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Single-Tooth Rehabilitation Combining Root Displacement and Crown Lengthening Two-Year Follow-Up: A Case Report

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Clinical Relevance

Combined techniques to expose circumferential tooth structure associated with subsequent restoration may represent a valid option in many situations. This case provides an example of the successful management of the anterior tooth rehabilitation combining root displacement and crown lengthening.

SUMMARY

Rehabilitation of an extensively compromised single anterior tooth represents an intriguing challenge for dentists, particularly when the rehabilitation involves esthetic, psychosocial, and functional requirements. The success in rehabilitating a patient with a conservative approach depends on a critical evaluation of the remaining structures, precise treatment plan, systematic treatment strategies, and patient compliance. In this case, the patient's chief complaint was the undesirable appearance of the maxillary right lateral, caused by the displacement of the post and crown. Clinical examination revealed a remaining tooth with coronal fracture, severe loss of tissue due to caries, and absence of ferrule effect. Radiographic examination revealed that the fracture margin was located subgingival. This case report describes a single-tooth rehabilitation involving a combination of root displacement via orthodontic extrusion and crown lengthening. The rehabilitation was followed

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by post-and-core restoration using a prefabricated glass fiber post associated with a disilicate lithium crown. The clinical decision making and combined effect of both treatment strategies are explained in this report. The treatment required three months, including recovery times after surgery and the placement of the provisional crown. The patient was esthetically and functionally satisfied with the restoration. Patient follow-up examination was performed 24 months after the treatment. This clinical report contributes to the clinical practice and exemplifies the possibility of rehabilitating the natural tooth using combined techniques, which may offer particular advantages regarding prognosis and invested efforts.

INTRODUCTION

Failures of post-restored and endodontically treated teeth often occur in anterior due to trauma, secondary caries, or post-and-core displacement.[1] The rehabilitation of teeth with extensive loss of coronal tooth structure represents one of the most challenging scenarios for dentists.[2] Typical treatment options including implant-supported single crowns or fixed partial dentures have evolved as the primary choice of therapy for these cases.[3] Still, whenever possible, conservative procedures that preserve existing structure should be included in the treatment plan.

The preservation of tooth structure is utmost in maintaining the balance among biological, mechanical, functional, and esthetic parameters.[4] The clinician must be able to assess the dimensions of the remaining tooth structure as well as the influences of biological and occlusal factors. The decision to treat a tooth endodontically should be based on prosthetic restoration of the tooth, bone quality, esthetic demands, cost–benefit ratio, systematic factors, potential adverse effects, and patient preferences.[5] The assessment of these critical factors allows the clinician to make clinical decisions based on the best evidence and is in the patient's best interest.[6] The periodontal ligament absorbs the occlusal loads and provides a better transfer of force at the root interface level.[7] Furthermore, implant placement may be subsequently performed in the event of failure of conservative structure-preserving approaches.[8]

When performing restoration of endodontically treated teeth with extensive loss of coronal tooth structure, the presence of ferrule is highly relevant for the expected mechanical behavior of restored teeth.[9] The clinician should use available tissue to provide a ferrule whenever possible.[10] Prosthetic and periodontal factors should be taken into account to ensure a ferrule with the desired height and circumferential area.[11] Ferrule height values from 1 to 2 mm have been shown to provide improved survival of extensively damaged endodontically treated existing structures.[9]

Another critical factor to take into account is the crown-to-root ratio. Different techniques can be performed to reestablish the ferrule before beginning the restoration. Surgical crown-lengthening procedure refers to osteotomy procedures followed by an apical flap repositioning to the reinstatement of biologic width.[12] However, this conventional surgical approach may compromise the crown-to-root ratio and lead to an unpleasing gingival alignment and extremely long clinical crowns.[13] Slow root displacement by orthodontic extrusion is a less invasive and viable alternative for reinstatement of biologic width, with the advantage of allowing the gingival papilla to keep surrounding the teeth.[14] The intended orthodontic movement of the tooth often results in the displacement of the gingival margin by approximately 80% of the total amount of extrusion.[15] In this approach, the crown-to-root ratio of the erupted tooth slightly increases, thus improving the long-term periodontal prognosis and esthetic appearance facilitating the subsequent prosthetic rehabilitation.

This case report documents successful conservative structure-preserving treatment with the use of the combined techniques described above: root displacement by orthodontic extrusion and minimally invasive crown lengthening for the rehabilitation of anterior tooth with extensive loss of coronal tooth structure.

CLINICAL CASE REPORT

A healthy 38-year-old man presented for comprehensive evaluation complaining about the undesirable appearance of the maxillary right lateral, caused by the displacement of the post and crown. Clinical examination revealed a coronal fracture, destruction due to caries, and absence of ferrule effect (Figure 1). The following equipment was used to photograph the patient: camera Nikon D7000; macro lens micro-NIKKOR 105 mm, Nikon; Flash, Nikon R1C1 wireless close-up Speedlight; Light softboxes 30 x 20 cm (Nikon Corp, Tokyo, Japan). The radiographic examination revealed a subgingival fracture margin extended almost to the alveolar crest level on the facial surface (Figure 1). A multidisciplinary treatment was discussed, and informed consent was obtained by the patient. The decision was made to perform crown lengthening with orthodontic extrusion and periodontal surgery and subsequent restorative treatment with a fiber post and crown treatment.

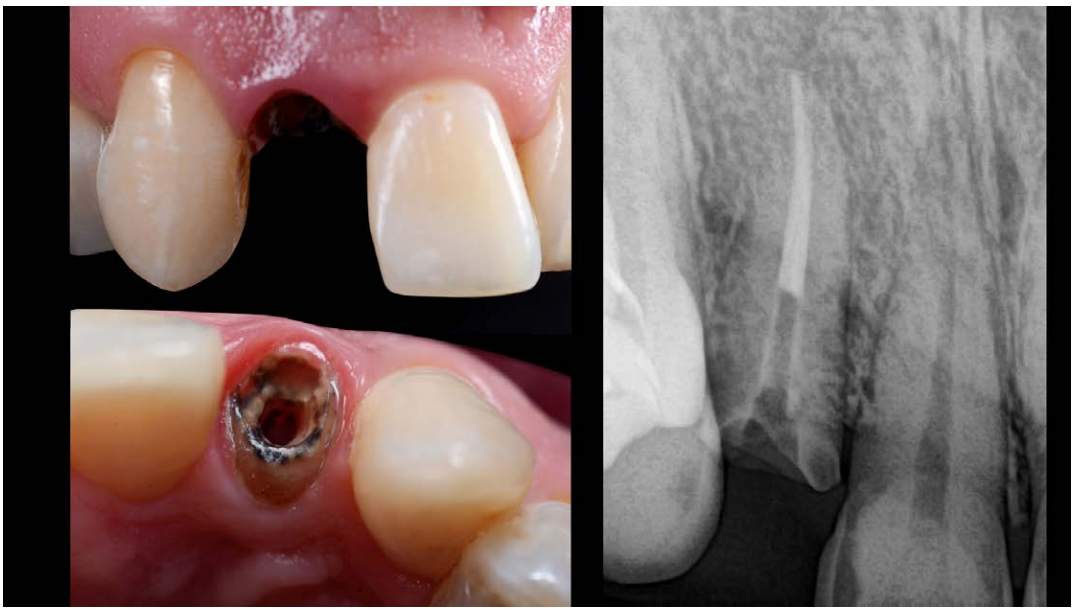

Figure 1. *Preoperative labial and occlusal views of coronal fracture on tooth 7 with invasive margins evident in the vicinity of the alveolar ridge. Initial radiograph examination.*

Since the endodontic treatment was acceptable, the orthodontic extrusion was initiated. The orthodontically guided extrusion made use of the patient's existing post and crown. A provisional crown was relined with self-cure temporary resin (Alike, GC, Alsip, IL, USA) to reach the internal fit. The temporary restoration was cemented with glass ionomer (GC Fuji Temp LT, GC, Tokyo, Japan). Afterward, passive sectional 0.022 inches x 0.028 inches Edgewise standard brackets were bonded cement (Morelli, Sorocaba, SP, Brazil) using an orthodontic bonding (Orthocem, FGM, Joinville, SC, Brazil) on maxillary teeth (tooth 6 and tooth 8). The maxillary right lateral bracket was positioned toward the cervical third. After, a stainless steel archwire (0.017 inches x 0.025 inches) was placed passively in teeth (tooth 6 and tooth 8). For the maxillary right lateral incisor, the wire was not inserted into the bracket but subjected to active extrusion force promoted by two elastomeric rings (Figure 2).

The incisal and lingual portions of the provisional restoration were reduced to prevent occlusal interference during extrusive movement. A simple orthodontic assembly was used to apply force along the long axis of the tooth root. Extrusion of 2-3 mm was obtained in three weeks (Figure 2). Following extrusion, it is essential to establish a healing time, allowing the mineralization of the bone and maturation of the tissues around the extruded teeth, for approximately two to three months.

Periodontal surgery was performed to level the soft tissues after reaching the planned orthodontic extrusion (Figure 3). The provisional crown was removed with the aid of ultrasonic instrumentation, and the surgical procedure was conducted. Local anesthesia with 2% lidocaine and epinephrine was applied. An intrasulcular incision was made using a #15C surgical blade (Swann-Morton, Sheffield, England), and it was extended to each side of the adjacent tooth. Full-thickness mucoperiosteal flaps were raised both labially and lingually with Molt periosteal elevator (Hu-Friedy, Chicago, IL, USA; Figure 3). Granulation tissue was thoroughly removed with Gracey periodontal curettes (Hu-Friedy; Figure 3).

Furthermore, bone architecture recontouring was performed using Ochsenbein periodontal chisels (Hu-Friedy; Figure 3). At this time, it should be highlighted that dentists must take care to remove all interproximal bone to prevent inadvertent trauma to the teeth. The distance from the tooth fracture margin to the crest of the alveolar bone was measured with a probe (Hu-Friedy; Figure 3).

Next, an intraoperative tooth preparation was carried out (diamond bur, 8850F, Kommet, Lemgo, Germany) after osteotomy and osteoplasty, positioning the margins at a distance of at least 1 mm from the gingival level. This step facilitates the elimination of undercuts, root proximity correction, and smoothing and cleansing of root surfaces by removing calculus and cement remnants.[16] The flap was closed (Nylon 6:0, Shalon Medical, Goiânia, GO, Brazil) with vertical mattress sutures anchored to the periosteum with the rationale of obtaining a greater closure strength and a

Figure 2. *Phases of the orthodontic extrusion of the maxillary, right lateral incisor. Note the elastic thread was exerting force against the rectangular wire and the coronal migration of the gingival tissue. After three weeks, the extrusion was deemed sufficient and then splinted to the adjacent teeth. Post extrusion radiograph.*

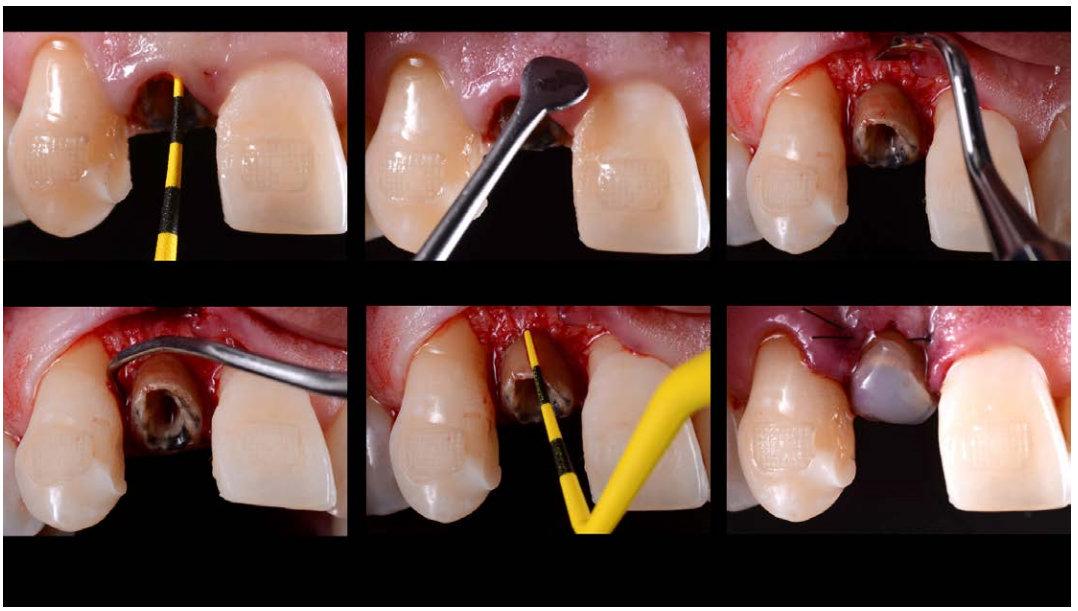

Figure 3. *Close-up views of the clinical sequence of surgical crown lengthening performed on the maxillary right lateral incisor*

better distribution of tension in the underlying tissues at the desired apical position (Figure 3). Finally, the patient was instructed to rinse the area twice a day with a 0.12% chlorhexidine solution (PerioAid, Dentaid, Barcelona, Spain) during the following week. The suture was removed after 14 days.

In the follow-up appointment, the gutta-percha in the root canal was partially removed using #2 Largo Peeso and #2 Peeso reamer post drills (Figure 4). After this step, a periapical radiograph was employed to check the preparation and to select the fiber post size, according to the anatomical dimensions of the root canal (Figure 4). The chosen fiber post (Whitepost-DC-E #2, FGM, SC, Joinville, Brazil) was demarcated and cleaned with ethyl alcohol blended 70%. Then, phosphoric acid at 37% (Gel Etchant, SDS Kerr, Brea, CA, USA)

Figure 4. *Root canal preparation by post drill #2. Bonding procedures. Periapical radiograph to check the adaptation of the fiber post. Temporary restoration.*

was applied for 30 seconds, followed by water rinsing and light air-drying. An organosilane (Prosil, FGM) and an etch-and-rinse adhesive system (Ambar, FGM) were applied following the manufacturer instructions. Light-curing was performed for 20 seconds with a light-emitting diode (LED) curing unit (Valo, Ultradent, South Jordan, UT, USA) with 1000 mW/cm^2.

At the same time, the root canal was etched with 37% phosphoric acid for 15 seconds, followed by water rinsing and light air-drying and then carefully dried with absorbent paper before the bonding procedure. An adhesive system was applied to the root canal walls with a microbrush (Figure 4). The adhesive excess was removed with absorbent paper points. Light-curing of the adhesive was performed for 24 seconds with a LED light source in high power mode at 1400 mW/cm^2. The dual-curing resin cement (Allcem Core, FGM) was directly applied into the canal and onto the fiber post surface, and the fiber post was placed into the final position and stabilized (Figure 4). It was light-cured for 40 seconds with a LED light source at 1000 mW/cm^2.

Next, the tooth was prepared, and a provisional restoration was performed (Figure 4). The early tooth preparation offers the following advantages[17]: less aggressive abutment preparation; no interference from the temporary phase with the reestablishment of the biologic width; easy supragingival preparation using the healed soft-tissue margin as a guide; easy supragingival relining of the provisional restoration; conditioning of the soft tissues during the maximal regrowth period; and no need for retraction cords during abutment preparation and relining of the temporary restoration (necessary in the case of delayed tooth preparation and provisional relining) (Figure 4).

After 60 days of surgical follow-up, the soft tissue displayed stability, and the final restoration was planned. The crown preparation was finished using an 8850F diamond bur and H375R carbide bur (Kommet) on a 1:5 increaser contra-angle (TI Max X95, NSK, Tochigi, Japan) to enhance the preparation before impression. The prepared areas were then polished using silicone points (Jiffy, Ultradent, South Jordan, UT, USA). A two-step impression was performed with heavy-body followed by light-body addition silicones (President, Coltene, Altstätten, Switzerland). All information, including a set of photographs and impressions, was sent to the laboratory.

A bilaminar lithium disilicate crown (IPS e.max Press and Ceram, Ivoclar Vivadent, Schaan, Liechtenstein) was prepared in the laboratory. Shape, color, and contact points of the restoration were checked during a try-in appointment. The final ceramic crown had the internal surface acid treated using 10% hydrofluoric acid for 20 seconds (Dentsply, Petrópolis, RJ, Brazil). The restoration was cleaned with 37.5% phosphoric acid for 10 seconds, followed by a water rinsing. The ceramic crown was placed in an ultrasonic bath with distilled water for 4 minutes to remove residual acid and then dried. An organosilane (Prosil, FGM) was applied for one minute and lightly air-dried. An adhesive system (Ambar APS, FGM) was used

following the manufacturer guidelines. The tooth preparation was cleaned with pumice stone and water, rinsed thoroughly with water, and surface dried.

Modified dental dam isolation (Nictone, Zapopan, Jal, Mexico) and a retraction cord 000 (Ultrapack-Ultradent) were placed before the bonding procedures. The surfaces of the adjacent teeth were protected with Teflon tape during etching for 15 seconds. An adhesive system (Ambar, FGM) was applied and light-cured for 20 seconds. Before the light cure of adhesive internally applied in the restoration, a luting cement (All Cem, FGM) was loaded into the crown. The crown was then placed over the prepared tooth for correct fitting and alignment. The excess cement was removed using a silicone point polishing tip (KG Sorensen, Cotia, SP, Brazil) and dental floss (Superfloss, Oral B, Ireland). The restoration was light-cured for three seconds, and a thin coat of glycerin was applied to block the air. The curing was then completed with light activation for 40 seconds on each side. The remaining cured cement was removed using a #12 surgical blade. The rubber dam was removed, and the patient was asked first to perform closure without force and then centric, protrusive, and lateral excursions.

A follow-up examination was performed 24 months after the treatment. Clinical and radiographic images taken during the follow-up examination demonstrate that the bone levels, gingival architecture, and esthetic appearance remained stable, as shown in Figures 5 and 6.

DISCUSSION

Evidence supports that the use of implant-supported single crowns results in reliable long-term outcomes with a five-year survival rate reaching 96.8% (95% confidence interval [CI]: 95.9-97.6).[18] It would be reasonable to suggest that dentists adopt implant-supported single crowns as a treatment for this case. Nevertheless, biological and technical complications such as peri-implantitis bone loss and soft tissue complications occurred adjacent to 9.7% of the single crowns after five years. Additionally, when a tooth is removed from its alveolar socket, the blood to the facial bone is interrupted.[19] Even with expected healing after tooth extraction, the alveolar defect will only become partially restored. The highest amount of bone loss is in the horizontal dimension and occurs mainly on the facial aspect of the ridge, which may compromise the esthetic outcomes.[20]

In this case report,[21] we demonstrated the combined effect of root displacement and minimally invasive crown lengthening for the rehabilitation of an anterior tooth with extensive loss of coronal tooth structure. The case report presented "current integrated management approaches"[22] to solve the patient's issues, which were practical and demonstrated stability after 24 months, supporting mechanical and biological needs. The ultimate healing and symmetrical alignment of the periodontal soft tissues were prime concerns to the crown-lengthening approach. The reduced ostectomy promoted by the combination with orthodontic extrusion seems to confirm that the supplementary orthodontic approach improves the short- and long-term outcomes.[23]

Orthodontic extrusion and crown lengthening is the best approach for the conservative establishment of biological width. Slow orthodontic teeth extrusion has also been investigated to enhance hard and soft periodontal tissue quality before implant positioning in the esthetic area.[20] In the last several years, surgical extrusion, or intra-alveolar transplantation, has also been proposed in the literature as a third option to reposition the tooth into a more coronal position to allow restoration.[24]

Although predictable, adopting the crown lengthening alone would compromise the esthetic outcomes but would reduce cost and time of treatment. Orthodontic extrusion is highly suitable for a dentist to restore otherwise hopeless teeth and maintain the biologic distance between the apical portion of the junctional epithelium and the alveolar crest.[25] The foremost limitation of forced orthodontic extrusion is the long duration of the treatment stabilization period.[26] It is also contraindicated in a small crown-to-root ratio, lack of occlusal clearance for the required amount of eruption, and periodontal complications.[27]

Van Venrooy and Yukna[28] first studied the amount of vertical bone deposition, and they reported a mean of 2.00 mm of crestal bone deposition after three weeks of orthodontic extrusion. There is no high quality of evidence on the efficacy of orthodontic strategies aimed at tooth extrusion.[29] The consensus in the literature is that orthodontic extrusion success relies on stable anchorage for the extrusion. The anchoring elements will act as support for the discharge of the forces applied to cause tooth movement.[30] Fixed orthodontic appliances or mini-implant screws can be used for the anchorage.[14] In the present case, we also used brackets and provisional posts for better discharge of the forces at the root level.

In our case, planning the decision-making process included clinical, biological, and patient preferences in support of our evidence-based approach. The root-to-crown ratio, the amount of expected forced orthodontic extraction to allow a ferrule design, and the desire to reduce the side effects of individual approaches have

Figure 5. *Clinical and radiographic controls of tooth 7 after the multidisciplinary treatment.*

Figure 6. *Treatment 24-months postoperative. Note the favorable clinical and radiographic outcomes.*

led to the selection of a plan that combines treatments to establish biological width.

Concerning the restorative aspect of this case, adhesive core build-up with fiber post was chosen. The entire system comprised of post cementation and core build-up works in harmony toward reinforcing the tooth.[31] Fiber-reinforced posts have been used mainly for their biomechanical properties similar to those of dentin.[32] The documented long-term clinical use of fiber posts consistently indicate a conservative failure that leaves the root intact when compared to metal post use.[33] In a previous meta-analysis, the survival rate for fiber posts considering repairable failures was 83.9% in studies from five to 10 years of follow-up.[34] It is worth mentioning that if fiber post failure occurs, the fiber post can be replaced while keeping the existing root structure intact.

Full-ceramic crowns have become a standard procedure in the treatment of anterior teeth.[35] Lithium disilicate crowns are a reliable and long-lasting treatment option to restore the anterior zone to fulfill esthetic and functional demands.[36] The most common

technical complication reported was the fracture of the core framework, followed by porcelain chipping and debonding of the restoration from the tooth.[37] Nevertheless, several studies reported an encouraging survival rate for lithium disilicate single crowns ranging from 100% after two years to 96%-98% after five years and 94%-96% up to 10 years.[37,38] The crown made in the above case was esthetically integrated, considering the patient's facial harmony and symmetry with its lateral incisor counterpart. From the patient perspective,[22] he was fully satisfied with the resulting appearance and functional aspects of the tooth. The patient continually maintained the hygiene of the restored area, and no post, core, or crown complications were observed at the 24-month follow-up. Future studies on long-term clinical outcomes and predictors for the combined approach of root displacement and minimally invasive crown lengthening restored with fiber post merit consideration.

CONCLUSION

A severely compromised tooth was recovered with combined management of root displacement and minimally invasive crown lengthening. This approach, in concert with modern restorative dentistry, led to successful results and patient satisfaction. These results were documented during an examination 24 months after treatment.

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Conflicts of Interest

The authors of this manuscript certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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