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Seminars in
ORTHODONTICS

Miniscrew Implants: The Spider Screw Anchorage System

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The stability of the anchorage unit plays an important role in orthodontic tooth movement. Controlled orthodontic tooth movement, such as retraction or intrusion, is difficult to achieve without causing undesirable movement of the anchorage unit. This article describes characteristics, surgical procedure, and clinical use of the Spider Screw® (HDC Company, Sarcedo, Italy, hdc@goldnet.it), as a nondental and noncooperation-based anchorage system.
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The Spider Screw®

In orthodontic mechanotherapy, even a small reactive force can cause undesirable tooth movement.[1,2] Consequently, it is important to have dependable stability in the anchorage unit that supports the forces selected to move the dental units. Any uncontrolled reactive forces can have a negative effect on the outcome of the orthodontic treatment of a malocclusion. Many traditional anchorage systems are dependent on patient cooperation and, consequently, they have unpredictable success rates. Titanium miniscrews may be an ideal anchorage system that fulfills the clinical needs of the orthodontist.[3-7] Some of their benefits include dependability, are well accepted by patients, can be immediately loaded, are simple to insert and remove, and conform to the anchorage needs of the orthodontist.

The Spider Screw® (HDC Company, Sarcedo, Italy, hdc@goldnet.it) is a self-tapping, commercially pure titanium miniscrew. The screw can be loaded immediately with forces in the range of 50 to 300 g. Complete osseointegration is neither expected nor desired with this anchorage system. The Spider Screw® anchorage system can be used to support a variety of orthodontic tooth movements in clinical situations involving mutilated dentitions, poor cooperation, or extraction cases requiring maximum anchorage.

This system is available in either 1.5- or 2.0-mm diameters. The 1.5-mm diameter screw comes in 6.0-, 8.0-, or

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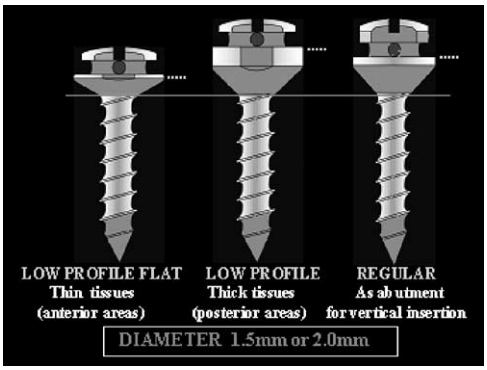

Figure 1 Different heights of Spider Screw® head and collar.

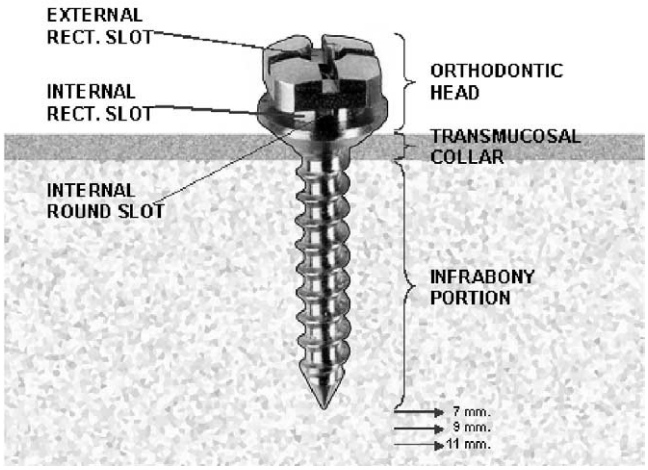

Figure 2 Spider Screw® characteristics.

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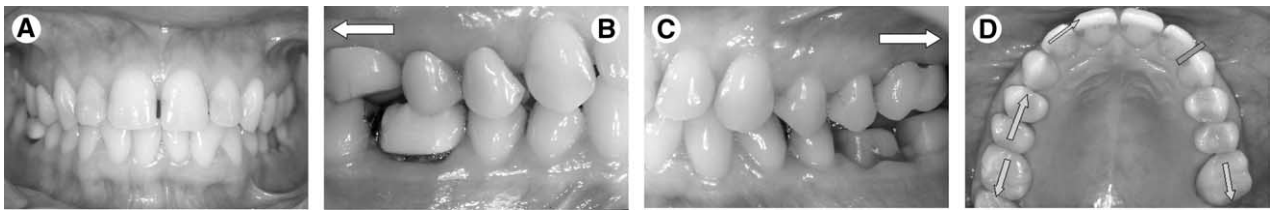

Figure 3 Patient with upper midline deviation and anterior spacing. (A) Anterior. (B) Right buccal; note Class III canine. (C) Left buccal; note Class I canine. (D) Maxillary occlusal.

Figure 4 Orthodontic appliance with anchorage provided by Spider Screw® on left side. (A) Right buccal. (B) Left buccal. (C) Maxillary occlusal.

10.0-mm lengths, while the 2.0-mm diameter screw comes in 7.0-, 9.0-, or 11.0-mm lengths. Spider Screws® are dispensed in prepackaged, sterile, mono-use envelopes.[8,9] Both diameters are available in three different transmucosal designs to accommodate the soft tissues—low profile, low profile flat, and regular (Fig 1). The low profile screw has a longer transmucosal collar combined with a flat head and is utilized in the thick soft tissues of posterior segments, the low profile flat screw has the same head combined with a short collar and is indicated in the thin tissue of the patient's anterior segments, and the regular design has an intermediate length with a raised head, and when combined with a resin core can be used as a temporary prosthetic abutment.

The head of the Spider Screw® is designed with internal and external rectangular slots 0.021 × 0.025 inch in size. It also has a round internal vertical slot 0.025 inch in diameter (Fig 2). The extramucosal head of the screw is small enough to avoid soft tissue irritation yet large enough to accommodate orthodontic attachments.

Treatment Planning

Every treatment plan requires careful evaluation of the forces necessary to elicit the desired movements as well as the anchorage necessary to support these forces. The most frequently used anchorage systems involving extraoral traction or intraoral elastics are associated with several problems. For example, intraoral elastics cause undesirable effects,[10] and necessitate appliance placement in the lower arch even when not required by the treatment objectives. In addition, both are dependent on patient cooperation. Moreover, many adults avoid orthodontic treatment due to aesthetic requirements of conventional anchorage. Skeletal anchorage provides a solution to achieve sagittal and vertical movement without cooperation and without compromise of the final orthodontic results. It also allows appliance placement in one arch or one segment only.

Treatment planning must include a careful choice of miniscrew location. The placement location will enable the clinician to control or effect extrusive and intrusive movements of teeth. The placement of the Spider Screw® requires a location that has sufficient bone depth to accommodate the miniscrew and at least 2.5 mm of bone width to protect the anatomic structures.[4,8,9] Sites of choice include the maxillary tuberosity, the mandibular retromolar area, edentulous areas, interdental sites, the palatal vault, and the alveolar processes above the root apices in the anterior region.

For example, a patient presented with an upper dental midline discrepancy to the right side and an interincisal diastema (Fig 3). The treatment plan was designed to close the diastema while reopening space for the missing upper 1st molar to achieve a bilateral Class I canine relationship. Skeletal anchorage became the option of choice as the patient rejected both extraoral traction and lower arch appliances. The maxillary right 3rd molar was extracted and anchorage was provided by insertion of a Spider Screw® in the residual space between the maxillary left 2nd premolar and left 2nd molar. The Spider Screw® was used as indirect anchorage in this case. A 0.012-inch metal ligature extending from the Spider Screw® to the upper left

Figure 5 Posttreatment intraoral photographs. (A) Anterior. (B) Right buccal. (C) Left buccal.

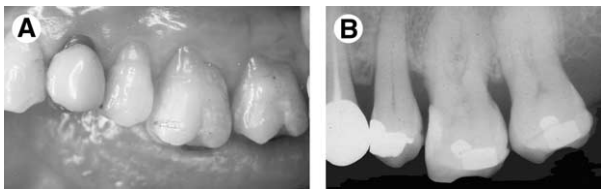

Figure 6 Overerupted maxillary posterior teeth before treatment. (A) Left buccal. (B) Periapical x-ray.

canine resisted the forward movement of the canine from the compressed open coil spring (Fig 4). On the patient's right side, a compressed open coil spring was employed to distalize the 2nd molar while the reactive force corrected the Class III premolar and canine relationship and shifted the upper midline as the diastema closed (Fig 5).

Miniscrews should be incorporated into treatment planning when it is difficult to achieve the desired results with traditional anchorage. They are particularly useful in adult cases when there are compromised periodontal conditions or partial edentulous arches. They are also useful for molar intrusion since intruding extruded molars can create undesirable effects in open bite cases.[11]

A patient presented with a malocclusion characterized by supereruption of the upper left 2nd premolar, 1st molar, and 2nd molar toward the edentulous ridge in the lower left quadrant (Fig 6). This supereruption created an aesthetic problem and precluded the possibility of prosthetic treatment in the lower left quadrant. Anchorage for intrusion in the upper left quadrant was provided by two Spider Screws®. One was placed in the interradicular septum between the maxillary left 1st and 2nd premolars and a second was inserted distal to the upper left 2nd molar. The segmental orthodontic appliance consisted of brackets with a sectional 0.016 × 0.022-inch arch wire. Two 150-g Sentalloy coils from the Spider Screws® to the appliance were used to initiate intrusion. (Fig 7). In the final 2 months of treatment, a bracket was placed on the upper left 2nd premolar for intrusion using an elastic from the mesial Spider Screw®. Appliance placement was limited to three teeth in the maxillary left quadrant to achieve the

Figure 7 Orthodontic intrusion anchorage system.

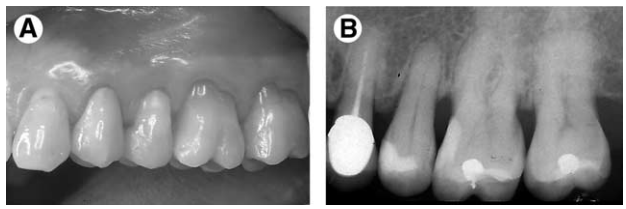

Figure 8 Posttreatment photographs. (A) Left buccal. (B) Periapical x-ray.

desired results (Fig 8). Routine home care and periodic professional hygiene with scaling and root planning were performed during the orthodontic treatment.[12]

Presurgical Orthodontics

Although temporary anchorage device (TAD) placement usually does not require presurgical orthodontics, it may be necessary to orthodontically diverge roots to create adequate space for interradicular placement in some cases. For example, in select cases with class II malocclusions, the maxillary 1st molars are distalized into super Class I positions before miniscrews are placed mesial to the 1st molars. The mini screws are then used as anchorage for retraction of the remaining teeth.

Surgical Procedure

The surgical armamentarium for Spider Screw® insertion includes a low-speed contra angle hand piece, a bur with a depth stop, and a hand screwdriver. During surgical planning, the surgical site and screw length are determined. Every effort must be made to avoid contact with local anatomical structures. A site locator can be fabricated from resin and orthodontic wire and utilized to determine the insertion position of the screw in the bone (Fig 9A). Long cone radiographs are taken to visualize the site locator relative to the delicate anatomical structures (Fig 9B). Each screw length corresponds to a bur with a depth stop of equal length. Under local anesthesia, a pilot drill is used to create a 1.2 or 1.5-mm diameter pilot hole (Fig 10A). A speed of 60 to 100 rpm is maintained to be able to feel the transition from cortical bone to medullary bone as well as to minimize bone overheating. Ample saline solution or water is employed to cool the site. If necessary, a small 5-mm incision can be made in mobile mucosa before plac-

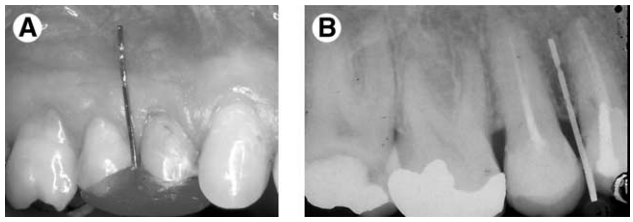

Figure 9 Miniscrew placement guide. (A) Surgical guide. (B) Radiographic evaluation of intended screw placement site.

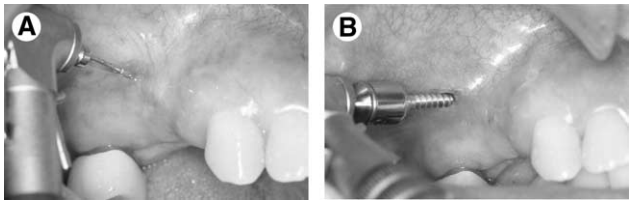

Figure 10 Miniscrew placement protocol. (A) Pilot hole preparation with 1.5-mm drill. (B) Spider Screw® insertion with low speed contra angle handpiece.

ing the pilot hole. Finally, the screw is inserted into the site at a velocity of 20 to 30 rpm (Fig 10B) avoiding excessive force that might fracture the miniscrew (40 Newton cm^2 [Ncm^2]). Because the screw at the beginning is maintained only by mechanical retention, it should be placed perpendicular to the direction of the applied forces. If it appears that the bone support is inadequate, it is advisable to use a longer screw to reach the opposite cortical plate.

If the screw has minor mobility, light forces applied immediately[5] often cause a slight inclination of the miniscrew in the bone and favors better stabilization. After the screw is inserted, a 0.2% chlorhexidine rinse is advised for the next 7 days. The anatomy of the Spider Screw® transmucosal collar facilitates home care oral hygiene.

It is recommended that the Spider Screw® be inserted under the direction of an orthodontist or by the orthodontist directly. The placement of the screw is mandated by the orthodontic requirements and if it must be relocated due to osseous conditions, the new site is best determined by the orthodontist.

Orthodontic Mechanics

The Spider Screw® is connected to the teeth by forces attached to the orthodontic screw head. When spring forces are placed on the Spider Screw®, it is best to secure them with a metal ligature attached to the vertical slot to avoid accidental detachment. The internal rectangular slot also helps to maintain elastic and ligature ties away from the soft tissues and avoids trauma to them. Forces applied to the miniscrew can vary from 50 to 200 *g* and, occasionally, 300 *g* depending on the quantity of bone and the desired orthodontic movements.[8,9,11]

Miniscrew anchorage can be direct or indirect. In Class II noncooperative patients, indirect anchorage is generally used at the beginning. For example, in a Class II patient (Fig 11) two Spider Screws® (1.5 mm diameter) can be inserted mesially to the upper 1st molars after distalization of the molars to a Class I relationship. In this case, the Spider Screws® are used to retract the teeth anterior to the created space.

A 0.016 × 0.022-inch rectangular wire with stops mesial to the first molars and hooks mesial to the canines was inserted. On the right side, a metal ligature was placed from the miniscrew to the canine and a 150-*g* Sentalloy coil spring was placed between the 1st and 2nd premolars to distalize the 2nd premolar (Fig 11D). On the left side a metal ligature was placed to the hook and a 150-*g* Sentalloy coil spring was extended from the molar to the canine.

Spider Screws® also offer reliable direct anchorage for the retraction of groups of teeth or individual teeth (Fig 12). To retract and simultaneously intrude teeth, miniscrews can be located above the occlusal plane. There is a tendency for buccal inclination of the clinical crowns as intrusion is attempted. Control can be achieved by torquing archwires or with transpalatal bars. As an alternative, crown control can be maintained by the placement of a palatal miniscrew and the application of palatal and vestibular forces simultaneously (Fig 13).

Precise rapid intrusion and orthodontic movement can be

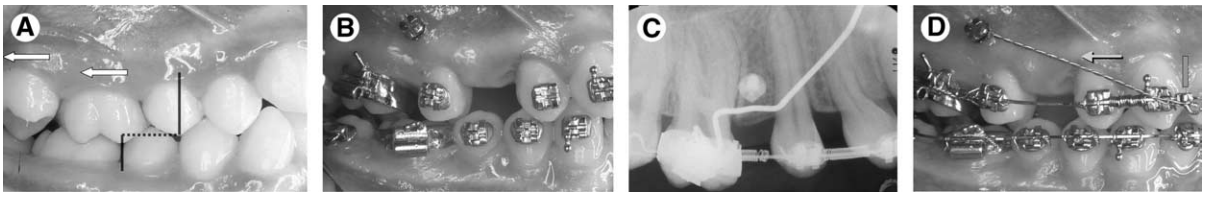

Figure 11 Indirect anchorage from Spider Screw®. (A) Right buccal with Class II malocclusion. (B) Right buccal with Spider Screw® inserted after upper 1st molar distalization. (C) Bitewing x-ray. (D) Upper right canine ligated to Spider Screw® to distalize 1st premolar.

Figure 12 Direct anchorage from Spider Screw® to retract anterior teeth. (A) Anterior. (B) Right buccal. (C) Left buccal.

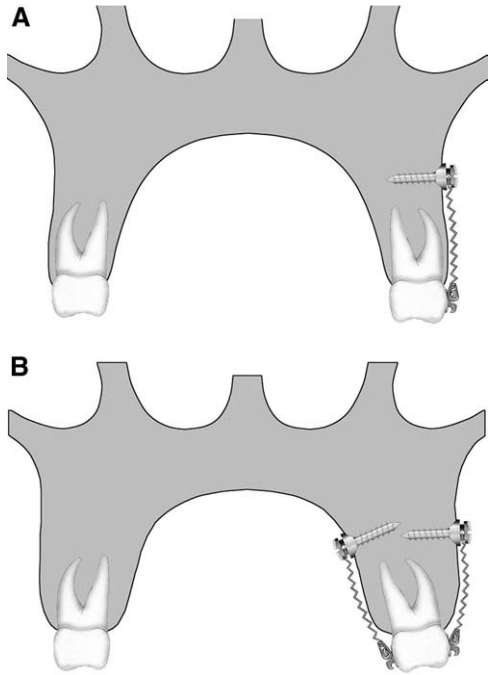

Figure 13 Torque possibilities with Spider Screw®. (A) Buccal tipping during intrusion. (B) Pure intrusion using buccal and lingual screws.

effected by using proper forces and anchorage (Fig 14). It is important, however, to eliminate any inflammation, eliminate pockets, and establish a sound periodontal environment before intrusion is attempted. Good home care, professional cleaning, and scaling and root planning are necessary during orthodontic therapy.[13-15]

The regular Spider Screw® (2 mm) can be used in an edentulous area as anchorage and as a provisional prosthesis simultaneously (Fig 15). For example, in a Class II malocclusion characterized by a missing upper right 2nd premolar and a 1st molar, a temporary bridge extended from the maxillary right 1st premolar to the maxillary right 2nd molar. The maxillary right lateral incisor was rotated and a carious lesion was present on its distal surface (Fig 16). The treatment plan was to create a Class I canine relationship by retracting the upper right canine and then rotating the lateral incisor so it could be properly restored. The bridge was removed and a long Spider Screw® was inserted into the edentulous ridge at the 2nd premolar level (Fig 17) where it served as an abutment for a temporary bridge in the upper right quadrant. Brackets were placed on the upper teeth and a segmental 0.016 × 0.022-inch SS wire was inserted. The upper right 1st premolar and canine were retracted by 150-*g* elastic forces applied on the buccal and palatal surfaces. The upper right lateral incisor was then rotated into proper alignment. At the completion of orthodontic treatment, the Spider Screw® was removed and the final prosthetic reconstruction was placed (Fig 18).

Removal Procedure

Spider Screw® anchorage is not dependent on osteointegration. One study has demonstrated that 2-mm-diameter

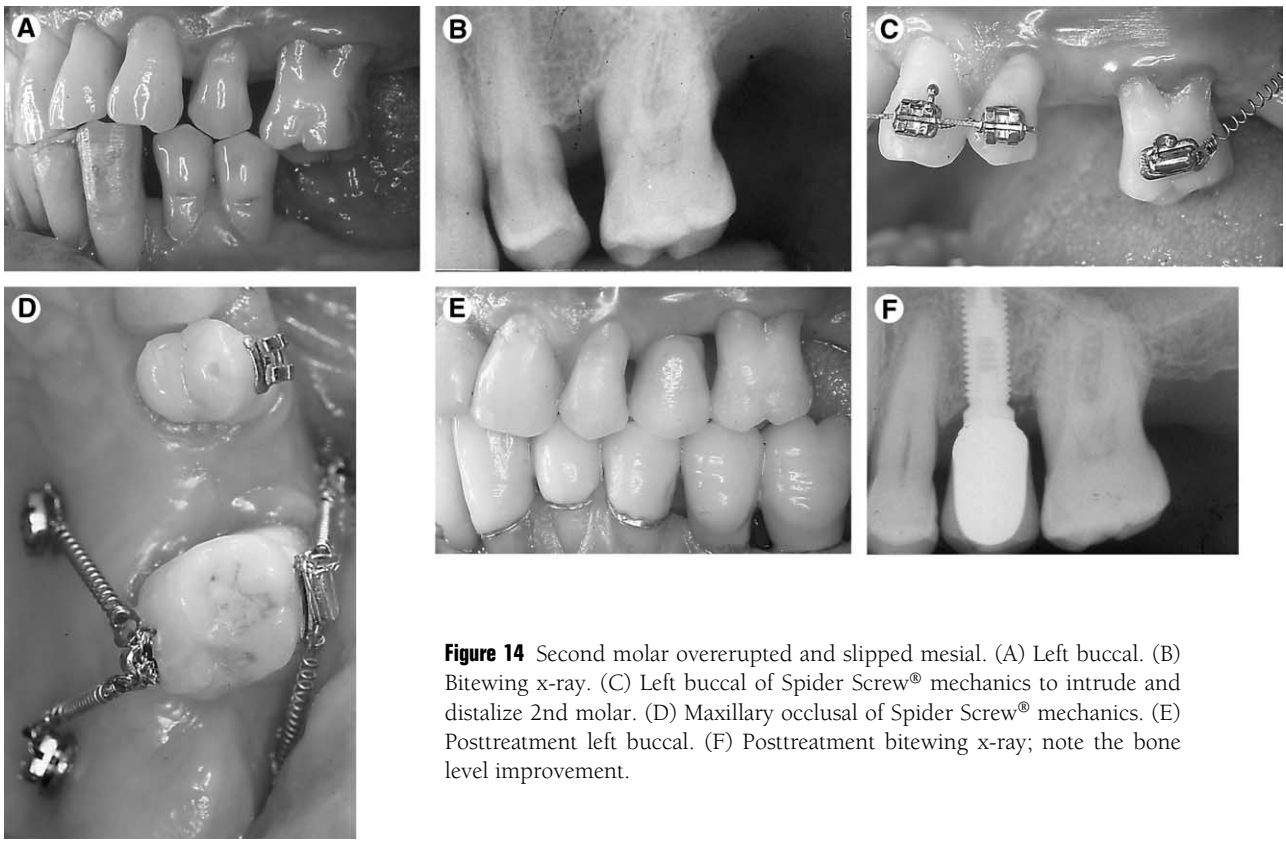

Figure 14 Second molar overerupted and slipped mesial. (A) Left buccal. (B) Bitewing x-ray. (C) Left buccal of Spider Screw® mechanics to intrude and distalize 2nd molar. (D) Maxillary occlusal of Spider Screw® mechanics. (E) Posttreatment left buccal. (F) Posttreatment bitewing x-ray; note the bone level improvement.

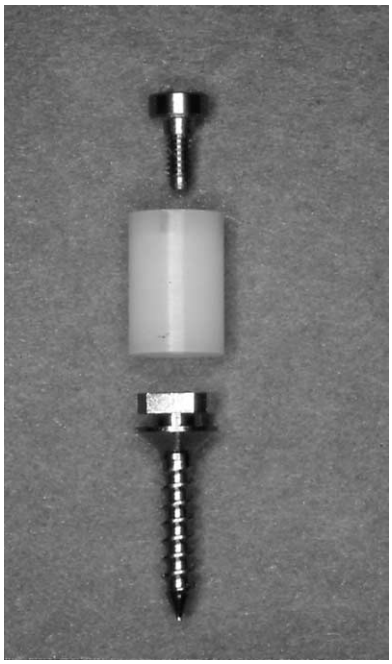

Figure 15 Spider Screw® regular with acrylic abutment.

implants placed in beagle dogs and used for intrusion osseointegrated less than 25%.[7] The forces applied were similar to those used in clinical practice and the screws were removed easily. In clinical practice, the screws are also easily removed, indirectly suggesting minimal Spider Screw® osseointegration. Other studies also indicate that, despite the presence of a certain degree of osseointegration, the smooth surface of the screw facilitates easy removal.[13,16] To remove the miniscrew, it is simply unscrewed with the appropriate screwdriver. It can usually be accomplished without anesthesia and healing takes place in a few days (Fig 19).

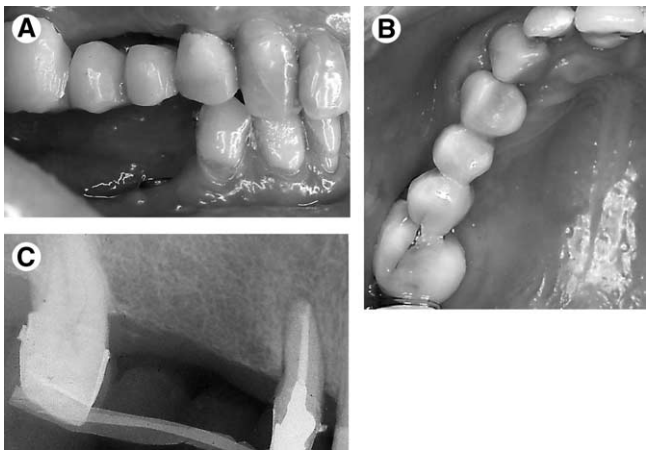

Figure 16 Class II malocclusion and missing upper right 2nd premolar and 1st molar with right lateral incisor rotated. (A) Right buccal. (B) Maxillary occlusal. (C) Bitewing x-ray.

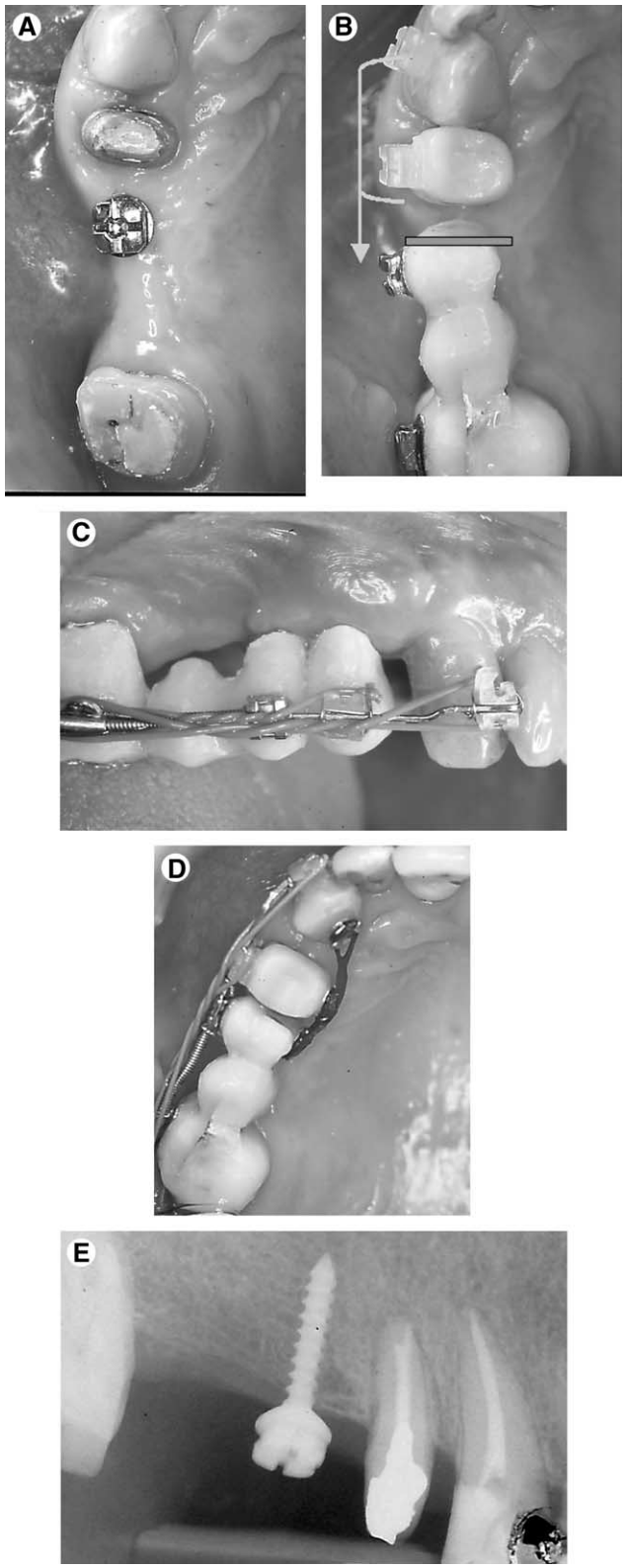

Figure 17 Temporary bridge anchored to Spider Screw®. (A) Maxillary occlusal with bridge removed. (B) Maxillary occlusal with new temporary bridge. (C) Right buccal. (D) Maxillary occlusal. (E) Bitewing x-ray.

Complications

One possible complication is inflammation of the peri-implant tissues, especially in areas of frenum tissue or muscle tissue.[17,18] These problems can be controlled with proper oral hygiene and topical application of a 0.2% chlorhexidine rinse. Sometimes, insertion of the miniscrew high in the vestibule creates mucosal complications. In these cases, the clinician should attempt to use anchorage mechanics that requires minimal adjustments at the orthodontic head of the screw. In the event of miniscrew mobility, it can be replaced with a longer and larger miniscrew. If this is not sufficient, another site for placement should be chosen. If, during insertion of the miniscrew, the periodontal ligament is inadvertently invaded, the patient will show symptoms of pain on percussion or mastication. If a root is contacted during insertion, the patient will develop sensitivity to hot and cold. In these cases, the miniscrew should be removed and anti-inflammation therapy and possible antibiotic therapy should be initiated.

Presently, there is only one study on factors influencing the stability of the titanium screw.[18] The results of this study showed that there are three critical factors. The first is screw diameter; the second is peri-implant soft tissue inflammation, and the third is bone quality. According to this same study, in presence of poor bone quality, it s suggested to use a longer screw with thicker diameter and apply reduced forces to test the screw's stability before applying larger forces. In all cases, the control of inflammation seems to be an extremely important factor.[17,18] To minimize inflammation, one must avoid the frenum and insert the miniscrews in areas with keratinized gingiva thus increasing natural tissue resistance and facilitating the patient's ability to maintain good peri-implant hygiene. Finally, select a screw with a proper collar length compatible with the thickness of the soft tissues in the area.

Summary

The Spider Screw® is versatile and can be placed intraorally in any location with sufficient bone. Likewise, the simplicity of the surgical insertion makes the Spider Screw® a viable anchorage option in the orthodontic armamentarium.

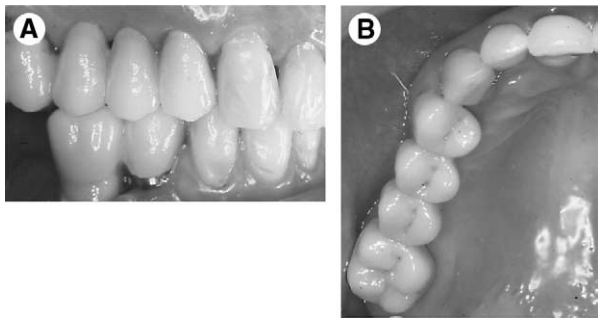

Figure 18 Posttreatment photos. (A) Right buccal. (B) Maxillary occlusal.

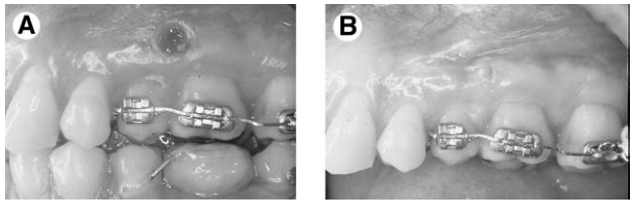

Figure 19 Spider Screw® removal procedure. (A) Immediately after removal. (B) Seven days later.

Through the use of a surgical guide, it can be precisely and dependably placed in areas of reduced space approximating important anatomical structures. Miniscrews of 2-mm diameter and up to 11 mm long can be utilized in areas of bone that have reduced quality or quantity. The variety of transmucosal heights and the specifically designed orthodontic head controls tissue trauma and inflammation while simultaneously providing ease of use by the orthodontist.

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