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Crown fragment reattachment: report of an extensive case with intra-canal anchorage

CASE REPORT

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Abstract – This paper describes the resolution of an extensive complicated crown-root fracture of an endodontically treated maxillary central incisor. Initially, the fractured crown was splinted to the adjacent teeth with orthodontic wire and composite resin. Subsequently, the crown fragment was reattached by means of a fiber post using a hybrid composite resin. Early stage success was achieved with the observance of normality in function, esthetics, and health of the tooth and surrounding periodontal structures. An athletic mouthguard was fabricated to prevent further trauma. Advantages, disadvantages, and prognosis of the treatment presented are discussed.

Dental trauma is a relatively prevalent condition that may present restorative challenges. It has been reported that approximately 20% of children experience a traumatic dental injury to their permanent teeth before leaving school (1), and approximately one in six adolescents and one in four adults suffer a traumatic dental injury in their lifetime (2, 3). Epidemiologic studies show that most dental injuries involve just one tooth and that the majority of the affected teeth are maxillary central incisors (3–5).

Dental trauma on maxillary incisors has been associated with certain conditions such as overjet, gender, race, ethnicity, and age (3–8). In addition, these injuries have also been associated with the practice of contact sports. Shayegan et al. reported that the practice of sports was the cause of 4% of dental injuries among girls and 8% among boys (5). Huang et al. concluded in a recent review that, among the main events related to traumatic dental injuries, contact sports were described in the literature as being responsible for up to 49% of injuries. In this study, the percentage found for 'sports and leisure' was 31% (9).

In the permanent dentition, the most common type of dental injury is the uncomplicated crown fracture, which accounts for over half of tooth traumas (6). Uncomplicated crown fractures can typically be treated according to the extent of hard tissue loss with enamel recontouring, composite bonding, or porcelain veneers (6). Complicated crown and crown-root fractures, on the other hand, represent a dilemma for the restorative dentist. While uncomplicated crown fractures can be managed with conservative restorative options, and severe complicated crown-root fractures typically are unrestorable, complicated crown and crown-root fractures where both the crown and the root are available and relatively intact may sometimes be managed with a tooth fragment reattachment technique using intra-canal anchorage. While this treatment option may not provide as much predictability as the extraction of the tooth and the placement of a single-tooth implant, the reattachment of large coronal segments may still be advantageous in many situations (10, 11).

The objective of this case report is to present a conservative approach for the treatment of an extensive crown-root fracture of an endodontically treated maxillary central incisor. Advantages, disadvantages, and prognosis of this treatment modality are discussed.

Clinical case report

A 20-year-old healthy African-American female patient was referred to our clinic with a recent history of a sport-related injury (4 days prior to the referral) leading to loosening of her maxillary left central incisor. She was otherwise healthy, with no signs and/or symptoms of other trauma-related complications. The patient reported that she had a dental traumatic injury on this same tooth previously, although the timing of that previous injury could not be precisely verified. On clinical examination, we noted a complicated horizontal crown-root fracture of tooth #9 (FDI #21), presenting mobility, asymmetry, and tenderness of the immediately adjacent periodontal tissues (Figs 1 and 2). The fracture line was localized just below the gingival margin on the buccal and lingual surfaces, with no visible damage on the coronal fragment. At this initial visit, the fragment was being held in place by the periodontal ligament (Fig. 3). A periapical radiograph revealed slight enlargement of the periodontal ligament, previously completed (adequate) root canal treatment, a large composite

Fig. 1. Frontal extra-oral view of 20-year-old female patient presenting following dental trauma on tooth #9 (FDI #21, maxillary left central incisor).

Fig. 3. Intra-oral lateral view of the injured area. Note extreme mobility on the traumatized tooth.

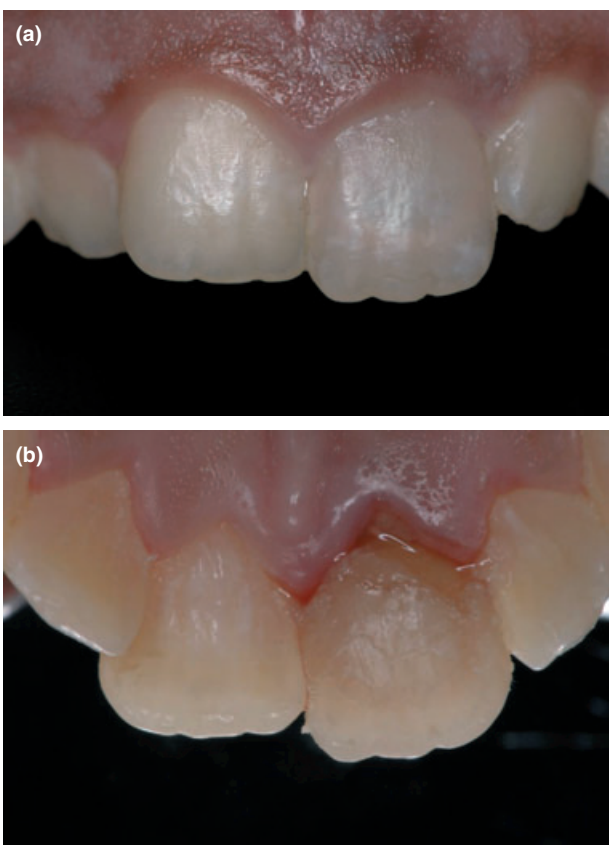

Fig. 2. (a) Frontal and lingual (b) close-up views of the injured area. Note the mismatch in the incisal alignment between the right and the left maxillary central incisors.

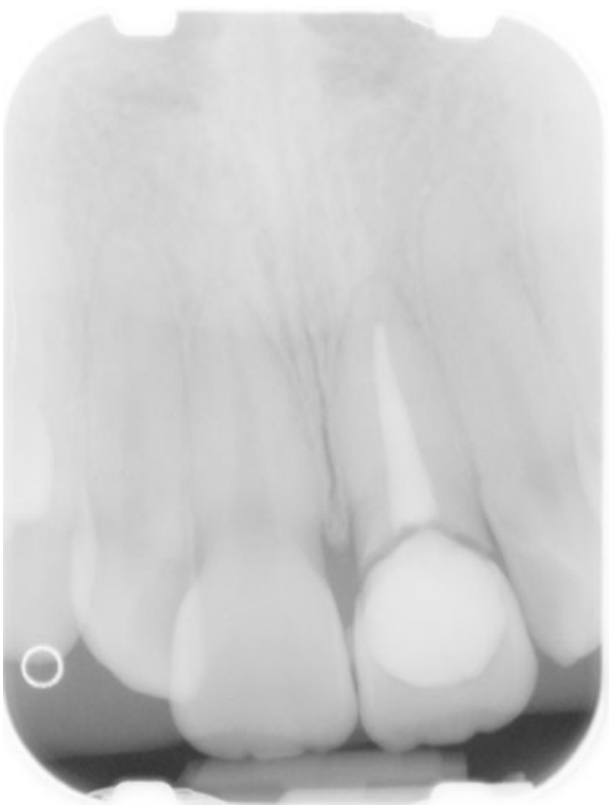

Fig. 4. Intra-oral periapical radiograph of the injured area. The X-ray revealed slight enlargement of the periodontal ligament, previously completed (adequate) root canal treatment, a large composite restoration on the endodontic access, and absence of periapical pathosis and/or dental caries.

restoration on the endodontic access, and absence of periapical pathology and/or dental caries (Fig. 4). No root or bone fracture was observed. The adjacent teeth responded within normal limits to vitality testing. Based on the clinical and radiographic findings, a diagnosis of complicated crown-root fracture was achieved, and both an urgent and a definitive treatment plans were proposed.

Urgent treatment

The goal of the urgent treatment was to achieve patient comfort and reasonable esthetics while maintaining health and providing limited function. The fractured coronal fragment was stabilized with a rigid splint bonded to each adjacent tooth as follows: the area was

Fig. 5. The fractured crown segment was repositioned and splinted with a rigid splint and composite resin. Compare the incisal level of the fractured crown in this figure with that on Fig. 2a.

Fig. 7. Extra-oral view of the splinted crown (compare with Fig. 1).

Fig. 6. Lingual close-up (mirror image) of the splinted crown.

Fig. 8. Intra-oral view of the injured area 2 weeks after the splint, when the patient presented for reattachment.

anesthetized, the fragment was superficially cleaned with a curette and gauze to remove supra-gingival plaque (the fragment was not displaced at this visit), the coronal fragment was repositioned using finger pressure, and the rigid splint was bonded to the teeth using an acid-etch technique and composite resin (Figs 5–7). The position of the traumatized tooth was verified and instructions to prevent damage to the splint were given to the patient, who was also advised to avoid any activities that could lead to further trauma.

Definitive treatment

On the second visit, 2 weeks after the urgent treatment was provided, the patient presented with a much improved soft tissue aspect, and no reports of tooth mobility or any discomfort (Fig. 8). Options for definitive treatment were presented to the patient and her guardian. These options included extraction of the tooth and restoration of the site with an implant-retained crown, crown lengthening and/or orthodontic extrusion of the root and restoration with a post-and-core and crown, and reattachment of the coronal fragment with an intra-canal anchor. The patient and guardian were informed that the location of the fracture could determine whether or not the tooth could be saved, and that could only be determined after the patient was anesthetized and a conservative soft tissue flap was raised. After all aspects of these options were presented and discussed, the patient and guardian opted for reattachment of the coronal fragment, should it be viable. The main reasons were the conservative aspect of this treatment option, the fact that the patient would still retain her natural tooth, and the fact that the other options could still be pursued if the reattachment fails.

A silicone index was fabricated using a putty polyvinylsiloxane impression material to generate a reliable positioning device to reattach the fractured crown (Fig. 9). After anesthetizing the area, the splint was carefully removed from the fractured tooth, and a conservative gingival flap was raised for access, to determine where the margin of the fracture was, and to evaluate the need for crown lengthening. The flap consisted of an intra-sulcular incision on the facial and lingual surfaces of the fractured tooth as well as half of

Fig. 9. A silicone index was fabricated using a putty polyvinylsiloxane impression material to generate a reliable positioning device to reattach the fractured crown.

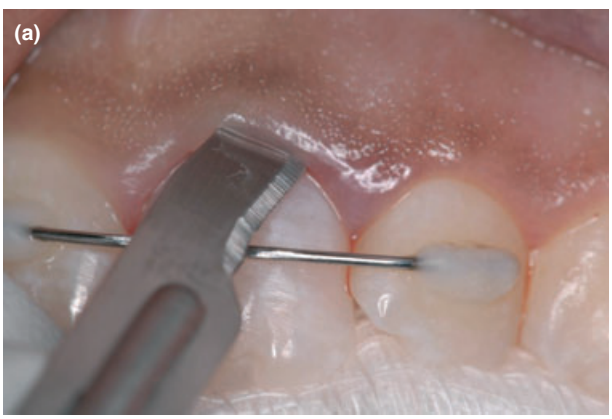

Fig. 10. (a) An intra-sulcular incision is made extending from (and including) the distal and mesial papilas of the fractured crown, on both facial and lingual aspects. (b) After the incisions were completed, the fracture crown is carefully removed. Note the architecture of the soft tissue maintained after removal of the fractured crown.

the surfaces of the adjacent teeth (Fig. 10a). As the coronal fragment was only retained by the pericoronal periodontal ligament, it detached immediately after the incisions were made (Fig. 10b). Upon direct inspection, we determined that the fracture line did not violate the

Fig. 11. Incisal view, noting no violation of the biologic width.

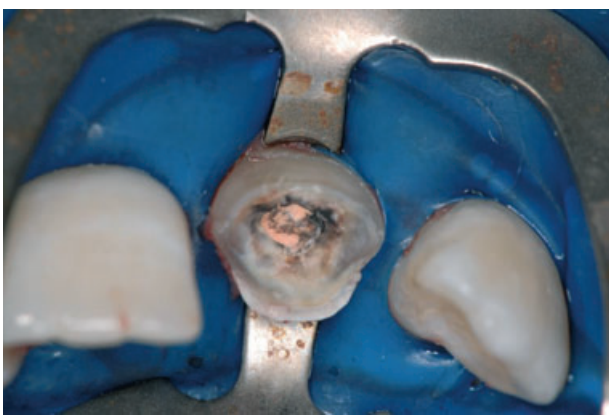

Fig. 12. The field is isolated with rubber dam.

biologic width (Fig. 11), and therefore osseous recontouring was not needed. A rubber dam was placed and stabilized with a #212 retainer (Fig. 12) and the coronal fragment positioned to verify fit (Fig. 13). The length of the remaining root was determined using a periapical radiograph, and the root canal space was prepared for placement of a prefabricated fiber post (Figs 14 and 15) (D.T. Light Post Illusion #2, Bisco, Schaumburg, IL, USA). The post was luted following manufacturer's instructions. The coronal aspect of the post was sectioned to accommodate for the crown fragment while still providing enough length for resistance and retention form (Fig. 15). After complete removal of the old composite and most remaining dentinal tissue, the internal aspect of the fragment was etched for 30 s with phosphoric acid, rinsed, coated with two coats of adhesive Single Bond (3M ESPE, St. Paul, MN, USA), lightly dried to evaporate the solvent, and light-cured. Then, a hybrid composite (Ceram-X Duo, Dentsply Caulk, Milford, DE, USA) was inserted on the inner (lingual) surface of the fragment and on the cervical portion of the remaining tooth (Figs 16 and 17). The crown fragment was immediately repositioned with the help of the silicone index (Fig. 18), the excess composite

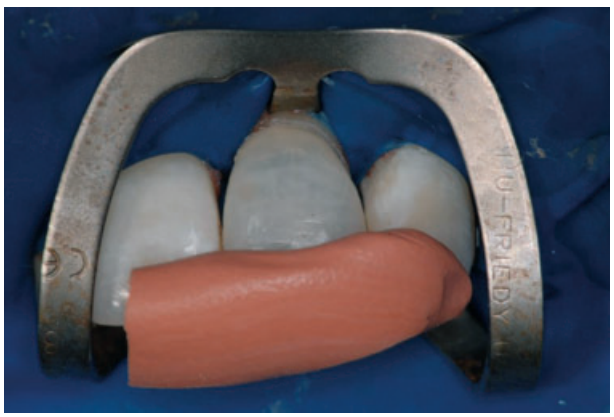

Fig. 13. The silicone index is trimmed, and the crown fragment is tried in place. Note very good adaptation between the crown fragment and the tooth at the cervical aspect.

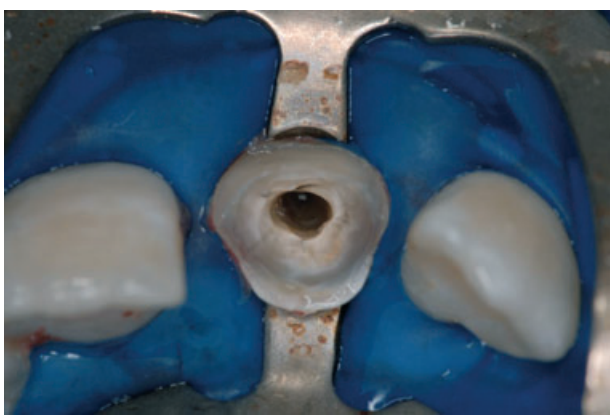

Fig. 14. Carious dentin and gutta percha are removed from the entrance of the root canal.

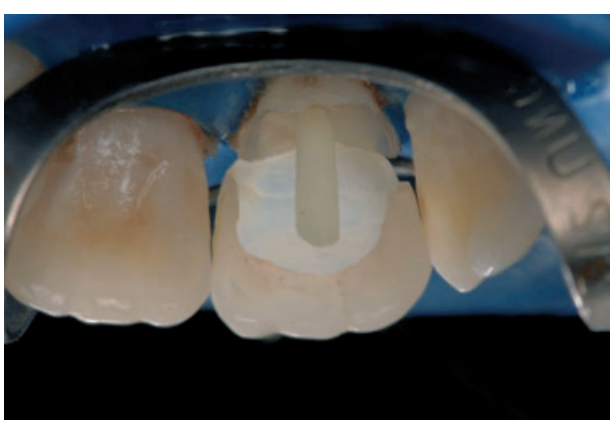

Fig. 15. After the post space is adequately prepared, a prefabricated fiber post is luted with a composite resin-based cement. The crown segment is tried after of the post has been cemented and sectioned.

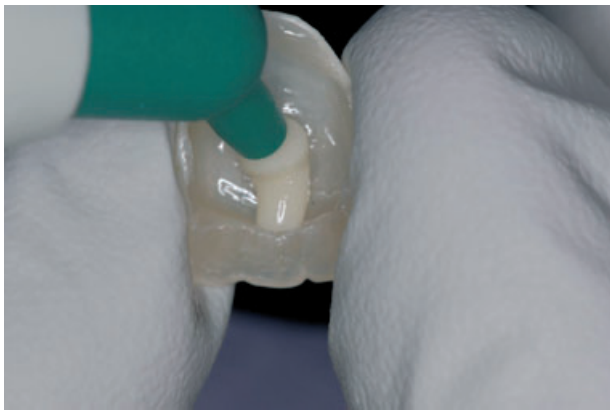

Fig. 16. After etching and bonding, a restorative composite resin is applied in the crown segment.

Fig. 17. The same restorative composite is applied to the cervical aspect of the tooth.

Fig. 18. The crown fragment was immediately repositioned with the help of the silicone index.

was removed and the reattached crown was light-cured for 40 s. Composite material was incrementally added to the lingual surface to reestablish natural anatomy and contour (Fig. 19). Flame-shaped carbide burs and #12 BP blades were used to remove excess of material and finish the restoration. The restoration was thoroughly polished with Jiffy Points (Ultradent, South Jordan, UT,

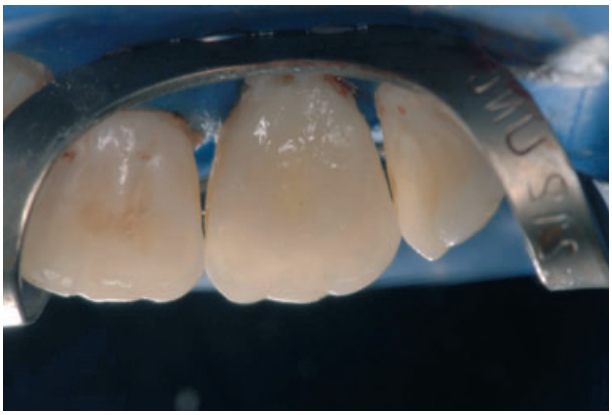

Fig. 19. Lingual view (mirror image) after restoration of the lingual aspect with composite resin.

Fig. 20. Facial view immediately after reattachment and removal of the rubber dam. Note the excellent adaptation between the crown fragment and the tooth at the cervical aspect.

Fig. 21. Frontal intra-oral view after the soft tissue has been sutured.

USA) and 30-flutes carbide burs. Subsequently, the rubber dam was removed and the gingival tissue repositioned for sutures. Figures 20 and 21 illustrate the

Fig. 22. Frontal extra-oral view of the patient's smile 2 weeks after the reattachment.

reattached crown immediately after removal of the rubber dam before and after sutures were placed, respectively. The occlusion was carefully checked and adjusted, and the patient was instructed to return within 2 weeks for a follow up. Other routine postoperative instructions were given in writing.

Follow up

The patient was observed 2 weeks after the reattachment, and presented with the tooth asymptomatic and no complains of discomfort (Fig. 22). The intra-oral exam revealed that the soft tissue was healing within normal limits, and that the reattachment was stable (Figs 23 and 24). A PA radiograph was non-contributory (Fig. 25). The patient was very pleased with restoration. The patient was given a custom-made athletic mouthguard, along with instructions for use and other recommendations regarding trauma prevention.

Discussion

The treatment performed and presented on this clinical case report is one of many possible options that could have been used to resolve the clinical problem. Other treatment options may have included extraction of the tooth and placement of a single-tooth implant. Given the absence of adequate ferrule, post-and-core and crown restoration would probably not be a good option unless the tooth was orthodontically extruded and/or crown-lengthened, which would result in a discrepancy in the cervical diameter of the tooth compared with the maxillary right central incisor. The decision ultimately must be made taking into consideration advantages and disadvantages of each technique and, more importantly, in conjunction with the patient and his/her own desires and limitations. In addition, the clinician should always favor the most conservative alternative, the treatment option that leaves other options still 'on the table' while providing for adequate esthetics, function, and an acceptable prognosis.

One of the advantages of the presented technique is the possibility to use the patient's own tooth. Recent

Fig. 23. Frontal intra-oral view of the reattached crown 2 weeks after the reattachment.

Fig. 24. Lingual view (mirror image) of the reattached crown 2 weeks after the reattachment.

Fig. 25. Post-treatment intra-oral periapical radiograph of the injured area.

studies have shown that oral disorders have biological, emotional, and psychosocial consequences for the individual. Ramos-Jorge et al. found that adolescents whose teeth have been esthetically treated for enamel-dentin fractures run a greater risk of presenting oral impact on daily performances when compared with adolescents who have never suffered dental injuries. The study also showed that adolescents treated for enamel-dentin fracture had a risk of presenting an impact on daily activities 3.3 times greater than adolescents that had never experienced dental trauma (12). When the fragment is viable and can be reattached, the tooth fragment reattachment has a favorable psychological outcome.

Another advantage of the tooth fragment reattachment is the possibility of a very esthetic result. This is especially true if the fragment is not excessively restored and fragmented. Shade selection is also an important step to optimize the esthetic outcome. This was the case in our report. As the reader can perceive, the fragment was much damaged on the lingual surface as a result of previous trauma and treatments. Once the fragment was properly cleaned from any remaining old composite, the remaining tooth structure could be described as a natural veneer. The dentin aspect of the crown was mostly replaced with composite. The superposition of enamel and composite could allow a very natural appearance of the restoration, mimicking the translucency of the adjacent tooth.

The function of the tooth is also an important characteristic to be restored by the chosen restorative option. In the case here presented, the restoration of the tooth in question would necessarily imply the use of a post system mainly because of the lack of tooth structure coronal to the gingival margin to support the restoration/fragment. A fiber post system is a logical option because it can be bonded to the root canal walls and to the coronal fragment, and it presents adequate physical and mechanical properties. The post and core material should be esthetically compatible with the crown and surrounding tissues (13). Some concern exists that post and core separation is more likely to occur when composite is used as a core material (14). Realistically, in this case composite was the only material we could use that combines esthetics and mechanical properties. Resin luting agents show good adhesion to carbon fiber posts and glass fiber posts (15). It has been also postulated that the stress distribution characteristics of the bonding materials could reinforce the tooth (16). However, a flexible post can cause failure of the bonding interface between core and dentin due to fatigue of the adhesive interface.

A careful and correct bonding protocol is also crucial if the intent is to maximize the longevity of the

restoration. With this in mind, we proceeded to remove all of the old and compromised composite as well as most of the dentin from the fragment before reattaching it. Dentin removal from the fragment before bonding has been shown to increase the bond strength and prevent the eventual darkening of the devitalized dentin fragment (17). Capp et al. found that tooth fragments reattached by bonding, after previously having dentin removed from the fragment, exhibited better fracture strength than teeth with dentin not removed (17). Although the limitations of an *in vitro* load-to-fracture study are well known – making rather difficult to extrapolate the findings to a clinical situation – their conclusion relies on the fact that more enamel surface area is available for bonding (17). This argument can be considered valid if we think that enamel bonding is more predictable than dentin bonding over time.

It is difficult, if not impossible, to determine how long the restoration presented in this case report will provide a reasonable degree of esthetics and function. The literature does not provide strong evidence to support or condemn the technique we used. It is evident that in dental trauma the pattern of fracture is different from case to case. This variability makes it difficult to perform well-controlled longitudinal studies, even when the same restorative technique is used. And, ultimately, the pattern and location of the fracture line/margin are the most important factors when deciding which technique to use. However, an increasing number of case reports is becoming available, and if clinicians are engaged enough to report follow ups, a more detailed analysis could be performed in the future to extract reliable conclusions based on clinical reports. In any case, if the young patient could benefit from the restoration for some years before receiving a more complex – and expensive – prosthetic solution, our objective will have been achieved.

Conclusion

Traumatic dental injuries are common among children, adolescents, and young adults. A conservative restorative option is described as a treatment for a crown-root fracture. The fragment reattachment was made possible with the use of an intra-canal fiber post system. Prognosis is uncertain as a result of a lack of longitudinal studies comparing the same pattern of fracture as well as the same restorative technique. The main objective of the presented technique-restoration is to provide a highly conservative approach that combines esthetics and function, postponing the use of a more aggressive prosthetic solution.

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