Guided Selective Preservation of Tooth (SPOT) Protocol: Fully Guided Socket-Shield Technique

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Abstract: The socket-shield procedure focuses on soft- and hard-tissue preservation of the extraction socket in an immediate implant procedure. Selective preservation of tooth (SPOT) is a tooth-guided protocol for socket-shield preparation for both anterior and posterior teeth. It allows for consistent apex removal as well as shield preparation, implant site preparation, and immediate implant placement. The use of osseodensification burs in the guided SPOT protocol allows the clinician to incorporate a sequential clockwise rotation for simultaneous precise apex removal with shield preparation. In addition, a counter-clockwise operation is implemented for implant site preparation with compaction-autografting of bone and dentin into the alveolus trabecular bone to improve implant primary stability and, subsequently, early healing. Guided SPOT enables improved drilling accuracy, enhances reproducibility, and reduces chairside time through the implementation of two static surgical guides to produce two separate trajectories: one for guided apex removal and shield preparation and the other for guided implant site preparation. This facilitates the prefabrication of a provisional restoration or custom anatomical healing abutment. This article presents a fully guided protocol for the SPOT procedure and immediate implant placement for a single-rooted tooth.

The socket-shield technique is used to preserve the buccal bone in hopeless teeth.[1] Leaving the buccal portion of the root with its healthy periodontal ligament (PDL) attached in the alveolar process preserves the bundle bone and its blood supply, which prevents the collapse of hard and soft tissues.[2] PDL preservation and its microcapillary network connects the shield and provides a primary blood supply to the poorly vascularized cortical bone on the buccal and coronal aspects of the site. This technique can also be applied to maintain the interdental papillae height between two adjacent implants and/or an implant adjacent to a natural tooth.[3]

Any tooth that is to undergo the guided selective preservation of tooth (SPOT) protocol, as described in this article, should have an intact buccal plate, healthy PDL around the socket-shield root, no detectable tooth mobility, and adequate root dentin to maintain buccal shield integrity. In cases where the root length within the buccal bone is short, a wider shield with proximal extensions is recommended to increase the total socket-shield surface area that is in contact with the bone to stabilize the shield and maintain greater blood supply from the PDL. Extending the socket shield into the proximal areas is also proposed in sockets adjacent to an edentulous space.[4] In most cases, the socket shield should be reduced to bone level, and its thickness should be approximately 1.5 mm to 2 mm.[5]

In cases where the root socket is narrow, the implant's most outer threads may eventually come in direct contact with the socket shield. Previously published histological studies have shown that when the implant is in contact with the shield, bone fills the gap in the space between the shield and the implant, leading to ankylosis of the shield and osseointegration with the implant.[6]

Small periapical pathology is not a contraindication for immediate implant placement or the socket-shield procedure; however, in cases where the apical bone destruction is extensive and negates the ability to obtain adequate implant primary stability, a two-stage implant procedure should be performed.[7]

Osseodensification used for implant site preparation has been reported to preserve bone bulk and produce bone compaction-autografting and a subsequent springback effect, which leads to higher bone-to-implant contact and improved implant stability in comparison to standard drilling.[8-12] Osseodensification has shown to enhance implant short- and long-term success rates.[13,14] Bone bulk preservation around the implant can accelerate bone remodeling and optimize osseointegration.[15-17] High insertion torque value and faster bone remodeling achieved with osseodensification improves the predictability of immediate implant placement when compared to traditional extraction drilling.[18]

> Periodontal ligament preservation and its microcapillary network connects the shield and provides a primary blood supply to the poorly vascularized cortical bone on the buccal and coronal aspects of the site. This technique can also be applied to maintain the interdental papillae height between two adjacent implants.

The SPOT technique uses the tooth as a guide for the clinician to manage two separate drilling trajectories (as will be illustrated in this article).[19] For single-rooted teeth, the first hole trajectory is created to facilitate apex removal through the root canal and subsequently to achieve adequate shield thickness and length preparation. The second hole trajectory establishes the implant site preparation in a palatal or lingual position. In some cases, these two trajectories may overlap. The SPOT protocol can also be applied to posterior teeth, where several trajectories can be utilized.[20]

SPOT Protocol Vs Standard Technique

In the standard socket-shield technique, a mesial-distal slot/cut utilizing diamond burs is used to separate the buccal root portion and remove the remainder of the tooth with the root apex. This presents a risk of damaging adjacent tooth structure in some cases. Also, with the standard socket-shield technique the possibility of inaccurate drilling trajectories is a documented risk, which may lead to buccal or palatal bony wall apical perforation, shortened shield length, and ultimately the socket shield loosening.[21,22] A guided slot approach to remove the apex has been proposed, but it may require the use of additional static guides with several additional steps that could complicate the procedure.[23]

In the SPOT protocol the apex removal is initiated first by a pilot drill through the root canal passing the apex, and then the apex is completely removed with the use of osseodensification burs (Densah® burs, Versah, versah.com) operating in the clockwise (CW) direction. With the simultaneous management of the apex, the Densah burs' CW operation prepares the buccal shield length and thickness. Furthermore, the counterclockwise (CCW) operation of these burs during implant site trajectory preparation facilitates bone and dentin autografting, which further increases implant primary stability and enhances the implant's subsequent osseointegration.[19] After both trajectories' preparations, a mesial-distal split can be performed to achieve adequate palatal/lingual root segment removal.

While the SPOT technique is aimed at improving the operator's ability to manage both the shield preparation and implant site trajectories with high predictability guided by the tooth root canal and the presence of the palatal/lingual root segments during implant site preparation, a guided SPOT approach utilizing a C-guide (C-Guide sleeve, Versah) with vertical stops in incremental steps may further enhance the procedure accuracy.[24,25] The guided SPOT technique is a static, computer-assisted implant surgery approach utilizing two separate trajectories produced through two static surgical guides (Figure 1 and Figure 2). The first guide helps increase apex removal and shield preparation precision, and the second guide aids implant osteotomy preparation with bone and dentin autografting. This guided approach eliminates the need for an additional third guide. (Other instruments used for the guided SPOT approach are shown in Figure 3.) Digital preplanning allows for precise positioning of both the apex removal trajectory to enhance and secure better shield thickness and length and the implant site preparation trajectory to allow for implant placement with no pressure on the shield. Furthermore, digital preplanning and guided implant placement allows for the utilization of a prefabricated immediate provisional crown or individualized healing abutment, thereby reducing operational chairtime for both the patient and clinician.[26,27] An example case utilizing the guided SPOT technique is illustrated.

Guided SPOT Technique Step-by-Step

Planning

The procedure begins with the use of an implant guided surgery planning software. The digital imaging and communications in medicine (DICOM) files of cone-beam computed tomography (CBCT) scans are merged with intraoral surface scans of the patient, who in this case presented with a hopeless maxillary right lateral incisor (Figure 4).

Next, the planning software is used to attain four required measurements (Figure 5): (1) root length in the bone, (2) the distance from the gingival margin to the buccal bone, (3) alveolar bone length, and (4) alveolar bone width. Figure 6 outlines the implant, temporary abutment, surgical guide, and temporary crown—both in 2D and 3D visualization through intraoral scan.

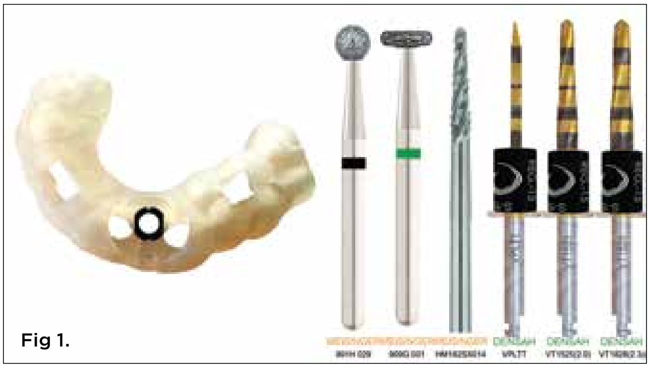

Fig 1.

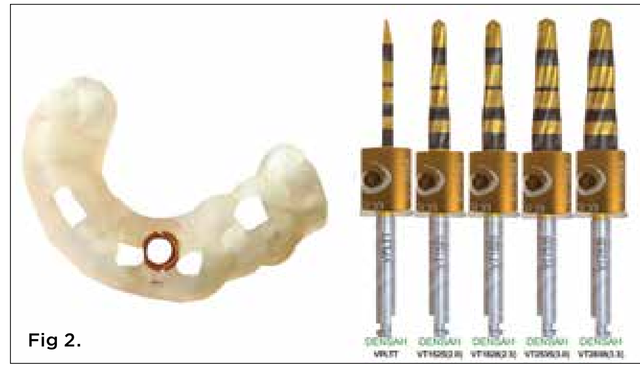

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Fig 3.

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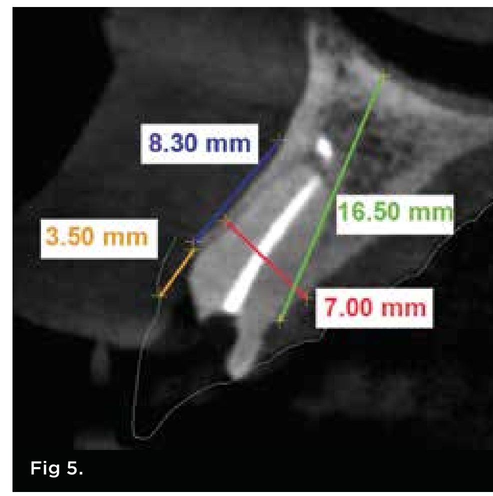

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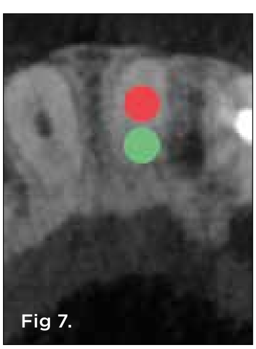

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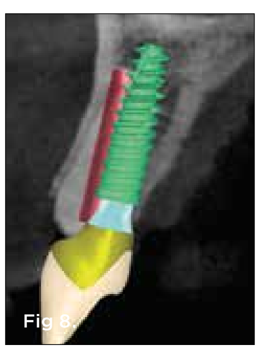

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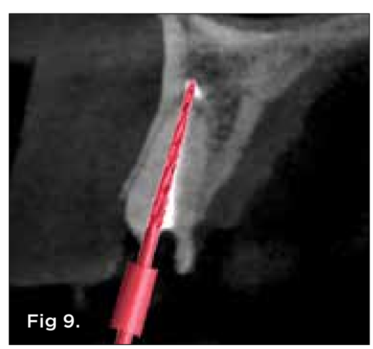


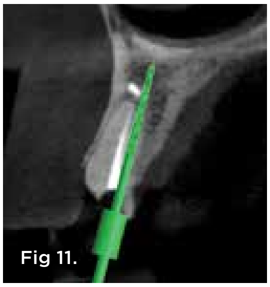
Fig 9.

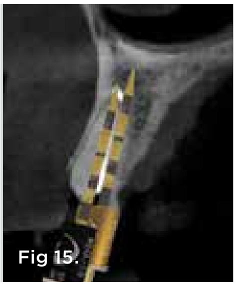
Fig 10.

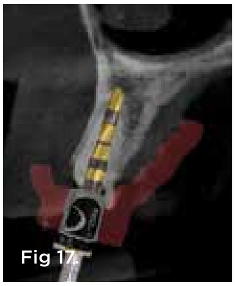
Fig 1. Static Guide One with small C-guide sleeve (left); apex removal and socket-shield preparation instruments (right), including guided osseodensification burs equipped with small gauge and G-stop. **Fig 2.** Static Guide Two with medium C-guide sleeve (left); implant site preparation instruments (right), including guided osseodensification burs equipped with medium gauge and G-stop to prepare the implant site. **Fig 3.** Mesial-distal split and shield preparation instruments. **Fig 4.** Initial presentation, facial view. Maxillary right lateral incisor had hopeless prognosis due to subgingival caries and horizontal fracture of the crown. **Fig 5.** Initial diagnostics CBCT with the four measurements for SPOT: root length in the bone (blue line), distance from the gingival margin to the buccal bone (yellow line), alveolar bone length (green line), and alveolar bone width (red line). **Fig 6.** Digital guided treatment plan of the SPOT two trajectories: apex removal trajectory and implant site trajectory. **Fig 7 and Fig 8.** Guided SPOT digital planning: Fig 7: Occlusal view with two trajectories—apex removal trajectory (red) and implant site trajectory (green). Fig 8: Custom figure (red) representing Densah bur VT1828 (2.3) dimension depicting trajectory one for complete apex removal/shield preparation; final implant position (green) trajectory two; titanium abutment (blue), temporary crown with emergence profile, and custom implant position planned. **Fig 9 and Fig 10.** Static Guide One plan: produce apex removal and socket-shield preparation guide using the small C-guide with guided pilot (Fig 9) and Densah burs VT1525 and VT1828 (Fig 10).

The next step of the planning stage entails three phases: the first static guide planning, the second static guide planning, and the temporary restoration design:

Static Guide One planning (apex removal trajectory with socket-shield preparation guide): The custom outline of the shape of Densah bur VT1828 (2.3) is positioned along the root canal surpassing the apex of the tooth; alternatively, an implant with a comparable outline is selected from the software database. The silhouette should engage the socket shield to remove any remnants of endodontic filling gutta percha (if present). This will produce







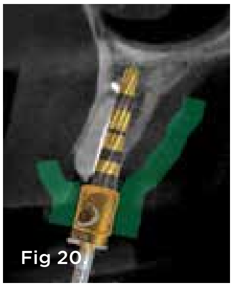


Fig 11 and Fig 12. Static Guide Two plan: produce implant site preparation guide using the medium C-guide with guided pilot (Fig 11) and Densah burs VT1525, VT1828, and VT2535 (Fig 12). **Fig 13.** Step 1: High-speed 3-mm diameter diamond bur (Meisinger 801H-029) is used to hollow out the middle of the tooth. **Fig 14.** Step 2: Diamond wheel bur (Meisinger 909G-031) is used to establish the restorative zone and flatten the root to bone level. **Fig 15.** Step 3: Two guided pilot hole trajectories are planned and executed using two separate static guides with guided Densah pilots. The root canal pilot trajectory is initiated with a high-speed bur (Meisenger HM162SX-014) to clear root canal contents and remove any filling material. Subsequently, the first static guide with a small C-guide (root canal/apex removal guide) is used with a guided Densah pilot equipped with a small gauge and G-stop operating in CW mode at 1,000 to 1,100 rpm with adequate irrigation to establish the first trajectory. The second static guide (implant guide) with a medium C-guide is used with a guided Densah pilot equipped with a medium gauge and G-stop operating in CW mode at 1,000 to 1,100 rpm with adequate irrigation to establish the implant site pilot trajectory. **Fig 16.** Clinical view of the two pilot trajectories achieved in Fig 15. **Fig 17 and Fig 18.** Step 4, apex removal trajectory: The first static surgical guide (apex removal and socket-shield preparation guide) using a small C-guide (Fig 17). Guided Densah burs VT1525 (2.0) and VT1828 (2.3) equipped with small gauge and G-stop are used with the first static surgical guide in CW mode at 1,000 to 1,100 rpm with adequate irrigation to further widen the root canal pilot hole and completely remove the apex (Fig 18). **Fig 19.** Apex removal is confirmed by radiograph. **Fig 20 and Fig 21.** Step 4, implant site preparation trajectory: The second static surgical guide (implant site instrumentation guide) digital design using a medium C-guide (Fig 20). Guided Densah burs VT1525 (2.0) and VT1828 (2.3) equipped with medium gauge and G-stop are used with the second static surgical guide in CW mode at 1,000 to 1,100 rpm with adequate irrigation to further prepare the implant site osteotomy. Subsequently, guided Densah bur VT2535 (3.0) equipped with medium gauge and G-stop (Fig 21) is used in CCW mode at 1,000 to 1,100 rpm with adequate irrigation to allow for bone and dentin particles autografting into the alveolar trabecular space. A post–implant site preparation radiograph (not shown) is then taken.

the first hole (root canal trajectory) achieving both complete apex removal with subsequent complete root canal content removal and socket-shield preparation (Figure 7 and Figure 8, Figure 9 and Figure 10).

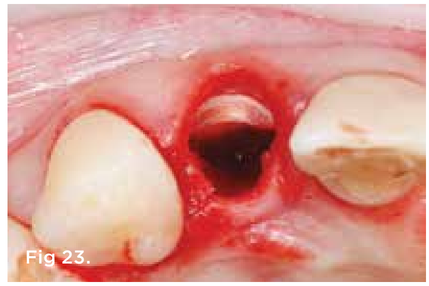
Static Guide Two planning (implant site trajectory preparation guide): The 3D final implant position is planned in the software such that the implant is placed in a palatal position and allows for adequate restorative space. Also, adequate space is provided between the implant and socket shield to prevent any possible contact or pressure between the implant threads and the socket shield (Figure 7 and Figure 8, Figure 11 and Figure 12). In some cases, the two hole trajectories may overlap, which dictates to plan the implant osteotomy and placement 2 mm to 3 mm deeper than the apex removal trajectory to achieve primary stability.

Temporary restoration design: The temporary restoration is designed in a computer-aided design (CAD) software to match the abutment and implant position. The patient's existing crown, if adequate, can be used as a reference.

Surgical Procedure

The surgical procedure is carried out in seven steps, as follows[19]:

Step 1 – Hollow out the tooth center: After crown removal, a



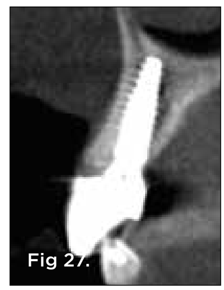


Fig 22. Step 5: A carbide bur (Meisinger HM34IL-012, shown in Fig 3) is used to create a mesio-distal root split prior to the removal of the palatal segment. **Fig 23.** Step 5, cont'd: Socket-shield height is reduced to the bone level approximately 2 mm to 3 mm subgingivally using bur (Megagen 3DD50). Subsequently, shield thickness is reduced to 1.5 mm to 2 mm with burs (Megagen 2DD3034 and 1DD1911), and an internal coronal chamfer is created using a diamond shaping bur (Megagen GD40G). (These burs are shown in Fig 3.) **Fig 24.** Step 6: Implant placed through the second static guide (implant site guide). (Biomaterial would subsequently be used to graft the jumping gap.) **Fig 25.** Implant placement is confirmed by radiograph. **Fig 26.** Step 7: A prefabricated screw-retained provisional restoration is placed to seal the socket and maintain proper emergence profile. **Fig 27.** Passive fit of the implant restoration is confirmed radiographically. **Fig 28.** Healing at 4 months postoperative after removal of the temporary crown for final crown fabrication, frontal view. Note adequate soft- and hard-tissue volume with maintained interdental papillae. **Fig 29.** Final crown in place. **Fig 30.** One-year postoperative CBCT image with the final restoration. **Fig 31.** One-year clinical postoperative final crown restoration. Note maintained soft- and hard-tissue volume.

3-mm round diamond bur (Meisinger 801H-029, Meisinger, meisingerusa.com) is used to hollow out the center of the tooth approximately 3 mm subgingivally, leaving approximately a 1-mm dentin ring around the circumference of the root (Figure 13).

Step 2 – Establish the restorative zone: The restorative zone is created using a diamond wheel bur (Meisinger 909G-031) to flatten the root to bone level working from the inside to outside. A curve from the mesiodistal aspect should be followed to preserve interproximal bone. During flattening, the outer dentin ring is separated and removed (Figure 14).

Step 3 – Establish two pilot hole trajectories: A guided Densah pilot equipped with a gauge and G-stop (Versah) is used through the C-guide to establish two separate pilots' trajectories: one for apex removal and the second for the implant osteotomy (Figure 15 and Figure 16).

Pilot hole one establishes the apex removal trajectory through the root canal. A high-speed bur (Meisinger HM162SX-014) is used to clear root canal content and remove any filling material. A Gates Glidden bur (#2 and #4) may also be used. After root canal content is removed, the guided Densah pilot equipped with a small gauge and G-stop is used through a matching-sized small C-guide to clear the apex. If any foreign material is present beyond the apex, drilling with a longer pilot drill is performed in the first pilot hole.

Pilot hole two establishes the implant trajectory in a lingual or palatal position from the first hole (Figure 7) A guided Densah pilot equipped with a medium gauge and G-stop is used through a matching-sized medium C-guide to start the implant site trajectory. In some cases, the two pilot holes may eventually overlap.

Step 4 – Widen both pilot hole trajectories: Apex removal trajectory: Static C-guide one is utilized with the small C-guide and guided Densah burs VT1525 (2.0) and VT1828 (2.3), equipped with a small gauge and G-stop, operating in CW (clockwise) mode at 1,000 to 1,100 rpm with irrigation. Guided Densah burs are advanced approximately 1 mm past the apex to widen the root canal hole trajectory and to achieve complete apex removal. The last guided Densah bur (VT1828 (2.3)) in this step is used to further prepare the shield to produce a semilunar shape and to completely remove any remaining root canal content. A radiograph is taken to verify complete removal of the apex and all filling materials (Figure 17 through Figure 19). All apical infection must be removed to secure osseointegration.[28]

Implant site preparation trajectory: Static C-guide two is utilized with the medium C-guide and guided Densah burs VT1525 (2.0) and VT1828 (2.3), equipped with a medium gauge and G-stop, operating in CW (clockwise) mode at 1,000 to 1,100 rpm with adequate irrigation to widen the implant osteotomy. For the final osteotomy preparation, guided Densah bur VT2535 (3.0) is subsequently used at 1,000 to 1,200 rpm with adequate irrigation in CCW (counterclockwise) mode. This allows for bone and dentin particles compaction-autografting apically into the alveolar trabecular bone space (Figure 20 and Figure 21).

Step 5 – Root split and further socket-shield preparation: A long shanked tapered bur (Meisinger HM34IL-012) is used to create a mesial-distal split with caution taken to not impinge on the implant osteotomy and to preserve adjacent bone (Figure 22). After extracting the palatal root section remnants, the buccal shield height is reduced to be approximately 2 mm to 3 mm subgingival using a designated shaping bur (Megagen 3DD50, Megagen, imegagen.com). Afterward, socket-shield shaping and preparation is performed using diamond burs (Megagen 2DD3034 and 1DD1911) (Figure 23). The Megagen GD40G bur is used to create a coronal "S"-shaped restorative space. (Root split and shield shaping burs are showed in Figure 3.)

Step 6 – Implant placement: Static C-guide two is used to place the implant into the preplanned position (Figure 24 and Figure 25). Grafting the jumping gap is necessary if and when the gap is larger than 1 mm to 2 mm. If a wider-diameter implant placement is needed, a wider guided Densah bur (VT2838 (3.3)) is used with the surgical guide to further widen the implant site osteotomy.

Step 7 – Restorative step: A prefabricated temporary screw-retained crown or individual healing abutment is placed (Figure 26 and Figure 27).

The results of the present case, from 4 months postoperative, to final crown delivery, to 1-year follow-up, are depicted in Figure 28 through Figure 31.

Discussion

In the original socket-shield procedure, standard implant burs are used to remove the apex and create a palatal osteotomy for the implant bed.[1,29,30] These drills tend to generate significant chatter and may produce shield microfracture or mobility and possible eventual shield failure.[31] To reduce the risk of root/shield fracture, the technique was subsequently updated with a mesial-distal root split to clear the apex prior to socket-shield preparation.[32] The technique was further improved with the use of Gates Glidden drills to reach the apex prior to the mesial-distal split, but this still did not provide predictable complete apex removal.[31] Therefore, it was determined that a dynamic navigation system or a guided approach with multiple static surgical guides was needed to achieve apex removal, mesial-distal root split, and implant site preparation.[33,34] Although effective, these techniques require significant planning, surgical skills, multiple guides for each step, and extended chairtime. Other approaches proposed to fabricate an additional static guide for the socket-shield preparation and to remove endodontic obturation materials.[35]

The SPOT technique utilizes trajectories for two independent holes: one trajectory for root canal preparation that clears the root canal contents and removes the apex, and the second trajectory for adequate implant site preparation and placement. Both trajectories start with a narrow pilot that is expanded further with osseodensification burs used in both the CW direction to precisely cut into dentin to remove the apex and prepare the shield thickness and length, and the CCW direction (osseodensification mode) to prepare the implant site with autografting of both dentin and bone to help achieve adequate implant early stability.[9,19] Histological studies have demonstrated that dentin graft progressively remodels into native bone over time.[36,37] Histological analysis of dentin grafted sites prepared with osseodensification for implant placement has shown more than 64% of direct bone-to-implant contact after 16 weeks without any dentin particles in contact with the implant.[38]

> "A guided SPOT approach utilizing a C-guide with vertical stops in incremental steps may further enhance the procedure accuracy. The guided SPOT technique is a static, computer-assisted implant surgery approach utilizing two separate trajectories produced through two static surgical guides.

The use of the Densah burs in the SPOT procedure provides a favorable guided approach because the need for a mesial-distal root split for apex removal is eliminated. In guided SPOT, the osseodensification burs provide less vibration than regular implant drills, which may reduce the risk of both shield and trabecular bone fracture.[8,10,15,19] Digital planning of the shield shape and length provides simplicity and, furthermore, increases accuracy of the apex removal and shield preparation through use of the first static guide and enables adequate implant site preparation through use of the second static guide. The universal guided kit for the Densah burs allows the clinician to use the surgical keys in incremental steps (eg, 5 mm, 10 mm, 15 mm, etc.), which increases the level of guidance and improves accuracy.[24]

Through the first static guide (apex removal guide), Densah burs VT1525 (2.0) or/and VT1828 (2.3) are used in CW cutting mode

(1,000 to 1,100 rpm) with adequate irrigation to further clear the root canal content with root apex removal and subsequently create a semilunar shield preparation. This allows complications regarding short shields to be managed by extending the shield interproximally to increase the shield-to-bone surface area, which may preserve the interproximal papillae in complex situations.[3] Through the second static guide (implant trajectory guide), Densah burs with adequate diameter according to the planned implant diameter are utilized in osseodensification mode (ie, CCW) (1,000 to 1,100 rpm) with adequate irrigation to prepare the implant site in the preplanned position with compaction-autografting of bone and dentin to help achieve early implant stability.[9,19]

Conclusion

Guided SPOT is a static guided surgery for the socket-shield procedure. It utilizes two static guides to create two precise pilots' osteotomies. These pilots' osteotomies are then expanded using osseodensification burs in cutting mode (CW direction) to remove the apex and further prepare the shield length and thickness, and then used in the osseodensification mode (CCW direction) to compact-autograft bone particles and dentin into the trabecular space enhancing the immediate implant primary stability. While this article presented the guided SPOT protocol for a single-rooted anterior tooth in the esthetic zone, the same principles may also be applied to multirooted teeth.

DISCLOSURE

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