Multi-disciplinary management of a patient with a post-traumatised incisor presenting concurrent replacement and inflammatory resorption: a case report

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This case report describes the multidisciplinary management of a young male who presented with a Class I incisor relationship and bi-maxillary dento-alveolar protrusion on a Class I skeletal base. The occlusion was complicated by an ankylosed and moderately infra-positioned upper left permanent central incisor, an anterior crossbite, crowding, a reduced overbite and centreline discrepancy. The incisor was traumatised and avulsed when the root was immature and the tooth was reimplanted with delay. On referral for orthodontic treatment at age 11.5 years, the upper left central incisor was experiencing ankylosis-related (osseous replacement) resorption and external root resorption simultaneously. Aside from the orthodontic aims, it was important to address the disrupted alveolar development to facilitate later prosthodontic replacement of the upper left permanent central incisor by idealising the inter-coronal and inter-radicular spaces. Treatment consisted of fixed orthodontic appliances in conjunction with the extraction of all second premolars and the upper left permanent central incisor with episodic surgical curettage. An upper Hawlix retainer was provided immediately at debond and a cantilevered resin-retained bridge was placed four months later. (Aust Orthod J 2015; 31: 216-225)

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Introduction

The aim of this clinical article is to report the challenges and complications that were encountered during the interdisciplinary management of a patient presenting with a Class I malocclusion complicated by a post-traumatised incisor suffering simultaneous replacement and inflammatory resorption.

Review of the literature

The prevalence of dental trauma of permanent teeth in children aged between eight and 14 years has been reported to be between 6.1–27.6%1 6 with a peak incidence at ages 9 to 11 years.7 8 The most commonly affected permanent teeth are the maxillary central incisors, which account for 53.2–88.1% of all injured permanent teeth.2 4 6 10 All studies report a greater proportion of males sustaining dental trauma across all age groups.1 8 The prevalence of traumatic avulsion of permanent teeth is between 2.5–16%,7 13 of which 15.2–80.2% involve maxillary central incisors.9 11

If an avulsed tooth cannot be reimplanted because it was not retrieved – the incidence of which could be as high as 62.5%14 – it will undoubtedly impact on the patient’s aesthetics, speech and masticatory ability, and overall quality of life. However, when the tooth is reimplanted, there is normally a guarded long-term prognosis related to the stage of root development, the extra-alveolar time and storage medium prior to reimplantation.15 16
Complications of reimplanted teeth include pulp necrosis, chronic apical periodontitis, root resorption (inflammatory or ankylosis-related (osseous replacement)), ankylosis with possible infra-position, and tooth loss.\textsuperscript{15-17}

In a retrospective study\textsuperscript{10} that included 49 avulsed and reimplanted teeth, 13 (26.5\%) teeth exhibited inflammatory resorption and 21 (42.9\%) exhibited osseous replacement resorption. Both forms of resorption had a higher prevalence in teeth with open apices compared with those exhibiting closed apices. Over the five-year observation period, 19 of the 49 avulsed and reimplanted teeth were extracted because of inflammatory resorption, osseous resorption and infra-position. Eleven (22.4\%) teeth had open apices and eight (16.3\%) had closed apices. An additional retrospective study\textsuperscript{17} that included 73 avulsed and reimplanted teeth showed that 21 (28.8\%) teeth experienced inflammatory resorption and 15 (20.5\%) experienced osseous replacement resorption. The literature indicates that the overall prevalence of osseous and inflammatory root resorption of avulsed and reimplanted teeth is between 49.3–90.8\%.\textsuperscript{10,15,17}

Furthermore, ankylosis may infringe on the growth of the alveolar processes and contribute to the development of infra-position of the affected tooth. This is more marked the younger the patient at the time of avulsion and reimplantation.\textsuperscript{18-20} It should also be noted that between 8–48.3\%\textsuperscript{1,21-26} of children and adolescents receive orthodontic treatment at a time which approximately coincides with the peak incidence period during which the permanent dentition is likely to be traumatised. Therefore, it is possible that there are children who need interdisciplinary management of their traumatised teeth and their malocclusions simultaneously.

Case report

An 11.5-year-old boy was referred to Kingston Hospital NHS Foundation Trust, United Kingdom (UK) by his general dental practitioner (GDP) for orthodontic treatment. Four years earlier, the patient had traumatically avulsed the upper left permanent central incisor when he slipped on a waterslide. The tooth was retrieved from the bottom of the swimming pool and stored in dry conditions until the patient was seen in an emergency dental clinic, whereupon the clinician reimplanted the tooth and immobilised it with a semi-rigid splint. The re-implantation was performed after a delay of three hours from the time of the accident. Following his return home a week later, he attended his GDP, who removed the splint and initiated endodontic therapy.

The patient’s complaints centred around the mal-alignment of his teeth and the appearance of the fractured anterior tooth.

Clinical examination and special tests

The patient presented in the early permanent dentition with a Class I incisor relationship and bi-maxillary dento-alveolar protrusion on a Class I skeletal base. The vertical proportions were acceptable but there was a crossbite of the upper left permanent lateral incisor, moderate crowding of both dental arches, a reduced overbite and a centreline discrepancy (Figure 1). The upper left permanent central incisor was moderately infra-positioned, producing an Index Score of 2,\textsuperscript{19} which was also associated with local arrest of growth of the associated dento-alveolus. The upper left permanent central incisor also had an enamel-dentine fracture (uncomplicated crown fracture) of the incisal edge, grey discoloration of the crown, and an apically positioned gingival margin relative to the contra-lateral incisor. The upper right central incisor was tilted mesially, which likely contributed to the centreline discrepancy (Figure 1). There was no tenderness to palpation of the related soft tissues and periodontal probing was within normal limits. There was no mobility or tenderness to percussion, although a metallic type of sound was audible when percussed, which culminated in the clinical diagnosis of ankylosis of the upper left central incisor.

Radiographs demonstrated two separate contours of the upper left central incisor root (Figure 2a, b). The coronal segment had a ragged outline, suggestive of ankylosis-related (osseous replacement) resorption. There was also the presence of a non-homogenous radio-opaque material within the root canal. The apical aspect of the root also showed evidence of non-homogenous radio-opaque material that appeared to have extruded. The root canal walls appeared intact, although there was bony lucency of the external contour of the root, suggestive of external inflammatory resorption. The periodontal ligament space was absent, in keeping with the ankylosic diagnosis. A cephalometric analysis (Figure 3) confirmed the clinical impression of a Class I
Figure 1. Pre-treatment extra-oral and intra-oral photographs. Note the posed display of the upper left permanent central incisor.

Figure 2a. Pre-treatment dental panoramic radiograph.

Figure 2b. Pre-treatment long-cone periapical (LCPA) radiograph demonstrating external inflammatory resorption and ankylosis-related (osseous replacement) resorption affecting the upper left central incisor.

Figure 3. Tracing of pre-treatment lateral cephalometric radiograph.
skeletal antero-posterior relationship. The Frankfort-mandibular plane angle and lower anterior facial height were within normal limits. The maxillary (115 degrees) and the mandibular (101 degrees) incisors were proclined relative to their respective dental bases (Table I). There was a slightly protrusive facial profile as both lips were ahead of Rickett’s Esthetic-plane.

**Treatment aims, objectives and plan**

It was important to address the disrupted alveolar development to ensure that future prosthetic treatment would not be compromised. In consideration of the poor long-term prognosis of the upper left central incisor, the degree of infra-position and the associated arrest of local dento-alveolar development, it was decided to extract the incisor and use orthodontic appliances to manage the inter-coronal and inter-radicular space for future prosthetic replacement with a resin-retained bridge (RRB). The orthodontic aims and objectives were:

- Maintenance of the Class I facial profile and Class I incisal and buccal relationships.
- Relief of the crowding.
- To align, level and co-ordinate the dental arches.
- To correct the overbite.
- To correct the centrelines.
- Finishing.
- Retention of the corrected occlusion.

**Treatment progression**

Upper and lower pre-adjusted Edgewise appliances with a 0.022” × 0.028” slot (MBT prescription) were bonded to all of the maxillary and mandibular teeth after the extraction of the four second premolar teeth. The bracket on the upper left lateral incisor was bonded in an inverted position to reverse the torque expression (from 10 degrees palatal root torque to 10 degrees labial root torque) to allow ideal placement of the palatally-positioned root whilst the crown position was concurrently corrected. Initially, the upper left permanent central incisor had a composite build-up of the incisal edge to restore aesthetics and also facilitate placement of an orthodontic bracket to assist in anchorage management during correction of the anterior crossbite. The upper left central incisor was extracted after the upper left lateral incisor was aligned. A year later the patient presented with swelling and discharge in the soft tissues in the upper left central incisor region. Radiographic examination revealed the presence of dental hard tissue and

| Variable                                      | Normal values | Pre-treatment | Near-end of treatment | Change |
|-----------------------------------------------|---------------|---------------|-----------------------|--------|
| SNA                                           | 82° ± 3       | 81°           | 80°                   | -1°    |
| SNB                                           | 79° ± 3       | 77.5°         | 77°                   | -0.5°  |
| ANB                                           | 3° ± 1        | 3.5°          | 3°                    | -0.5°  |
| SN to Maxillary Plane                         | 8°± 3         | 6°            | 7°                    | +1°    |
| Wits appraisal                                | -1 mm         | 1 mm          | 6 mm                  | +5 mm  |
| Upper incisor to maxillary plane              | 108° ± 5      | 115°          | 113°                  | -2°    |
| Lower incisor to mandibular plane             | 92° ± 5       | 101°          | 97°                   | -4°    |
| Lower incisor edge to upper incisor root centroid | 0–2 mm      | 4 mm          | 2 mm                  | -2 mm  |
| Interincisal angle                            | 133° ± 10     | 116°          | 122°                  | +6°    |
| Maxillary mandibular planes angle             | 27° ± 5       | 28°           | 28°                   | 0°     |
| Upper anterior face height                    | 54.5 mm       | 59 mm         | +4.5 mm               |        |
| Lower anterior face height                    | 68 mm         | 73 mm         | +5 mm                 |        |
| Anterior face height ratio                    | 55%           | 55.5%         | 55.3%                 | -0.2%  |
| Lower incisor to Apo                          | 0–2 mm        | 7.5 mm        | 4 mm                  | -3.5 mm|
| Lower lip to E plane                          | -2 mm         | 3 mm          | 1 mm                  | -2 mm  |
radio-opaque material in the region (Figure 4), which necessitated referral for surgical curettage under local anaesthetic. However, shortly after this procedure, the patient presented with a pustule in the upper left central incisor region (Figure 5a). Further radiographic examination demonstrated the continued presence of dental-like hard tissue and radio-opaque material in the area (Figure 5b). The patient was re-referred for surgical curettage that was successful in the removal of all radicular remnants and foreign material.

During the course of treatment a laboratory-fabricated acrylic tooth was incorporated into the upper fixed appliance to restore anterior aesthetics as well as to help idealise space for the prosthetic replacement, in conjunction with the use of elastomeric chain, bumper sleeve and stainless steel coils (Figure 6).

The appliances were removed after 36 months of active orthodontic treatment only after confirming that the aims and objectives of treatment were fulfilled. Radiographs were obtained to confirm that the space in the bounded saddle was equal to the mesio-distal dimension of the upper right central incisor and that the roots of the adjacent teeth were positioned correctly to allow the provision of a future...
implant-retained prosthesis. This was assessed using long-cone periapical radiographs instead of panoramic radiography as the latter may not provide precise images because of distortion and superimpositions (Figure 7). Final lateral cephalometric radiography and analysis (Figure 8) verified that the patient’s Class I profile was maintained. The retroclination of the lower incisors may have accounted for the overall reduction in lower lip protrusion, while the inclinations of the maxillary and mandibular incisors were reduced to average values (113 degrees and 97 degrees respectively) (Table I).

At debonding of the fixed appliances (Figure 9), a full coverage vacuum-formed retainer (VFR) was provided for wear in the lower arch on a part-time basis (12 hours per day). An upper fixed retainer was placed on the palatal surfaces of the upper right central and lateral incisor to help reduce the risk of relapse in the
upper left incisor region, especially whilst waiting for the gingival tissues to settle before fitting of the RRB. A Hawlix retainer (Figure 10), which incorporated the previously fabricated acrylic tooth, was provided for wear in the upper arch on essentially a full-time basis. The retainer was only to be removed for cleaning after meals and playing sports. A cantilevered RRB was fitted four months after completion of active orthodontic treatment (Figures 11, 12) with which the patient was delighted and commented that he felt he had a real tooth again. The patient did not expose any gingival tissue at rest or in function (Figure 12) and so the restoration of the upper left central incisor was not aesthetically demanding, and the slightly apical gingival margin of the incisor compared with the contralateral tooth was not readily discernible. Attempts to extrude the upper left lateral incisors may have improved aesthetics.

The patient is currently in the retention phase of treatment and wearing VFRs in both the upper and lower teeth on a part-time basis.

Figure 10. Hawlix retainer.

Figure 11. Post-treatment extra-oral photograph. Note the spontaneous smile with display of all upper anterior teeth.
Discussion

The infra-position of a reimplanted and ankylosed tooth results from local disruption of normal growth of the adjacent dento-alveolar bone in young individuals.\textsuperscript{18,27} At present, there is a lack of high-level evidence for the management of such clinical presentations, therefore it has been suggested that treatment planning should be based on the clinician’s experience, and be guided by the preferences and perspectives of the patient.\textsuperscript{28}

Malmgren\textsuperscript{29} has recommended that an ankylosed tooth should be removed in children and adolescents to avoid undesirable effects related to the arrest of the growth of the local dento-alveolar bone. De-coronation has been proposed as a preferred method instead of extraction as the alveolar height and width are preserved. This is an important consideration for prosthetic replacement of teeth; however, de-coronation was not considered appropriate for this patient in light of the persistent chronic infection.

An alternative treatment option is auto-transplantation. The optimal time for tooth transplantation has been reported to be when the roots have reached between two-thirds and three-quarters of the final root length.\textsuperscript{30} Since the root development of the extracted second premolars was complete, and also considering that the peri-radicular tissues may be a nidus of extra-radicular infection due to the diffuse presence of radicular remnants and foreign material, it was concluded that auto-transplantation would not be a feasible or successful option for the patient.

On presentation, the coronal portion of the patient’s root was undergoing ankylosis-related (osseous replacement) resorption. This is a commonly encountered outcome of immature teeth reimplanted following delay, with a reported prevalence ranging between 20.5–52.9\%.\textsuperscript{10,17} Radiographic examination also demonstrated a possible separate apical fragment of root that had an appearance suggestive of external inflammatory resorption. It may be surmised that when the tooth was avulsed, dental tissue remained within the alveolus and subsequently survived the trauma. The tissue developed and grew into the apical root end as Hertwig’s epithelial root sheath remained intact.\textsuperscript{31} Attempts to treat the coronal fragment may have led to bacterial contamination of the apical portion resulting in regional inflammatory resorption, whilst osseous replacement resorption, and possibly also inflammatory resorption, were occurring in the coronal fragment.

A Hawlix retainer\textsuperscript{32} was chosen as the most suitable intermediate retainer in the upper arch for a number of reasons:

1. Aesthetics: The laboratory-made pontic that was used during fixed appliance treatment, and with which the patient was happy, could be bonded into the acrylic baseplate of the Hawlix. In addition, as there was no anterior wirework, the aesthetic result achievable was considered superior over other retainer types.

2. Preservation of residual ridge: It was important to avoid loading of the ridge/mucosa in the upper left
incisor region due to the already reduced vertical alveolar ridge height. Loading from Hawley-type retainers is similar to acrylic spoon dentures as the rate of resorption is hastened.

3. Function: A Hawlix retainer combines ideal aesthetics achievable with a VFR, space maintenance, rigidity and facilitation of vertical settling, which are possible with a Hawley retainer, although additionally allows the wearer masticatory use.

The decision to provide a RRB was based principally on the age of the patient and the associated growth expected to occur. Dento-alveolar growth continues throughout life, at a rate of approximately 0.5 mm/year between the ages of five and 16, and 0.1 mm/year between 16 and 31 years of age. As the patient was 15 years old when active orthodontic treatment was completed, it was expected that dento-alveolar growth would continue and, therefore, the early placement of an implant would be expected to result in infra-occlusion over time. Therefore, a minimally invasive cantilevered RRB, which is conservative of tooth structure and has been shown to have a median survival of 9.8 years, was selected as an intermediate restoration until the patient was ready for dental implant consideration.

It is anticipated that, due to the reduction in alveolar bone volume attributed to the long-standing chronic infection, as well as loss of attached bone during the extraction of the upper left central incisor, the patient will most likely require ridge-mapping and/or three-dimensional radiography assessment to determine the practicability of an implant-retained prosthesis, possibly with bone augmentation.

During the retention phase, it is important to avert re-approximation of the upper right central incisor and upper left lateral incisor roots as this may hinder future implant placement and therefore necessitate orthodontic retreatment. It is expected that the fixed retainer on the palatal surfaces of the upper right central and lateral incisor, supplemented with a removable retainer, as well as provision of the RRB in the upper left permanent central incisor region, will help maintain the inter-coronal and inter-radicular spaces.

Summary
The present case report details the multidisciplinary management of a young male patient who presented with simultaneous replacement and inflammatory resorption. The affected permanent incisor was avulsed and reimplanted with delay when its root development was incomplete. The challenges and complications in treating the patient emanated from chronic infection attributable to an apical root portion that was not initially diagnosed and recovered, and is speculated, likely grew from remnants of Hertwig’s epithelial root sheath.

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