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Replacement of Severely Traumatized Teeth with Immediate Implants

Timing of treatment is of utmost importance with every dental injury. In most cases, the sooner the involved teeth are attended to, the better their prognosis. For several types of trauma, the prognosis is very guarded, even when treated immediately. This is especially true when the root fractures horizontally close to the cervical area.

In children and adolescents, every effort should be made to retain the root portion until they are fully grown; an implant can then be placed, usually at 17 to 19 years of age. Root submersion is the usual treatment of choice for these types of injuries, and in many cases, endodontic therapy is unnecessary.

For adults, however, an immediate implant with immediate loading has been suggested. Prerequisites are an intact labial facial cortical plate over the roots and extraction of the root atraumatically without any damage to the remaining bone. To investigate this possibility, Sheng et al from Zhejiang University, China, studied a case series of 15 patients with a total of 23 injured teeth who had been treated with immediate implants after severe trauma had rendered the tooth or teeth hopeless. All 15 patients had excellent functional and esthetic results, and no implants showed radiolucency, peri-implant suppuration or mobility.

The main problem after immediate implant placement and loading is the unpredictable stability of the soft tissue. Often, the labial bone is thin and is lost over time, resulting in an unsupported gingiva that ultimately recedes and causes esthetic problems, even though the implant is still functional.

Case selection for this type of treatment is very important. Ideally, the patient should have a thick, flat biotype with no bone lost labial to the alveolar bone. The thickness of the labial bone should be >1 mm, and the distance from the crest of the bone to the gingival margin should be <3 mm.

The decision to save or replace a traumatized tooth with an implant must be carefully made and must include a thorough discussion with the patient.

Information about reasonable expectations regarding success has to be discussed, and the patient needs to be warned that any treatment may require multidisciplinary involvement by different specialists beyond the treatment rendered by the restorative clinician.

Sheng L, Silvestrin T, Zhan T, et al. Replacement of severely traumatized teeth with immediate implants and immediate loading: literature review and case reports. Dent Traumatol *2015;doi:10.1111/edt.12201.*

Pulp Canal Obliteration After Reimplantation of Avulsed Teeth

Complete avulsion is a devastating injury for both the tooth and the patient. The success rate for reimplanted teeth varies from 10% to 80%. The main issue for every avulsed tooth is the extraoral time and storage conditions. A tooth kept dry for >1 hour after avulsion has a very poor prognosis. However, if it is reimplanted within a few minutes, a favorable prognosis is likely. A tooth not reimplanted at the site of the injury is best kept in a special storage medium. Milk is a very good, and readily available, alternative to specialized media.

A tooth stored in milk (≤2 hours) can have almost as good a prognosis as an immediately reimplanted tooth. Commercially made saline and saliva are also possible alternatives, but the tooth should never be kept in water. The difference in osmolarity between the periodontal ligament cells and the water causes the cells to absorb water until they literally burst.

For teeth with a closed apex, endodontic therapy should start 7 to 10 days after reimplantation. For an immature tooth with an open apex, there is the hope that the pulp will revascularize after reimplantation.

The overall success of revascularization has been reported to be between 18% and 40%. Again, it has been shown that the less time the tooth is outside of the socket (maximum, 40 minutes) and the larger the apical opening (>1.1 mm), the better the chance for success. Immature teeth have to be carefully monitored, and if signs of infection become evident, either by apical or lateral radiolucencies on radiographs or by the patient's symptoms, endodontic therapy must be initiated immediately.

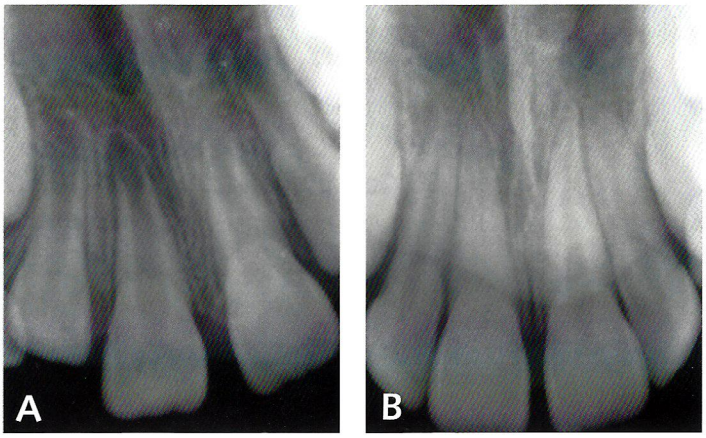

Figure 1. (A) Radiograph immediately after reimplantation of tooth #8. (B) Radiograph of the same tooth 4 years later, showing complete PCO. The tooth still responds normally to electric pulp testing and shows no signs of root resorption or infection. Continued yearly reevaluation is recommended. (*Images courtesy of Dr. Asgeir Sigurdsson.*)

To investigate both the overall success of revascularization and posttraumatic complications of immature teeth, Abd-Elmeguid et al from the University of Alberta, Canada, conducted an electronic search of MEDLINE, PubMed, Cochrane Library and Web of Science databases for available literature. After reviewing 257 studies, they found 6 that met all the inclusion criteria. From those, they evaluated 228 teeth with a follow-up period of 3 months to 13 years.

The researchers tabulated the number of teeth that became necrotic, the number of healed pulps and which of those healed pulps underwent pulp canal obliteration (PCO), and the time at which PCO was first observed as shown in Figure 1. Pulp healing after reimplantation of immature teeth was observed in 32.9% of the teeth, and pulpal necrosis in 67.1%. PCO occurred in 96% of healed pulps. First evidence of the obliteration was observed sometime between 3 and 14 months (mean, 9.5 months) posttreatment.

The authors concluded that PCO should be considered a normal part of pulpal healing after avulsion in a tooth with an open apex, and that relatively few teeth that undergo PCO become necrotic at a later time. Active monitoring for signs and symptoms of endodontic infection should continue for several years after avulsion, rather than only when a calcification is seen on radiographs.

Abd-Elmeguid A, ElSalhy M, Yu DC. Pulp canal obliteration after replantation of avulsed immature teeth: a systematic review. Dent Traumatol *2015;doi:10.1111/edt.12199.*

Apical Extrusion of Bacteria with Reciprocating Files

The aim of endodontic therapy is to prevent or heal apical periodontitis. In cases of necrotic and infected root canal space, the critical bulk of the bacteria is located in the apical area. The clinician has to rely on chemomechanical instrumentation to remove the bacteria from the apical area to ensure healing. In the last 20 years, rotating nickel–titanium (NiTi) systems have become a popular method to achieve this goal. More recently, reciprocating NiTi systems for instrumentation have been introduced. The main advantage of these systems is that they reportedly carry significantly less risk of screw-in effect, as well as less risk of file separation inside the canals while negotiating into the apical area of teeth.

However, given the back-and-forth movement of the reciprocating NiTi system, concern has been raised about the reverse movement of the file. It can act as a piston and thereby push bacteria and irrigation solutions through the apex. This extrusion could potentially cause all kinds of complications, such as

- postoperative pain
- a delay in periapical healing
- an increase in postoperative flare-ups

Teixeira et al from Rio de Janeiro State University, Brazil, investigated whether different working lengths (WLs) and apical preparation sizes had any effect on the incidence of bacteria extrusion when the canals were instrumented with reciprocating NiTi files. They theorized that instrumentation to the apical foramen and using larger files would cause more extrusion than instrumenting 1 mm short of the apical foramen and using smaller files.

The researchers prepared 68 extracted single-rooted teeth that had been contaminated with *Enterococcus faecalis* for 30 days prior to the experiment. They divided the teeth into 4 experimental groups (of 15 teeth) and used the remaining 8 teeth as positive ($n = 4$) and negative ($n = 4$) controls.

The teeth were instrumented to either #25 or #40 apical sizes at either the apical foramen or 1 mm short of the apical foramen. Bacteria extruded from the apical foramen during instrumentation were carefully collected in vials containing 0.9% sodium chloride and were subsequently plated and cultured.

The authors found no significant difference in the number of bacteria collected among the 4 groups. It is important to emphasize that these results cannot be directly extrapolated to the clinical setting. However, they strongly suggested that, when using reciprocating files, the clinician should carefully follow the recommended treatment protocols for each system to reduce the risk of extrusion.

The most critical issue with reciprocating files is that, prior to using them, a glide path must be established down to the apex with hand files. Then the reciprocating files are to be used in a slow and gentle in-and-out pecking motion with about a 3 mm amplitude limit. And after each set of 3 to 4 pecking movements, the instrument should be removed from the canal, its flutes cleaned, the full glide path recapitulated with a small hand file and the canal irrigated with sodium hypochlorite. This is then repeated until WL is reached.

Teixeira JMS, Cunha FM, Jesus RO, et al. Influence of working length and apical preparation size on apical bacterial extrusion during reciprocating instrumentation. Int Endod J *2015;48:648-653.*

Screw-in Effect of NiTi Rotary Files

All motorized rotating endodontic files have the potential to engage the canals like a wood screw. When that happens, the clinician can lose control of the file's depth into the root. The primary risk is that it may continue screwing itself beyond the apex and into the bone, ultimately separating deep in the bone (Figure 2). Not only is this detrimental to the success of the endodontic therapy, it also causes damage to the sinus, mandibular nerve or

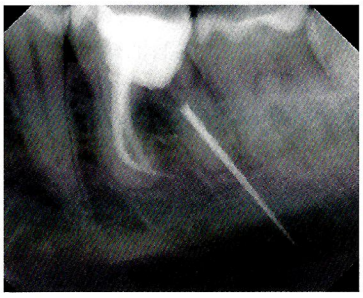

Figure 2. A rotary file engaged the distal canal, and the dentist lost control of it before it separated approximately 10 mm through the apex. The file entered the mandibular canal and damaged part of the mental nerve, damage that did not reverse after extraction of the tooth. (*Image courtesy of Dr. Mike Seare.*)

other structures apical to the teeth. Many of the new nickel–titanium (NiTi) rotary file systems have been carefully designed to minimize this effect. However, despite the flexibility of the NiTi alloy, which allows the instrument to better preserve the original root canal anatomy, especially its curvature, every NiTi rotary system carries this risk.

To investigate the screw-in effect, Ha from Kyungpook National University, South Korea, examined the effect of rotary instruments' common geometric characteristics on the screw-in forces. More importantly, they sought to determine what the practitioner could do to minimize the risk of this screw-in effect.

A computer-simulated 3-dimensional finite element analysis (FEA) was used for the investigation. The benefits of using the FEA are that it accurately represents complex geometry, it allows dissimilar material properties to be compared, and it is a simple and controllable representation of the clinical situation.

The researchers evaluated several simulated geometric cross-sectional designs of commercially available rotary files:

- triangular
- slender-rectangular
- rectangular
- square

Each of the cross-sectional designs was tested by being twisted into a model with 5, 10 or 15 threads on a standard 16-mm-long working surface, the most common length of a working surface of endodontic files. They all had the same peripheral diameter and a constant .044 taper.

The investigators then analyzed how these various designs would perform in 3 curved canals, simulated as rigid surface models. Each canal had 2 segments: a straight coronal segment measuring 7.6 mm in length and a curved apical section measuring 9.4 mm in length. The apical sections had curvatures of 15°, 30° and 45°, and radii of 35.9 mm, 18 mm and 12 mm, where the smaller radius represented more acute curvature of the canal. The rigid surface model was set to permit free rotation of the files within it. During the 4 prescribed rotations, the researchers measured the screw-in force that was driving the file model in the apical direction and the reaction torque on the simulated canal wall.

The authors found that the square cross-sectional design showed the highest screw-in force and reaction torque, followed by the rectangular, the triangular and the slender-rectangular cross-section, in that order. A smaller pitch (more threads or tighter-wound files) generated less screw-in force and reaction torque, as did a larger canal curvature radius and smaller canal angle.

This study strongly suggests that all clinicians using engine-driven rotary files should determine how prone the system is to screw-in forces prior to use. Clinicians are cautioned to hold the handpiece firmly to maintain good control and to use an outward brushing action to prevent the instrument from being pulled into the canal. This is especially relevant when small canals with acute curves are being instrumented.

The authors concluded that the screw-in force and reaction torque were higher for instruments with greater pitch and canals with greater curvatures. New instruments should be designed that reduce the risk of instrument fracture and preserve apical root integrity by keeping the screw-in effect to a minimum.

Ha JH, Cheung GSP, Versluis A, et al. 'Screw-in' tendency of rotary nickel–titanium files due to design geometry. Int Endod J *2015;48:666-672.*

In the next issue Spring 2016

- Unfinished root canal treatments and cardiovascular disease
- Intraoperative pain during endodontic treatment

Our next report will focus on these issues and studies that discuss them, as well as other articles exploring topics of vital interest to you as a practitioner.