require consideration, including insertion torque [15], implant stability [15,16] and osteotomy quality [15]. Compared to the multiple-drill protocol, single-drill procedures have been shown to achieve significantly higher insertion torque values, implant stability, and osteotomy quality [14], all of which influence treatment stability, as well as whether or not an immediately placed and loaded implant will satisfy clinical and patient expectations. More importantly after one year, the survival rate for implants immediately placed and loaded in extraction sites drilled with a single-drill system has been shown to be 98.8%, with no biological or mechanical complications being reported [12].

Conclusion

Although comparative, long-term studies are needed to provide further support for the safety, predictability, and efficacy of the OneDrill® system, its proprietary design and protocol represent a revolutionary approach for completing rapid osteotomies and immediate implant placements that achieve primary stability. By combining all the components and functions of traditional multiple-sequence drills into one, including site marking, drill guiding, increasing diameter width, and safeguarding against violating ideal osteotomy depth, the OneDrill® allows dentists to focus exclusively on maintaining accurate angulation. The need to repeatedly change the drill throughout the implant procedure to slowly widen the osteotomy diameter is eliminated. Instead, a specific OneDrill®, which is coordinated to the length and diameter of the selected implant (e.g. OsseoFuse® HexaPlus™), embodies each step (or diameter) that would be needed from start to finish. Equally important, as the OneDrill® proceeds through the osteotomy site, its bone shaping creates and designs the areas that form the foundation for "step-locking" allowing an augmented primary stability for immediate implants. The result is greater predictability, efficiency, reduced procedural time and discomfort, and enhanced patient satisfaction.

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