An internal root resorption lesion in the maxillary right central incisor was treated with orthodontic extrusion to improve the surrounding soft and hard tissue. Simultaneously with extraction, socket preservation was performed. After 4 months of healing, guided bone regeneration was performed and an implant was placed. At the second surgical phase, a flap was coronally advanced, and a connective tissue graft was placed. The emergence profile was modeled with a provisional crown before the final crown. The result was successful and well maintained over the 10-year follow-up period. The hard and soft tissue levels were stable, and no signs of inflammation were observed.

Dental implants have been proposed to rehabilitate edentulous spaces or to substitute teeth indicated for extraction due to severe disease or trauma. Following tooth extraction, several physiologic changes affecting the alveolar bone take place, including bone formation in the socket and resorption, leading to dimensional changes of the alveolar ridge. Van der Weijden et al observed an average reduction of 3.87 mm (95% CI: –4.059 to –3.673) in the buccolingual ridge thickness and a 1.67-mm vertical midbuccal resorption (95% CI: –1.910 to –1.428) following socket healing. In order to limit bone resorption and reduce the overall treatment time, different approaches have been proposed based on extraction site management and the timing of implant placement.

Immediate implant placement was first reported in the late 1970s. Since then, the interest in this approach has consistently increased, mainly due to its main advantages, which include reducing the number of surgeries and treatment time, correct 3D implant positioning, bone preservation in the extraction area, and optimum esthetics of soft tissues. Nonetheless, there is no clear consensus in the literature to address the treatment of a fresh extraction socket. In 2019, the 15th European Workshop in

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Periodontology assessed this topic and made some recommendations to help clinicians: In the presence of an acute infection (purulence), inability to achieve primary stability upon implant placement in a correct 3D position, a thin periodontal phenotype, a high smile line, and/or the absence of an intact alveolus, other treatment approaches should be considered. Thus, when some or all of these conditions are present, alveolar ridge preservation at tooth extraction can be performed, and an early (4 to 8 weeks), delayed (3 to 4 months), or standard (> 4 months) implant placement are advocated.

Deciding the best treatment approach is especially complex in the esthetic area and could become more demanding if other factors, such as a root resorption, are present. Several procedures have been proposed to address these deficiencies/lesions, one of which is orthodontic extrusion. Ingber introduced orthodontic extrusion to treat one- and two-walled intraosseous defect, allowing proper implant-site development.

Therefore, this case report aims to demonstrate the long-term clinical and radiographic outcomes of a case where alveolar ridge preservation associated with soft tissue augmentation was combined with orthodontic extrusion in preparation for implant placement.

Case Report

Background

A 24-year-old woman with non-systemic diseases and a smoking habit (15 cigarettes per day) was referred to one of the present authors (R.F.A.) by her general dentist in order to place an implant at the maxillary right central incisor site, where the tooth would be restored with a post and crown, the dentist decided to perform an endodontic surgical treatment.

The patient’s main complaints were esthetic embarrassment and tooth discomfort because of the external root reabsorption (Fig 1).

Orthodontics Phase

Because the gingival margins of the two central incisors were not level, the bone peak between the right central and lateral incisors was incorrect. The patient had a medium/normal smile line, and it was decided to perform slow orthodontic traction in order to coronally move the gingival margins and alveolar bone (Fig 2).

Two weeks before placing orthodontic brackets, oral hygiene instructions and supragingival debridement and polishing were performed. Moreover, a supported periodontal treatment was scheduled every 2 months during the treatment plan.

The orthodontist (M.P.) performed a slow traction (light force of...
15 g) of the right central incisor for 3 months, with a buccal root torque component and constant extrusive forces (no more than 2.0 mm of extrusion per month). At the end of the active extrusion, a retention and stabilization period of 4 months was performed prior to the extraction, as described by Korayem et al.\textsuperscript{14}

**Surgical Phase**

**Tooth extraction**

Seven months after beginning slow orthodontic traction, the patient was locally anesthetized with articaine (Artinibsa 40 mg/mL + 0.01 mg/mL, Inibsa), and the tooth was gently extracted in order to maintain the buccal bone. To reduce alveolar bone resorption, socket preservation was executed with a xenograft (Bio-Oss, Geistlich) covered with a connective tissue graft collected from the palate, then sutured with 6.0 polyglycolic acid sutures (Safil, B. Braun) (Fig 3).

The recommended postoperative medication included ibuprofen (Brufen, Abbott Laboratories) every 12 hours for 5 days and rinsing thrice daily for 10 days with 0.12% chlorhexidine (Eludril, Pierre Fabre).

**Implant placement**

After 4 months, the region was anesthetized with articaine (Artinibsa), and a Widman flap was made between the right lateral incisor and the left central incisor. A full-thickness flap was raised, and an implant was placed (3.75 x 10 mm; Osseotite, Zimmer Biomet). Due to the root shape, the buccal bone dehiscence was treated with a guided bone regeneration technique using a xenograft (Bio-Oss) and collagen.
membrane (Bio-Gide, Geistlich). The graft was sutured with 4.0 polyamide sutures (Supramid, B. Braun) (Fig 4).

The recommended postoperative medication was as follows: amoxicillin and clavulanic acid (875 + 125 mg; Clavamox DT, Bial) every 12 hours for 8 days, ibuprofen (600 mg; Brufen) every 12 hours for 5 days, and 0.12% chlorhexidine mouthwash (Eludril) 3 times a day for 10 days. Sutures were removed after 1 week.

Second Surgical and Prosthodontics Phase

The second surgical phase was performed 4 months after implant placement to improve the quality and volume of the soft tissues. The measured implant stability quotient (Osstell) was 79 to 80.

During the surgical intervention, a connective tissue graft collected from the palate was placed in the vestibule of the flap and sutured (6.0 polyglycolic acid sutures, Safil), which were removed 10 days later.

A month later, the prosthodontist (A.S.) began modelling the soft tissues with minimal continuous transformations of the temporary crown emergence profile over an 8-month period (Fig 5). During this period, the crown of the right lateral incisor was fractured. Figure 6 shows clinical views when crowns were placed at the right lateral and central incisors.

Follow-up

At the end of the treatment, supportive periodontal treatment was recommended every 6 months, considering the low risk profile of the patient. The only complication that occurred during the 10-year follow-up was the development of an endodontic lesion on the right lateral incisor 5 years after treatment, which was treated with nonsurgical endodontic methods.

Although the treatment period was long, esthetic results (pink esthetic score of 10) and soft and hard tissue stability were well maintained 10 years after final crown placement (Fig 7).

Discussion

Although trauma, orthodontic treatment, and intracoronal bleaching have been identified as predisposing factors for invasive cervical resorption lesions, the etiology and...
pathophysiology of this phenomenon is still unclear.\textsuperscript{15}

Different treatment approaches have been proposed in the literature to replace hopeless teeth in the anterior region.\textsuperscript{16–18}

Slow orthodontic extrusion, when indicated and performed well (slow, controlled extrusion forces associated with a well-controlled vector of traction),\textsuperscript{14} is able to model the periodontal tissues and augment both the remaining bone and soft tissues.\textsuperscript{17,19–24}

When planning and predicting the final results of this kind of treatment, the amount of residual bone and the initial soft tissue position should be taken into consideration; in fact, one key factor is the assessment of the remaining periodontal ligament.\textsuperscript{14,21} Although there is no consensus on the minimum amount of periodontal ligament required

\textbf{Fig 5} (a) The temporary screw-retained crown was placed to model the soft tissues. (b and c) The temporary crown was subsequently modified and adapted over 8 months.

\textbf{Fig 6} The definitive crown was placed 8 months after the second surgical phase.

\textbf{Fig 7} (a) Clinical and (b) radiographic views 10 years after the final crown delivery.
when performing this kind of approach, it is assumed that the greater the amount of residual periodontal tissues, the greater the tissue gains can be.\textsuperscript{14}

Different orthodontic techniques for slow extrusion procedures have been described in the literature, most of them requiring the use of brackets. In recent years, other methods have been reported, including the use of mini implants and aligners.\textsuperscript{25,26} Nevertheless, it must be taken into consideration that the gold standard for this kind of approach is the use of brackets.\textsuperscript{14} This technique is not free from limitations: When the root is vestibularized, the buccal bone plate can be reabsorbed, and a complementary guided bone regeneration must be performed before or simultaneously with implant placement.\textsuperscript{14}

The final result of the present case is considered successful, as a pink esthetic score of 10 was achieved. However, greater vertical bone and soft tissue gains would have been appreciated. Some possible explanations for this limitation were the limited amount of periodontal ligament, the initial position of the soft and hard tissues, and the presence of other complication factors such as the endodontic lesion and root resorption.\textsuperscript{14}

Despite the limitations in vertical bone and soft tissue growth, orthodontic extrusion is often associated with other augmentation procedures, especially those aiming to achieve vertical gains.\textsuperscript{27}

This case report has a long follow-up period, and the limitations of the knowledge at that time must be considered. New implant and abutment designs available today report better results in the anterior sextants, allowing the reduction of physiologic bone loss around implants during osteointegration and improved soft tissue healing around implants.\textsuperscript{28,29} Thus, the implant and abutment designs used in the present case should be considered as a limitation.

Despite the few disadvantages seen with this kind of treatment, it also has several advantages, such as the reduced necessity for, and extent of, bone and soft tissue augmentation.\textsuperscript{14,27} The described treatment with almost 10 years of follow-up presents this technique as a relevant treatment option with good stability over time, even in cases with small amounts of residual periodontal tissues and other complication factors. Another factor of success that should be taken in consideration is the patient’s inclusion in a supportive periodontal treatment recall program, as this is associated with long-term stability and implant health.\textsuperscript{30}

Although the present results are similar to results reported in previous studies,\textsuperscript{14,19–21} the present authors infer that if the amount of residual periodontal tissues was greater and complication factors (root resorption and an endodontic lesion) were not present, the final result of the slow orthodontic extrusion would have been more extensive.

Despite the present limitations, the described technique showed long-term success in a case where alveolar ridge preservation associated with soft tissue augmentation was combined with slow orthodontic extrusion.

Conclusions

This case report shows that orthodontic extrusion can be considered as a treatment option if the patient’s biologic factors, the forces applied, and the treatment times are respected. However, the long-term maintenance of the results is dependent, in most cases, on both soft and hard tissue manipulation, especially in the esthetic area.

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