A biological conservative approach to complex traumatic dento-alveolar lesions

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Of all the kinds of traumatic dental injury, luxation injuries associated with crown-root fractures deserve special attention due to the particular need for complex multidisciplinary treatment. Clinical experience has demonstrated the need for repositioning of luxated teeth and treatment of crown-root fractures by orthodontic or surgical extrusion and completed with periodontal plastic surgery (gingivoplasty). In many cases the outcome is good conservation and excellent esthetic results. This approach cannot however, always be recommended, for example because of the age of the patient. For this reason, a different protocol is proposed that involves, in addition to orthodontic repositioning of the luxated teeth, (as is required to return teeth to the physiological position), the extrusion, restoration and subsequent re-intrusion to the natural position (without the need for further surgery) of those teeth involved with associated crown-root fractures. Two cases illustrate the use of this proposed technique.
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INTRODUCTION

Of all the traumatic dental injuries to the permanent dentition, crown-root fractures account for 2 to 4% of all diagnosed lesions[1] as compared to 20 to 30% of luxations. Despite the relatively low incidence, they do however merit special attention due to the need for complex multidisciplinary treatment.

As recently stated in the IADT's Guidelines[2] for the evaluation and management of these traumatic dental injuries, the practitioner is presented with a choice of three ways of treating the concurrent crown-root injury after repositioning and stabilizing the teeth using an orthodontic splint. These are either to expose the subgingival fracture site with a gingivectomy (lengthening of the clinical crown), surgical luxation reposition (or extraction with root-rotation and replantation) of the injured tooth or by either slow or rapid orthodontic extrusion.[3,-5] There is a large and frequently conflicting body of literature on these methods, while clinical experience has shown that many cases are resolved with a good conservative and esthetic outcome by use of orthodontic extrusion.[6-8] In many cases, such a rehabilitation approach does not lead to appreciable recovery of the tooth due to the position of the gingival margins and/or to the development of difficult to conceal or unsightly diastemas with the neighboring teeth. In addition, for satisfactory esthetic results, bone plastic periodontal treatment is always necessary as well as prosthetic restoration.[9]

To solve these problems we changed the conventional orthodontic extrusion protocol proposed by Pontoriero *et al*.[10] for crown-root fractures. In addition to orthodontic extrusion movement of the tooth concerned, the modified approach includes also an orthodontic re-intrusion movement into a biologically natural position. This makes certain restorative techniques such as fragment reattachment technique[11,12] and the use of composite resins possible as alternatives to prosthetic crowns. These may be particularly indicated in young subjects (under 18 years), whose dental and skeletal growth cannot be considered as having ceased and who may also not readily offer the degree of collaboration required for surgery. We have also found that about 70% of the subjects that present teeth with crown root fractures are also luxated or subluxated. In such cases an immediate manual repositioning (when possible) and stabilization are required, traditionally obtained with an acid etch/resin splint to adjacent teeth.[13]

Patients are not always seen immediately, so manual reduction is often not possible, and frequently there is luxation or concussion of teeth adjacent to the injured one. For this reason the injured patient is fitted (several hours or days after trauma) with a fixed active orthodontic appliance designed to reposition the luxated

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teeth,[14] but which also can usefully be employed for the extrusion / re-intrusion procedure as is envisaged in the proposed method.

This arrangement gives precise control of the extrusive / re-intrusive movements of the crown-root injured tooth, causes negligible periodontal distress and provides a very good final aesthetic result.

MATERIALS AND METHODS

During the last three years this therapeutic approach has been performed on nearly 25 subjects suffering with various kinds of luxations associated with traumatic crown-root lesions.

This technique, being biologically conservative, is particularly indicated in all those dental luxations (buccal-palatal) and moderate-to-severe crown-root fractures i.e. those involving the root surface up to 3 to 4mm into the gingival sulcus. The method may also be used where lesions are more severe (under ridge fractures) if subsequently completed by plastic bone surgery.

The stages of the protocol employed can be summarized as follows:

- fixed orthodontic appliance bonding (brackets and 0.16 in. x 0.22 in. orthodontic wire) involving at least 8-10 teeth (including those that are injured).
- the engagement of light orthodontic forces (below 40/50g) to reposition luxated teeth (intrusions-extrusions and lateral luxations).
- slight excision of the circular periodontal ligament of the tooth to be extruded, due to the treatment that will be required for the crown-root fracture.
- weekly check-ups and additional minor excisions of the periodontal fibers of the tooth whose crown is to be extruded.
- periapical radiographs were periodically taken to confirm correct extrusion movements and repositioning of luxated teeth in the sockets.
- when the extrusion is completed (on exposure of crown-root fracture line) the injured tooth is debonded (wire and bracket removal); during the same session the injured tooth is restored, after any necessary minimal gingivoplasty, with composite resins or by original fragment reattachment tecnique and, in the case of endodontically impaired teeth, with the sealing of an endodontic carbon-fiber (or glass-fiber) post.[15] When restoration is complete, the brackets and orthodontic wire are reapplied to the dental crown in a suitable position for resuming orthodontic movement.
- activation of a progressive orthodontic re-intrusive movement, which generally takes place more rapidly.[15]
- At the same time the repositioning of luxated teeth is completed and any pulpal complications such as pulpal necrosis are treated, such complications being frequent in these types of traumatic injury.[16-18]

Table 1.

Spinas' Classification for Dental Crowns' Injuries

- Class A: all simple enamel lesions involving a mesial or distal coronal angle, or the incisal edge only *(fig 1).*
- Class B: all enamel-dentin lesions involving a mesial or distal coronal angle and the incisal edge. Where there is pulp exposure we define it as *Subclass b1 (fig 2-3).*
- Class C: all enamel-dentin lesions involving the complete incisal edge, the two angles and at least a third of the crown. Where there is pulp exposure we define it as *Subclass c1 (fig 4-5).*
- Class D: all enamel-dentin lesions involving a mesial or distal coronal angle and the incisal or palatal surface, with root involvement (crown root fractures). Where there is pulp exposure we define it as *Subclass d1 (fig 6-7).*
- Whenever a fractured tooth presents silent or necrotic pulp, we define this situation "h" (in Italian "h" is mute), even when the fracture in NOT complicated (example: Bh = enamal-dentin lesions which involve a mesial or distal coronal angle and the incisal edge, with no direct pulp exposure but with silent-necrotic-pulp) *(fig 8).*

- when the tooth reaches the correct position, particularly with regard to the relationship between the incisal and especially the gingivocervical margins of adjacent teeth, the orthodontic force is stopped.
- a passive orthodontic arch is modeled on the previously splinted teeth and kept in place for nearly 30 days in order to avoid relapse and to permit remodeling of alveolar periodontal structures (PDL and alveolar bone) and good oral hygiene, made also easier by excellent coronal contact points and the restoration of good gingival margin architecture.

The appliances can be removed and a cautious return to functional loading can be advised after this fixation period if the lesions appear to be stabilized.

This technique can be used both, on teeth that have already had root canal treatment, and on vital teeth as well as in all stages of root-apex maturation. Bleaching treatment is usually done in the case of endodontically treated teeth before final restoration of injured teeth.[19]

As a further illustration of the simplicity and advantages of the proposed technique, two clinical cases of complex dental injuries are reported here. The description will identify the crown lesion according to a recently published new Classification (Spinas *et al*, 2002)[20] for more immediate and precise morphologic identification of the dental lesion. This classification is summarized in Table 1.

Case Report I (F.A.)

A 17 year-old woman came to our Center, twenty-four hours after the injury. The patient had been in a car accident and reported severe dental trauma. A tooth fragment was recovered and correctly preserved in saline.

On examination the patient was found to have complex enamel-dentin-cementum with pulpal involve-

Figure 1A. Complex enamel-dentin-cementum with pulpal involvement fracture (D1 class) of tooth #11 is seen. Lateral and palatal luxation of #21 is noted.

Figure 1B. Radiograph of teeth #11, 21 is seen.

Figure 1C. A fixed orthodontic appliance was positioned as a splint.

Figure 1D. A rectangular wire 0.16 x 0.22in. was placed.

ment fracture (D1 class) of tooth #11; lateral and palatal luxation of #21 (preventing correct dental occlusion) (Figure 1 A) causing also occlusal trauma of the teeth 31–32 and considerable pain and muscle contraction.

Cold sensitivity tests showed: 12++; 11—; 21+; 22++; (where ++ indicates a positive tooth response and - indicates a negative tooth response).

Routine radiographic exams and photographs were taken. Radiographic examination provided further evidence of the severe luxation of tooth 21 (Figure 1 B).

Immediate endodontic treatment was done on #11 because of the severe pulpal exposure noticed.

A fixed orthodontic appliance, (brackets and 0.16 in. x 0.22 in. rectangular wire) (Figure 1 C), was positioned as a splint (from teeth 15 to 25) for the injured teeth and also to provide re-intrusive and buccally displacing forces on tooth 21. The aim was also to obtain the rapid normal occlusion of the dental arches (Figure 1 D).

A 15-day follow-up was scheduled after orthodontic splint activation and control. The patient was instructed to maintain the appliance unloaded and how to do optimal oral hygiene. Standard anti-inflammatory and antibiotic therapy was prescribed, as well as a soft diet.

At the 15 days follow-up, the orthodontic wire was re-contoured and #21 repositioning process was activated. Radiographs and photographs were taken (Figures 1 E-F).

By this point, after 30 days, #21 was correctly repositioned in relation to the socket and normal occlusion of the dental arches was now possible. In the meantime #11, with a severe crown-root fracture, was extruded so that

Figure 1E. Frontal view at 15 days. The orthodontic wire was recontoured and #21 repositioning process was activated.

Figure 1F. Radiograph at 15 days.

Figure 1G. After 45 days, the repositioning allowed full restoration by reattachment of the original fragment.

Figure 1H. Fragment to be reattached.

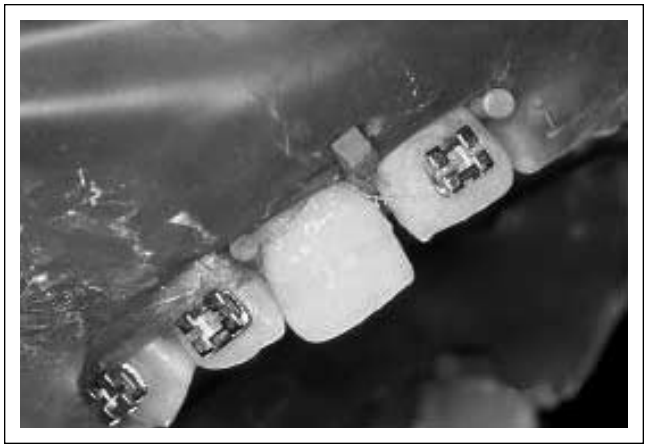

Figure 1I. Fragment in place.

Figure 1J. As expected #11 was noticeably extruded, so it was intruded.

Figure 1K. Periapical radiograph.

Figure 1L. Re-intrusion occurred for 30 days, then 30 days of passive wire to obtain optimal positioning.

Figure 1M. Eighteen months after treatment.

Figure 1N. Radiograph of 18 months post treatment.

the severe coronal lesion could be restored using the original crown fragment. After 45 days extrusion, with weekly check-ups and slight periodontal excisions,[10] the tooth was repositioned such that the coronal-palatal margin exposure was enough to allow full restoration by reattachment of the original fragment (Figures 1 G-H-I).

As had been expected, the restored #11 was now notably extruded after the crown restoration (Figure 1, I) and so re-intrusion was done to obtain a flawless periodontal design (Figures 1 J – K) without the need for any further work on periodontal fibers. Alignment of the gingival margins with neighboring teeth was good.

The required re-intrusion was obtained over a 30-day period. Once the optimal positions were achieved, the teeth were splinted with a passive orthodontic arch for nearly 30 days for complete periodontal stabilization.

After this period the splint was removed, followed by finishing and polishing of the crowns concerned (Figure 1 L). Finally buccal and palatal probings were performed around #11 and tooth #21, giving a quite normal socket probing depth of between 1.5 and 2.5 mm.[21]

Ensuing radiographic examinations (1, 6, 12, and 18 months) were used to check continued good aesthetic and functional results for the teeth that had been injured, while a very high level of patient satisfaction was reported (Figures 1 M-N).

Figure 2A. Complex fracture of tooth #12, palatal luxation of #11 and fracture of #21.

Figure 2B. Radiograph of #11 and #21.

Figure 2C. Fractures of #12 and #21,

Case Report II (I.S.)

A 16-year-old girl came to our Dento-Facial Trauma Centre 48 hours after the injury. The patient had fallen down steps at her workplace with resulting severe orofacial trauma. She was brought to the nearest emergency department, where a severe wound to the lower lip was treated. A tooth fragment retained inside the wound was removed, but not preserved. No further dental treatment was done over the following two days.

At our examination the patient presented with complex enamel-dentin-cement fracture (class D type)[20] of tooth #12; extrusive and palatal luxation of #11 (preventing correct arch occlusion); complicated enamel-dentin fracture with pulpal involvement (class b l type) of #21 with concussion; simple enamel fracture (Class A type) of #41 and the presence of infraction lines in #42 (Figures 2 A-C).

Cold sensitivity tests showed: 12++; 11—; 21+++; 22++; routine radiographic and photographic images were taken. Radiographic examination provided us with further evidence of the extrusive luxation of #11 (Figure 2 B).

A palatal coronal fragment of #12 was removed as it was connected to the gingiva by periodontal fibers alone. This was followed by $Ca(OH)_2$ pulp capping and covering with composite resin. Calcium hydroxide capping and composite resin covering were also performed to treat the injuries to #21.[18,22]

A fixed orthodontic appliance (brackets + 0.16 in. rectangular wire) was immediately put in place to splint from #14 to #24. This also exerted reintrusive and buccally

Figure 2D. A fixed orthodontic appliance was placed to restore normal occlusion as quickly as possible.

Figure 2E. Re-intrusive and buccally displacing forces on #11 and coronal extrusion force on #12.

Figure 2F. At 15 days persistent negative responses of #11 was noted and endodontics done.

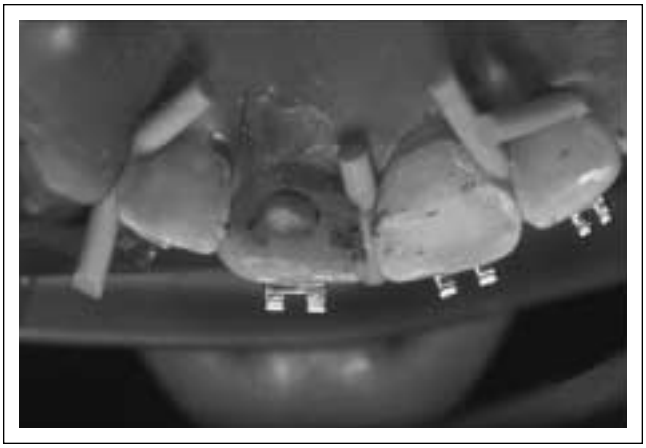

Figure 2G. Bleaching was done after completion of endodontic treatment.

displacing forces on luxated #11, coronal extrusion forces on #12 and had the additional aim of restoring normal occlusion of the dental arches as quickly as possible. (Figures 2 D-E)

A 15 days follow-up was scheduled for splint activation and monitoring. The patient was instructed not to exert any functional loading and antiinflammatory, antibiotic therapy and a soft diet were prescribed.

At the 15 days follow-up tests showed the persistent negative response of #11. The orthodontic wire was recontoured and activated.[23] Radiographs and photographs were taken, Figure 2 F.

By this point, after thirty days, #11 was repositioned with a normal socket position making normal occlusion of the dental arches possible.

At the next follow up (nearly 30 days after the injury), as #11 continued to give a negative response to cold sensitivity tests as well as slight crown discoloration, it was decided to proceed with endodontic treatment (Figure 2 G). After the completion of root canal treatment, a bleaching treatment was done to reduce the observed initial crown discoloration.[19]

In the meantime, utilizing the intrusive movement of #11, extrusion of #12 was done. This latter tooth had maintained a normal response to the pulpal sensitivity test and the extrusion was performed to more conveniently expose the palatal fracture line.

Tooth 12 was sufficiently extruded after 30 days that a simple composite resin restoration of the palatal crown-root fracture was now possible (i.e. with the

Figure 2H. Palatal fracture line exposed well beyond the gingival margin.

Figure 2I. With bleaching completed, a composite resin restoration was done on tooth #21 and on incisal edge of tooth #12.

Figure 2J. Incisal edge of tooth #12 restored.

Figure 2K. Palatal view of restored teeth.

palatal fracture line exposed well beyond the gingival margin) (Figure 2 H).

Re-intrusion of #12 was then done to obtain a flawless periodontal design (Figure 2 L); a process that was completed over a period of about 30 days. In the meantime, bleaching treatment of #11 was completed, a composite resin restoration was done on tooth #21 (Figures 2 I –J –K), and also on tooth #12 (incisal edge) and tooth #11 (incisal edge) to improve the aesthetic appearance of the injured tooth. After 30 days, good stabilization of all the teeth involved in the trauma was obtained, the orthodontic fixed splint was removed (Figure 2 M).

At the radiographical and clinical follow-ups (1 month, 6 months and 1 year) the continued good appearance and functionality all those teeth involved in this complex dento-alveolar injury was verified (Figure 2 N). No active periodontal lesions were revealed: periodontal probing socket depth of the teeth was now within normal ranges (2.5 to 3 mm).[21,24] The patient expressed her satisfaction with the results obtained.

DISCUSSION

The complex therapeutic approach described above has proven to be very useful and an effective alternative from the point of view of biological point conservation to traditional techniques, especially when luxated teeth can no longer be manually repositioned, i.e. more than 48 hours after the traumatic event.[2,9,18,26] The contemporary crown-root fracture treatment of the front teeth sector involves different ways of exposing the subgingival fracture site, i.e. by gingivectomy or simple orthodontic extrusion always completed by bone surgery and final prosthetic treatment.[3-5,9,10] This alternative treatment option permits optimal aesthetic and functional restoration, while not disturbing or harming the periodontal and alveolar tissues of the injured teeth. The technique requires good orthodontic skills and a clear understanding of pulpal and periodontal disease treatments.[18,22]

The cases treated by the authors to date have involved patients from 8 and to 30 years of age, with the same success rate in adult as in adolescents. The technique has proven to be mandatory in the treatment of

Figure 2L. Periapical radiograph.

Figure 2M. After 30 days, good stabilization of all teeth involved in trauma was achieved and the fixed orthodontic appliances were removed.

Figure 2N. One year follow-up.

those complex injury cases where many teeth are involved simultaneously, and where crown-root lesions are associated with luxated neighboring teeth. The use of the orthodontic procedures permits easy movements and vertical and sagittal repositioning of the luxated elements.

The above cases also show how severe dental traumas can be successfully resolved with minimal use of invasive techniques (no prosthetic appliances were usually required) and most of all with low patient collaboration requirements and little distress.

No complications like root resorption[25,27,28,15] were observed (maximum follow up three years); so that prognosis is generally good also when orthodontic movements are performed nearest to the injury time.

CONCLUSION

We believe this approach, though it requires some orthodontic knowledge, and is more time consuming than surgery, could be a useful alternative tool to consider when presented with lesions that would result in anatomical and esthetical damage using conventional techniques, especially if the dental and skeletal growth is not complete.

Spinas' Classification for Dental Crowns' Injuries

- Class A: all simple enamel lesions involving a mesial or distal coronal angle, or the incisal edge only (Figure 1).
- Class B : all enamel-dentin lesions involving a mesial or distal coronal angle and the incisal edge. Where there is pulp exposure we define it as *Subclass* b1 Figures 2, 3).
- Class C: all enamel-dentin lesions involving the complete incisal edge, the two angles and at least a third of the crown. Where there is pulp exposure we define it as *Subclass c1* (Figures 4, 5).
- Class D: all enamel-dentin lesions involving a mesial or distal coronal angle and the incisal or palatal surface, with root involvement (crown root fractures).

Where there is pulp exposure we define it as *Subclass d1* (Figures 6, 7).

- Whenever a fractured tooth presents silent or necrotic pulp, we define this situation "h" (in Italian "h" is mute), even when the fracture is NOT complicated (example: Bh = enamel-dentin lesions which involve a mesial or distal coronal angle and the incisal edge, with no direct pulp exposure but with silent -necrotic- pulp) (Figure 8)

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