case report

ORTHODONTIC EXTRUSION FOR PRE-IMPLANT SITE ENHANCEMENT IN A POSTERIOR AREA: AN INTERDISCIPLINARY CASE REPORT

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SUMMARY
Replacing a compromised dental element with a dental implant is a well documented procedure with a high success rate.
The immediate placement of a dental implant at the time of extraction requires a favorable anatomical scenario.
If the anatomical scenario is not ideal, it is possible to perform surgical procedures in order to increase hard and soft tissues after tooth extraction or to do orthodontic extrusion, which reduces the number of surgical procedures and times.
Extrusion must be followed by a prolonged retention period to allow remodeling and adaptation of the periodontal tissues with the new tooth position.
Orthodontic extrusion makes the positioning of dental implants more favorable. Ridge preservation allows placement of the dental implant within the bone thickness on a suitable axis.
The case presented included orthodontic extrusion and, subsequently, the extraction of a compromised tooth in order to guarantee an ideal quantity of hard and soft tissues for positioning a post-extraction implant.

Key words: interdisciplinary treatment, orthodontic extrusion, implant site enhancement, implant site development, immediate dental implant placement.

Introduction

The replacement of severely compromised teeth for endo-conservative or periodontal reasons with dental implants has proven to be an effective and predictable treatment.
There are many long-term clinical studies that have shown excellent survival rates for implants placed in edentulous and partially edentulous jaws (1, 2).
For the treatment of mono-edentulism, several treatment protocols have been suggested in order to improve the aesthetic and functional results while also shortening treatment times (3-6). One of the available treatment options is the immediate implant placement which denotes implant insertion at the time of tooth extraction (7, 8).
Immediate implant placement is used in surgical cases where the conditions of hard or soft tissues are ideal (4).
Statistically, most implant cases lack a sufficient amount of soft tissue and an underlying bone structure. The lack of these tissues is mainly due to site-specific anatomical limitations-such as a namely a thin buccal plate (9-11).
The post-extraction sockets, according to the Elian classification (12), are divided into type 1, type 2 and type 3 sockets.
Type 1 sockets have an ideal soft and hard tissue level and do not require pre-surgical treatments for immediate implant placement.
Most of the surgical procedures necessary for implant placement in type 2 and type 3 sockets, such as immediate implant procedures in the esthetic zone, require procedures to improve the

pre-implant site, simultaneous and/or post-implant site, or specifically tissue augmentation procedures (13, 14).
The final objective of these procedures is to provide peri-implant tissues that facilitate the achievement of optimal functional and aesthetic results similar to the natural physiological situation. For this purpose, various techniques and procedures have been proposed (15), one of which is orthodontic extrusion.
While this approach was originally introduced to save traumatized teeth from extraction, it has been suggested as a method for manipulating soft and hard tissues through the gradual extrusion of an "hopeless" tooth and its periodontal apparatus; thus improving the predictability of the implant site (3).
Numerous reports are available in the literature describing orthodontic extrusion as a reliable method for pre-implantation site improvement (3, 5, 16).
The traction forces applied to the periodontal ligament would also help to stimulate marginal apposition of the crestal bone in addition to the coronal shift of marginal gingiva.
Movement of a tooth by extrusion involves the application of tensile forces in all the regions of the periodontal ligament to stimulate the marginal apposition of the crestal bone. In the normal course of events, bone and gingival movements are produced with low intensity extrusive forces. When stronger tensile forces are exerted, such as in rapid extrusion, the coronal migration of the tissues supporting the tooth is less pronounced because rapid movement exceeds their physiological adaptability.
Extrusion must be followed by a prolonged retention period (17) to allow remodeling and adaptation of the periodontal tissues with the new tooth position. Rapid extrusion is associated with the risk that the periodontal ligament will be torn and that the ankylosis of the tooth may occur (18). Intense force may also lead to root resorption (19). However, the latter phenomenon remains very limited if the forces, even if intense, they are appropriately controlled (20).
Orthodontic extrusion, which preserves or regenerates the bone volume in the ridge, makes the positioning of dental implants more favorable. Ridge preservation allows placement of the dental implant within the bone thickness on a suitable axis.
In the following case the orthodontic extrusion approach allowed to modify the quantity of hard and soft tissues in order to face a favorable anatomical scenario for the immediate implant placement at the time of extraction and to avoid further surgical procedures for the hard and soft tissues improvement by reducing treatment plan session number.

Case presentation

A 40-year-old female patient came at the dental office for a critical sensitivity at the first quadrant level (Figure 1A).
On the objective examination, the element 17 had an occlusal amalgam reconstruction, the element 16 had been partially endodontically treated covered by a metal-ceramic crown and the element 15 had a large composite MOD reconstruction.
No occlusal precontacts had been detected.
Superficial plaque, calculus and a marginal gingivitis of the whole quadrant was found.
There was a 6 mm probing depth with bleeding at the right upper first molar distal, both buccal and palatal sites.
The vitality test was positive on element 17 and 15 but it was negative on 16.
An endoral radiograph of the area was taken and it showed the presence of subgingival calculus between the elements 16 and 17 and a large carious lesion affecting the disto-vestibular root of the element 16 (Figure 1B).
The pain origin was the marginal gengivitis caused by the calculus in the pocket and the iuxtagengival plaque.
Following the curettage of the quadrant, a periodontal revaluation of the element 16 was performed.

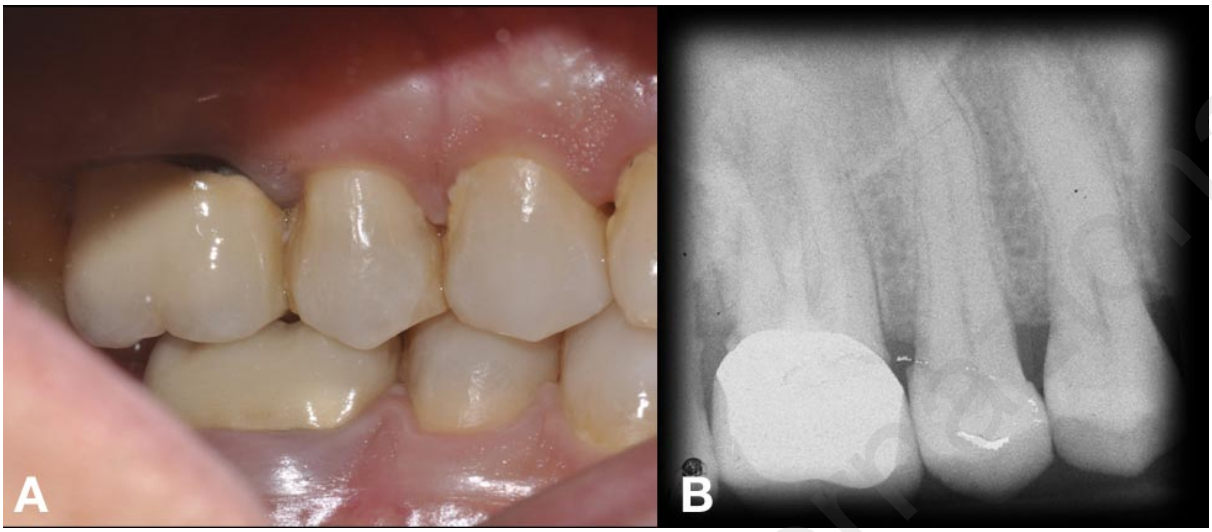

Figure 1
A) Initial clinical situation at the first visit. B) Initial radiographic situation where it can be appreciated the presence of a distal decay on 16.

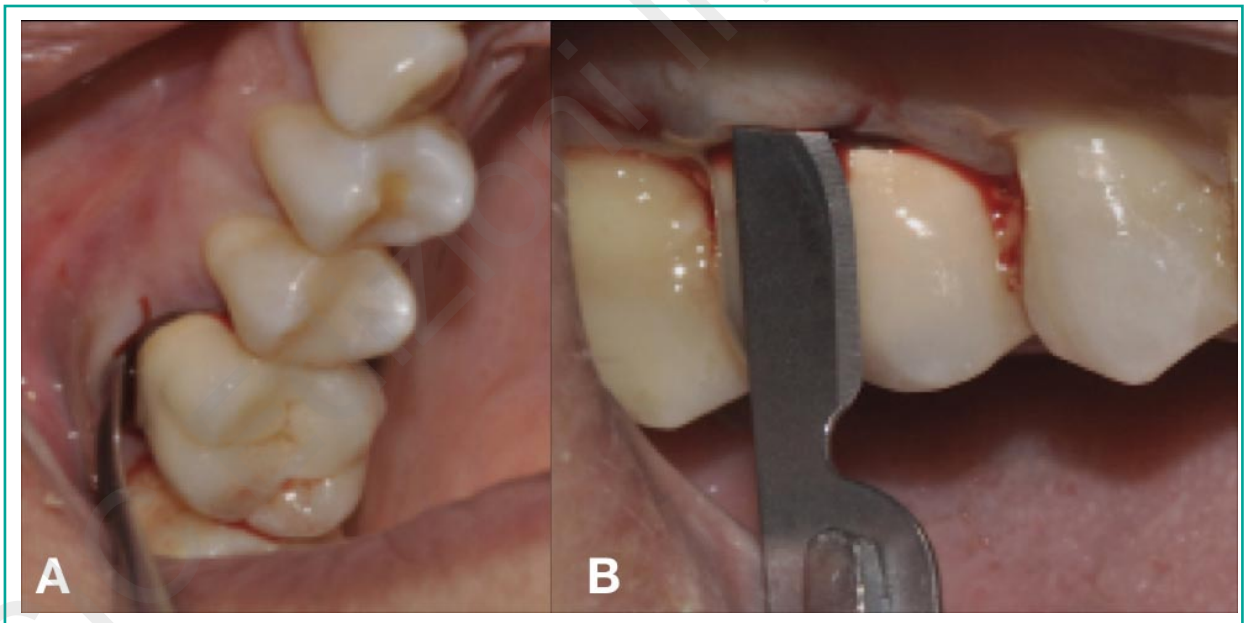

Figure 2
A) Fibrotomy from the occlusal view on the tooth 16. B) Fibrotomy from lateral view on the tooth 16.

Because of the impossibility to treat such a deep decay in an element already restored with a prosthetic crown and endodontically treated, it was decided to proceed with an orthodontic extrusion to keep the bone peaks at the optimal levels and to eliminate the distal defect.
The narrow roots were an advantage for orthodontic extrusion.
Orthodontic therapy provided a first phase in which a fibrotomy of 16 was carried out (Figure

Figure 3
A) Etching phase under rubber dam isolation before the orthodontic tubes placement. B) Positioning and bonding phases of the tubes for orthodontic extrusion. C) Orthodontic tubes and arch in position.

2A, B) and simultaneous banding with radiopaque PEEK tubes of 17, 16, 15 and 14 was performed.
The tube on the 16 was positioned 3 mm apically compared to the others, and a Nichel-Titanium wire 0.16 mm diameter was applied (Figure 3A, B, C).
Light and constant extrusion forces were applied.
The fibrotomy was repeated every 7 days for 4 weeks: the extrusion of 16 took place very rapidly; from the first inspection an occlusal grinding of the element and removal of the distal portion of the arch was performed.
Once the desired extrusion was obtained, the stabilization phase lasted three months with a passive Ni-Ti arch in place (Figure 4).
Under local anesthesia (mepivacaine with adrenaline 1:50.000, Omnia, Italia) an atraumatic extraction of the element 16 was performed by roots separation in order to preserve the interradicular septum of the post-extraction socket.
After tooth extraction (Figure 5A), to perform the implant osteotomy and to check that no accidental perforation of the maxillary sinus occurred, Cosci burs according to protocol were used. A 4.25 mm diameter and 10 mm lenght Sheltar SH implant (Sweden and Martina, Due Carrare, Padova, Italy) was placed inside the B-type alveolus according to Smith and Tarnow (21) classification, with preserved buccal plate, obtaining a primary stability of 50 Nw/cm (Figure 5B).

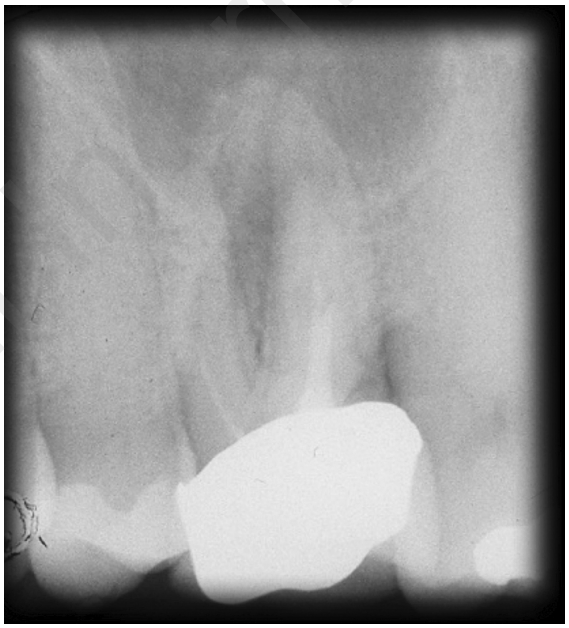

Figure 4
Final X-ray at the end of orthodontic extrusion.

Thanks to the orthodontic extrusion it was possible to avoid maxillary sinus augmentation and further surgical procedures to place implant in the ideal position (Figure 6).
The healing abutment was screwed onto the implant and the alveolus gap was filled with deproteinized bovine bone (Bio-Oss, Geistlich).
Three months after implant placement the surgical re-opening was performed, which allowed to increase the buccal gingival thickness, and soft tissue healing was waited (Figure 6A, B).

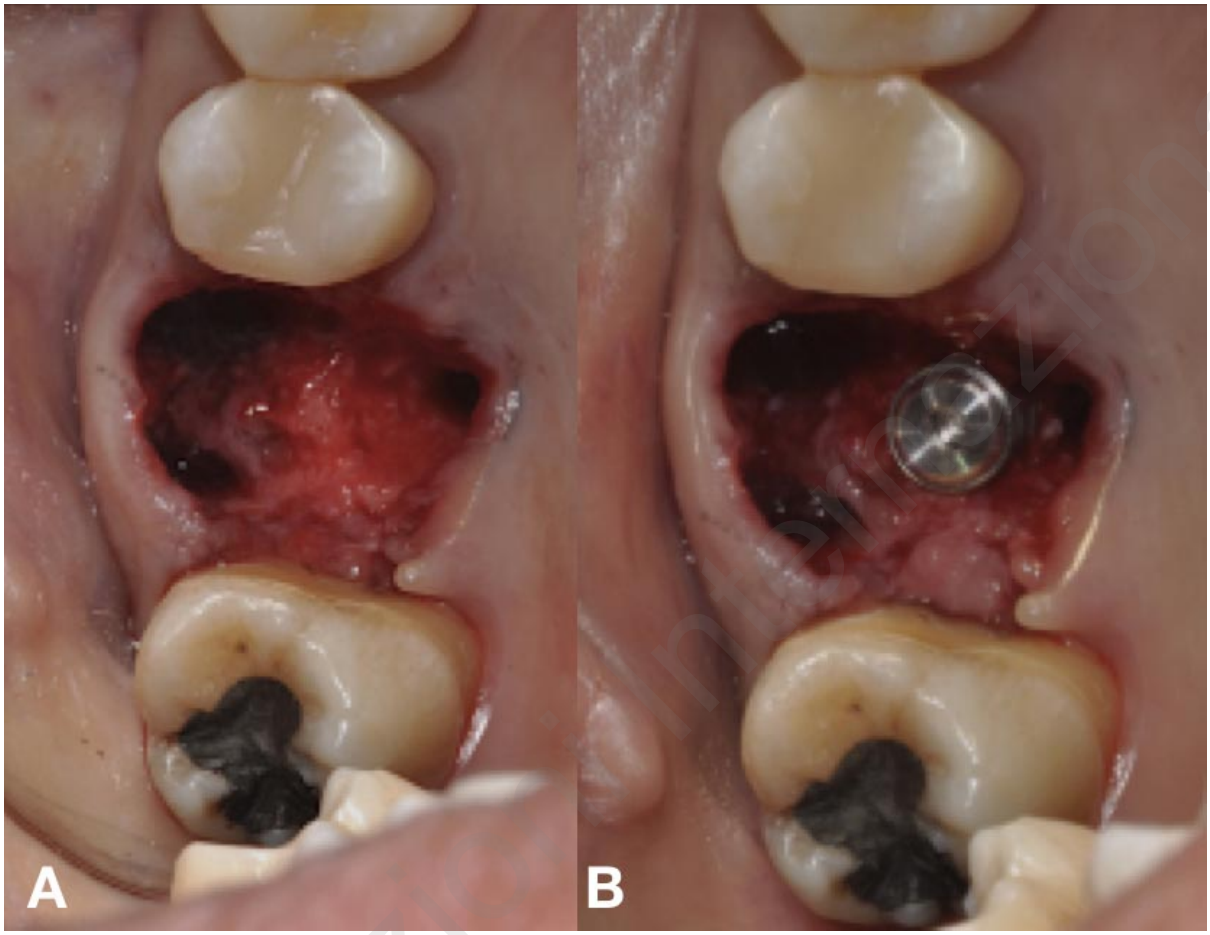

Figure 5
A) Socket after teeth extraction. It is a B-Type socket for Smith and Tarnow classification with preserved buccal plate. B) Implant placement inside the post-extraction socket septum.

After soft tissue maturation, four months after implant placement (Figure 6C), an open tray impression was taken with polyether impression material (Impregum Penta, 3M) (22).
The impressions have been cast and the model has been scanned with a laboratory scanner.
A multi-layered monolithic zirconia crown with vestibular layered feldspatic ceramic was created.
The Ti-base had luted with a laboratory cement to milled zirconia crown after the sintering.
The crown has been delivered and the occlusal check was performed. The access hole was closed with teflon and composite resin (Figure 7A, B, C).

Discussion

The present case report describes the successful outcome of an interdisciplinary approach including orthodontic extrusion, implant placement in the post-extraction socket and prosthetic rehabilitation of an hopeless maxillary molar.
The tooth treated in this case showed a subgingival palatine root caries difficult to treat. The presence of a periodontal defect, a previous prosthetic restoration and a failed endodontic therapy were negative prognostic factors together with the subgingival position of caries for tooth survival.

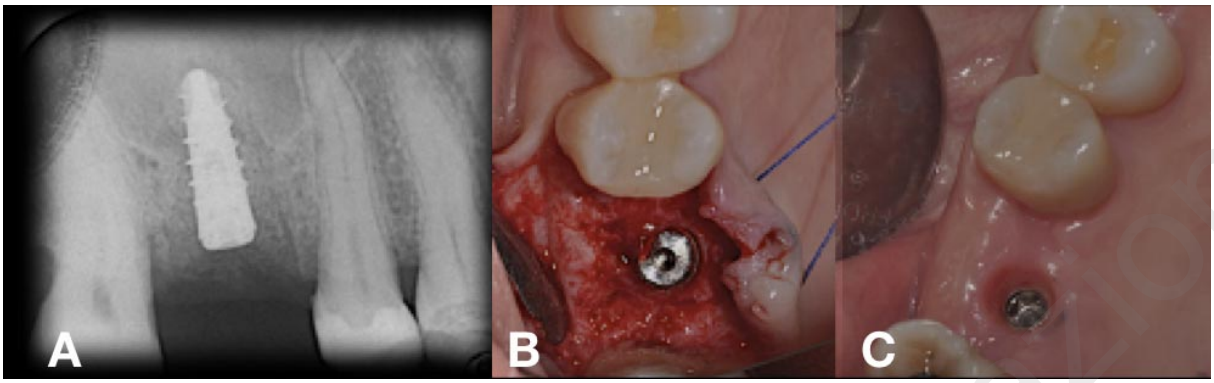

Figure 6
A) X-ray control one month after implant placement. B) Re-opening and soft tissue management three months after the implant placement. C) Soft tissues healing four months after implant placement.

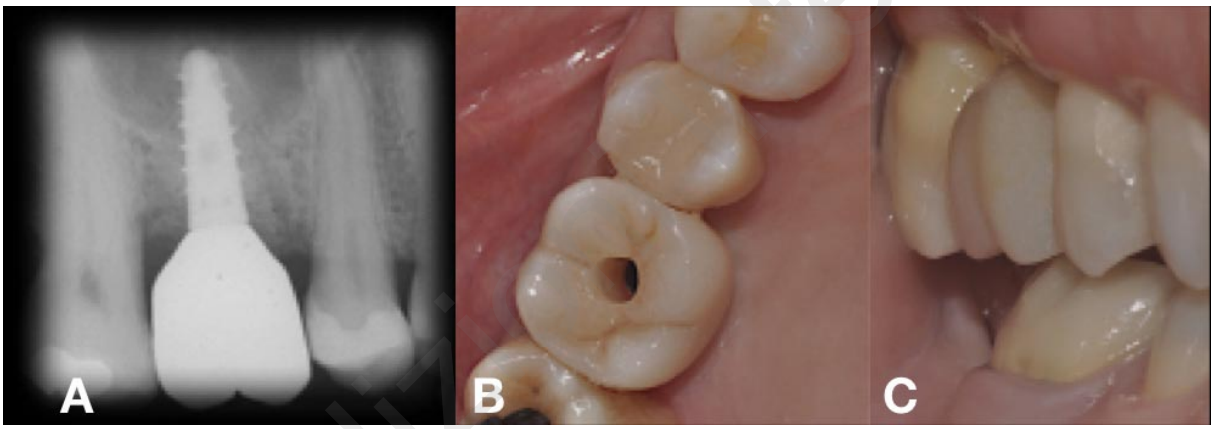

Figure 7
A) X-ray of monolithic zirconia buccally ceramic layered final crown in place. B) Occlusal view of the final restoration with the hole access to underline the correct implant position. C) Vestibular view of the final crown in position. Perfect integration of the prosthesis with adjacent tissues and teeth.

The periodontal defect was not a contraindication to orthodontic extrusion because, thanks to causal therapy, it was not an active infective site. The improvement of interproximal bone peaks and the presence of a post-extraction alveolus with optimal conditions were necessary for correct implant placement and maintenance (23, 24). Orthodontic extrusion has been well documented to serve this purpose.
In this case, orthodontic extrusion was recommended to provide good gingival and bone profiles that were critical for optimal surgery and to simplify the extraction from the perspective of having a post-extraction alveolus ideal for implant placement (25).
The immediate implant placement allowed to preserve the anatomical structures and to reduce treatment procedures.
The extraction of the dental element must be performed with the separation of the roots and in an atraumatic way to preserve the septum.
The post-extraction socket, in this case, was a type B socket, in which the implant was stabilized but not completely contained by the septum bone; a space would remained between the implant and some of the internal alveolar walls.

Regarding the distance between an implant and the adjacent bone plate, there are data that indicate that, even with the primary closure, a gap of <2 mm will be filled with bone; others have suggested that if the gap is > 2 mm and primary closure can be achieved, the site should be grafted (21). In contrast, other researchers have shown that implant success can be achieved, even without flap elevation, without grafting, and without primary closure. If the ridge architecture in a particular case is critical for aesthetic or restorative reasons, it has been shown that grafting the gap on the buccal of an immediate implant, without primary closure, has been shown to help preserve the ridge dimensions (21).

If the socket was a type B and some or all of the buccal wall was missing, a delayed positioning protocol would have to be used.

In this context, pre-implant orthodontic extrusion is an ideal non-surgical procedure to provide sufficient hard and soft tissue structure, facilitating simpler and more predictable implant placement.

However, due to the lack of sufficient evidence, it is difficult to determine whether a surgical intervention through the grafting of hard and soft tissues after tooth extraction is superior to orthodontic extrusion for the pre-implantation site improvement. Both techniques were considered reliable and effective to improve a planned implant site (16). On the other hand, orthodontic extrusion can still be expensive, time consumed and requires an experienced team. Furthermore, orthodontic extrusion is only applicable when the tooth fixation tool is still present. The connection, failure could lead to procedure failure and to further surgical approach for the surrounding tissue deficiencies management. Obviously, no trial is available to use a removable or fixed apparatus for orthodontic extrusion.

Furthermore, little information has been identified in the literature on a step-by-step sequential procedure on the application of this method. It is therefore of great interest to introduce a workflow on the application of orthodontic extrusion as a technique for the improvement of the pre-implantation site.

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