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Multidisciplinary approach in restoring a severely destroyed upper premolar: Case report

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Abstract

Clinicians often have to deal with severely destroyed teeth. One of the keys to long-term success of the prosthetic restorations is the presence of "ferrule" effect. This case report describes how a proper ferrule effect of tooth 2.5 was achieved with the rapid orthodontic extrusion and restored with ceramic-layered zirconium.

Keywords: *rapid orthodontic extrusion, ferrule effect, shoulderless/edgeless preparation.*

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INTRODUCTION

The general practitioners often have to deal with severely destroyed teeth in their clinical practice. The causes for sub-gingival teeth destruction could be different – oblique or horizontal fracture; carious lesion; external resorption; root perforation in the coronal third. One of the keys to long-term success of the prosthetic restorations is the presence of "ferrule" effect.

"Ferrule" effect

In general, a ferrule is a metal band or ring intended for strengthening. With reference to teeth, a "ferrule" effect is defined as a circumferential (360˚) metal/zirconium collar of the crown surrounding the parallel walls of the residual dental structures extending coronally to the margin of the crown. When abutments' walls are being encircled by a crown, this provides a protective effect by reducing stresses within the tooth (Juloski. J et. al) [7]. Ramos et al [6] report that the ferrule in prosthetic dentistry should be designed and built according to these two following features:

- being built with a material with modulus of elasticity larger than that of dental structures
- being designed not at the expense of residual dental structure

The first feature includes materials like metal or zirconia. You can't get a "ferrule" effect with materials like composite or other plastic materials.

Fig. 1. **Initial X-ray. The root filling of tooth 2.5. is not optimal. A decay beneath the crown margins, secondary decay on tooth 2.6. and bad contour of the filling of tooth 2.4. are observed**

The second feature means that when we want to design ferrule we must be as minimally invasive as possible to the residual dental structures, especially in the zone of the peri-cervical dentin (PCD) [5]. It's important to understand, that the clinician can get a proper "ferrule" effect only if the crown margin encircles natural tooth structures, not restorative materials. Clark and Khademi [5] refer to the remaining tooth structures as 3DF (three-dimensional ferrule). According to them the 3 dimensions of ferrule which have to be considered for the dentine walls of every abutment are:

- thickness
- height
- TOC (total occlusal convergence)

Rapid orthodontic extrusion

Rapid orthodontic extrusion (ROE) is one of the most favorable methods of gaining healthy tooth structures to achieve a proper "ferrule" effect. Movement of teeth by extrusion involves applying traction forces in all regions of the periodontal ligament. (Bach et al.) [3] The bigger forces used in ROE in comparison with slow orthodontic extrusion are one of the reasons why the migration of the tissue supporting the tooth is less pronounced.

Advantages of ROE

ROE is a simple procedure which allows to restore predictably severely destroyed teeth instead of extracting them. In comparison with surgical crown lengthening, which involves additional resection of bone of the adjacent teeth, such osteotomy can be avoided by use of ROE.

Disadvantages of ROE

The devices needed to perform ROE may cause esthetic problems and affect negatively the oral hygiene. Also, the retention period when applying ROE is more extensive – some authors recommend 1 month for every millimeter of extrusion. This makes the duration of the treatment more unfavorable for the patients. Nonetheless, there is also a

Fig. 2. **a – Residual tooth structures after decay removal (occlusal view)**
b – Residual tooth structures after decay removal (palatal view)

risk of ankylosis of the tooth because the periodontal ligament is being teared from the traction. Moreover, intense forces could lead to root resorption.

Indications to ROE *(Bach et al.) [3]*

- for treatment of a subgingival or infraosseous lesion of the tooth between the cemento-enamel junction and the coronal third of the root

Fig. 3. **Pre-endo build up**

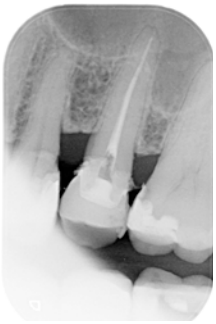

Fig. 4. **X-ray after endo retreatment**

Fig. 5. **Marking the desired depth of the canal on the diamond bur**

Fig. 6. **The bonded piece of wire in tooth 2.5**

- for treatment of a restoration impinging on the biological width
- for orthodontic extraction where surgical extraction is contraindicated

Contraindications to ROE *(Bach et al.) [3]*

- ankylosis or hypercementosis
- vertical root fracture
- root proximity
- when the crown-root ration will become less than 1:1
- insufficient prosthetic space
- exposure of the furcation

Fig. 7. **Fiberotomy**

Case report

Female patient, 46 years old, non-smoker, bad oral hygiene

At the clinical examination was established the presence of an old plaque-retentive PFM crown on tooth 2.5. At the palatal side beneath the margin of the crown was observed a carious lesion. An X-ray was done (Fig. 1) A decision was taken to remove the crown. The carious lesion had already destroyed the mesial, palatal and distal walls of the abutment. After decay removal the level of the residual dental structures was 1 mm sub-gingival, except of the buccal wall (Fig. 2 – a, b). Air abrasion with 50 microns aluminium oxide was performed (Rondoflex, Kavo) and a pre-endo build-up was built with flowable composite (G-aenial flow, GC) (Fig. 3)

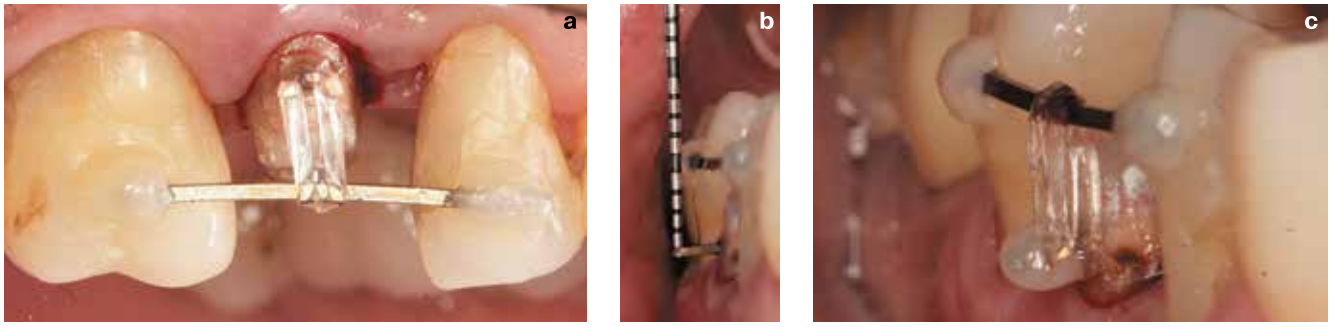

Fig. 8. **a – The piece of wire bonded to the vestibular surface of the adjacent 2.4. and 2.6, parallel to the occlusal plane. Activation of the extrusion with power chain; b – Initial distance between the reference points; c – Fixation of the power chain**

Fig. 9. **After 2 weeks of traction**

Fig. 10. **X-ray after 2 weeks traction. Notice the increased periapical space from the extrusion**

Fig. 11. **X-ray after 4 weeks traction. Notice the increased periapical space from the extrusion**

Fig. 12. **Retention of the abutment with flowable composite**

Fig. 13. **a – Edgeless preparation (palatal view); b – Edgeless preparation (buccal view); c – Temporary crown**

The endodontic retreatment was done in two sessions. The root canals were filled on the second appointment with single cone technique – gutta-percha cone and sealer (Ad-seal, Meta Biomed) (Fig. 4). A screw post (Dentatus) was cemented in the palatal canal with glass-ionomer cement (KetacCem, GC). The abutment was built with dual-cure composite (EnaCem HF, Micerium S.p.A.). Before starting the orthodontic extrusion, the old filling of tooth 2.6. was redone. (Enamel Plus HRI, Micerium S.p.A.)

The ROE was executed by the following technique:

A canal perpendicular to the tooth vertical axis and depth of 3-4 mm was made with diamond bur on the vestibular surface of the abutment. In that canal an about 8 mm long piece of orthodontic wire – stainless steel (0.018x0.025), was adhesively cemented. (Fig. 5,6) A fiberotomy on tooth 2.5. was done under local anesthesia to reduce the coronal migration of supporting tissue. (Fig. 7) A piece of the same orthodontic wire was bonded to the vestibular surface of the adjacent teeth 2.6. and 2.4. To activate the ROE an orthodontic power chain was used. (Fig. 8 – a, b, c). The traction continued for 4 weeks. Every week a fiberotomy was done under local anesthesia. On the second week the power chain was replaced with a new one. (Fig. 9, 10) After 4 weeks 2 mm extrusion was clinically established. (Fig. 11) The retention of tooth 2.5. was made with flowable composite. (Fig. 12) The retention continued for 6 weeks.

After six weeks of retention the orthodontic devices were removed. Finishing, polishing of the abutment and chair-side temporary crown were made. (Fig. 13a, b, c). The preparation technique is shoulderless approach with reverse shoulder on the buccal side. (Fig. 14)

Fig. 14. **Reverse shoulder**

The filling of tooth 2.4. was redone to improve the proximal contour of the tooth. (Enamel Plus HRI, Micerium S.p.A.) (Fig. 15a, b, c, d).

After the maturation of soft tissues around the abutment of 2.5 an impression for definitive restoration was taken. The retraction of soft tissues was made with a single cord technique (Siltrax Plus) (Fig. 16), which was removed from the gingival sulcus right before the moment of taking the impression. The impression was taken in occlusion – one step impression with putty and light flow (low viscosity) silicone. (Fig. 17)

A ceramic-layered zirconium (VITA VM 9, VITA Zahnfabrik; DD Bio Z – High Strength, Dental Direkt) crown was made for definitive restoration of 2.5. (Fig. 18a, b, c) The crown was cemented with glass-ionomer cement (KetacCem, GC) (Fig. 19 a, b, c, d).

Discussion

Tooth 2.5. was completely asymptomatic. On the initial X-ray no periapical lesion was observed. Nevertheless, the filling of the root canal was not optimal. Moreover, the root canal filling was not hermetically sealed since the carious lesion has reached it. Therefore, a decision was made to redo the endodontic treatment.

The screw post was passively cemented in the palatal canal. The screw posts fabricated from "Dentatus" are tapered and follow the conical shape of the root canal. This allows the practitioner to be minimally invasive during the preparation for the post which is essential for preserving the peri-cervical dentin (PCD) (Clark D, Khademi JA) [5]. The PCD is a key factor for protecting teeth's resistance. The post was cemented in the palatal canal because the palatal

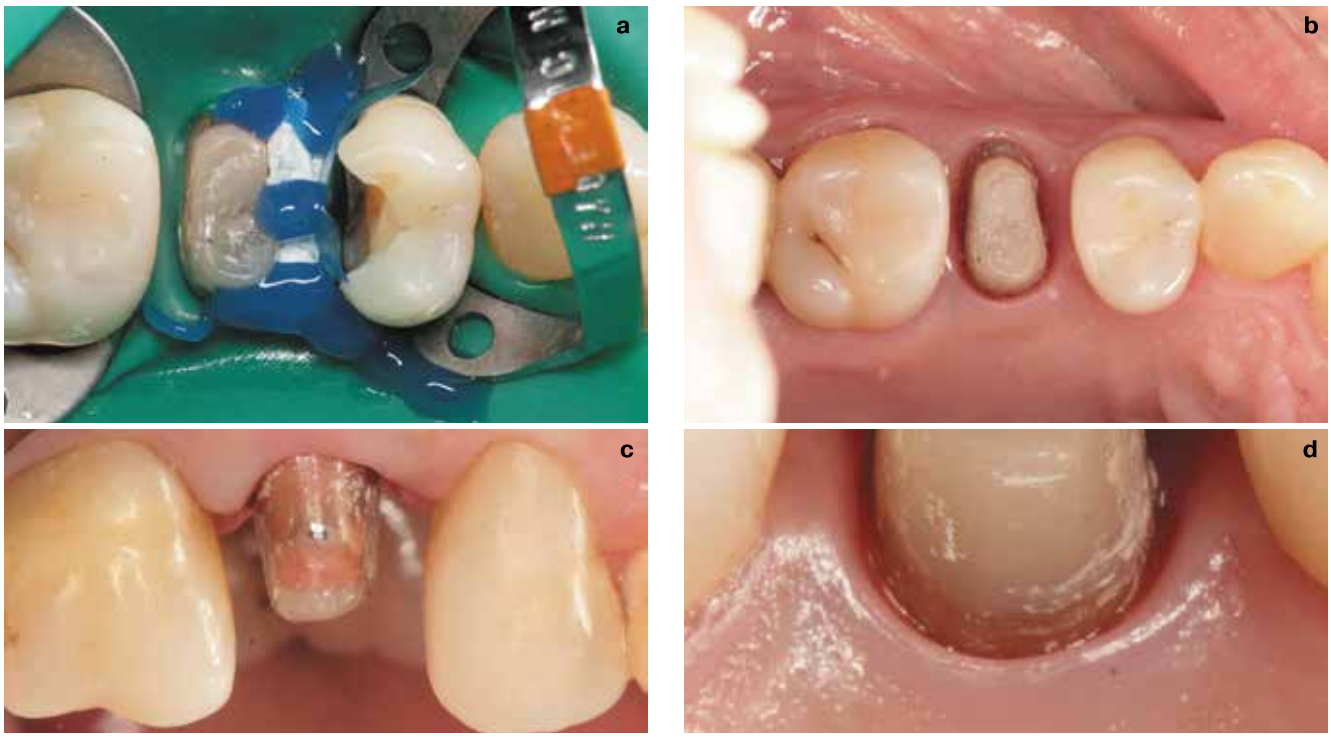

Fig. 15. **a -Matrixing 2.4. – Bioclear matrix system; b -Filling of 2.4. Soft tissues one week after placement of the provisional (occlusal view); c – Filling of 2.4. Soft tissues one week after placement of the provisional (buccal view); d –Soft tissues one week after placement of the provisional (palatal view)**

Fig. 16. **Preparation for impression with retraction cord**

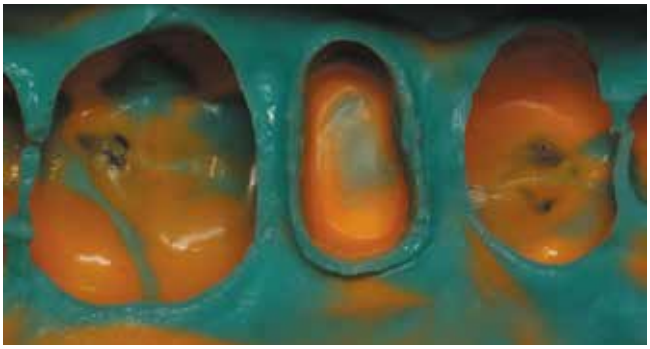

Fig. 17. **Impression for definitive crown**

Fig. 18. **a, b, c – Design of zirconium substructure (Alexandar Savov, DT)**

wall of the abutment was completely destroyed by the carious lesion.

Troiano G. et al. [2] concluded that there is no uniformity in the literature about the strategy used for the orthodontic extrusion. To transmit a force for extrusion, it is necessary to provide a stable anchorage that acts as a support for the discharge of the forces on the element to be extruded. A decision was made the orthodontic devices to be placed on the buccal side of the upper arch. In this way all interferences with the occlusion of the patient were avoided. The technique that was used in this particular case is described by Bach N. et al. Nevertheless, there is a risk of buccal tipping of the abutment because forces are not applied strictly parallel to the vertical axis of the tooth which will undergo the extrusion.

Carvalho et al. [1] compared the orthodontic extrusion alone (Group B) with the same technique combined with fiberotomy and root planning (Group A). They found that in Group A there was a greater amount of dental structure exposed and the level of gingival margin and bone tissues remain stable. In this particular case no coronal migration of soft tissues was needed, therefore a fiberotomy was performed once a week.

Fig. 19. **a – Definitive crown (buccal view) (Alexandar Savov, DT); b – Definitive crown (palatal view) – soft tissues (Alexandar Savov, DT); c – Definitive crown (occlusal view) (Alexandar Savov, DT); d – X-ray 1 month after cementation**

Simon et al. [4], suggested 1 to 3 weeks for the activation and 8 to 12 weeks for the stabilization of teeth in the final position. In this case 4 weeks of traction were followed by 6 weeks of retention. After 6 weeks of retention a provisional with contacts in maximum intercuspidation was made. No intrusion of the abutment was registered.

The filling of tooth 2.4. was redone in a way, which allows the dental technician to create optimal contact area between tooth 2.4. and the zirconium crown on tooth 2.5., which reduces the risk of food impaction.

Ramos et al. [6] conclude that the only way we have to prep the "ferrule" without affecting the 3DF is to avoid any "horizontal" invasion (like shoulder or chamfer), but to create a shoulderless /edgeless preparation. In comparison to bevel, the reverse shoulder on the buccal side protects the resistance form of the abutment and guarantees that over contouring of the crown will be avoided as well.

The main purpose of zirconium substructure design is to provide a good support for ceramic. This reduces the risk of chipping of ceramic. The contact areas with the adjacent teeth are also reproduced with the zirconium substructure. This guarantees that even if chipping is presented the contact area will remain intact and food impaction will be avoided. Zirconia with low translucency was used for the substructure, because of the dark color of the residual dental structures.

CONCLUSION

When dealing with severely destroyed teeth with lack of "ferrule" effect, ROE is a very suitable method for gaining "ferrule" and improving the longevity of our restorations. ROE is a more minimally invasive method compared to surgical crown lengthening which allows us to save unrestorable teeth. Most of the patients prefer to keep their own teeth as long as possible and this treatment method postpones extraction and implant /bridge placement. This makes ROE a very favorable treatment strategy, which is accessible even for general practitioners.

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