Post traumatic sequelae of anterior teeth: Endodontic considerations

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Abstract

**Background:** Epidemiological studies show that about 11.6% to 33.0% of all boys and about 3.6% to 19.3% of all girls suffer dental trauma of varying severity before the age of 12 years. Moderate injuries to the periodontium such as concussion and subluxation are usually associated with relatively minor symptoms and hence may go unnoticed by the patient or the dentist, if consulted. Patients with these kinds of injuries present years after a traumatic accident most of the time with a single discoloured tooth. This study sets out to document the incidence of various post traumatic sequelae of discoloured anterior teeth and to determine the treatment need based on the ‘periapical index’ (PAI) score.

**Methods:** One hundred and sixty eight (168) traumatized discoloured anterior teeth in 165 patients were studied. Teeth with root canal treatment were excluded from the study. Partial obliteration was recorded when the pulp chamber or root canal was not discernible or reduced in size on radiographs, total obliteration was recorded when pulp chamber and root canal were not discernible. Associated apical radiolucency was assessed using the PAI score with an ordinal scale of five scores ranging from ‘healthy’ to ‘severe periodontitis with exacerbating features’.

**Results:** Of the 168 traumatized discoloured anterior teeth, 47.6% and 31.6% had partial and total obliteration of the pulp canal spaces respectively, 20.8% had pulpal necrosis. Concussion and subluxation injuries resulted more in obliteration of the pulp canal space, while fracture of the teeth resulted in more pulpal necrosis (p<0.001). Injuries sustained during the 1st and 2nd decade of life resulted more in obliteration of the pulp canal space, while injuries sustained in the 3rd decade resulted in more pulpal necrosis. 70.0% of teeth
with partial obliteration of the pulp canal space required treatment while 73.5% of teeth with total obliteration were placed under observation.

**Conclusions:** Calcific metamorphosis developed more in teeth with concussion and subluxation injuries.
Background

Epidemiological studies show that about 11.6% to 33.0% of all boys and about 3.6% to 19.3% of all girls suffer dental trauma of varying severity before the age of 12 years\textsuperscript{1-3}. The male: female ratio ranged from 1.3-2.3:1\textsuperscript{1-3}. In Nigeria, the prevalence of traumatized anterior teeth in rural population has been reported to be 6.5\%\textsuperscript{4} while in the metropolitan population; it is much higher, 14.5\%\textsuperscript{5}. The number, type and severity of dental injuries differ according to the age of the patient and the cause of the accident. Most of the time, these results in coronal fractures that are easily recognizable by both the patients and their parents, and are also easy to diagnose by the dental practitioner\textsuperscript{6}. Moderate injuries to the periodontium such as concussion and subluxation are usually associated with relatively minor symptoms and hence may go unnoticed by the patient or the dentist, if consulted\textsuperscript{7}. The maxillary central incisors were the most frequently injured teeth in all studies. While many studies reported the maxillary lateral incisors as the second most frequently injured teeth, that of Forsberg and Tedestam\textsuperscript{8} reported the mandibular central incisors as the second most frequently injured teeth.

Concussion may be defined as an injury to the tooth supporting structures without abnormal loosening or displacement of the tooth but with marked reaction to percussion. Subluxation is an injury to the tooth supporting structures with abnormal loosening, but without displacement of the tooth. Patients with these kinds of injuries present years after a traumatic accident most of the time with a single discoloured tooth. This discoloration may be the result of obliteration of the pulp canal space, the pulp cavity being filled with dark tertiary dentine resulting in a tooth with less translucent appearance. Analysis by means of scanning and transmission electron microscopy shows that the tissues occluding
the pulpal lumen are either dentine like (49%), bone like (19%), or fibrotic (9%) which could not be correlated with explicit clinical diagnoses. This calcific metamorphosis may be recognized clinically as early as 3 months after injury. The pulp calcification and subsequent discolouration increases with time.

Approximately 3.8% to 24% of traumatized teeth develop varying degrees of obliteration. Studies indicate that pulpal necrosis will develop in about 1%-16% of these. While pulpal necrosis only occurs in 3% of teeth subjected to concussion. Following a severe traumatic injury to permanent immature teeth, the growth of calcified tissue in pulp canal space may occasionally occur. Also the pulp may become necrotic leading to the formation of a periapical lesion around a wide-open apex. All these presents various endodontic challenges to the dentist, in cases of symptomatic teeth with partial or complete obliteration of the pulp canal space, root canal treatment may become a difficult or an impossible task respectively. In traumatic teeth with periapical lesion and open apexes, it will be difficult to get a hermetic apical seal with conventional root canal treatment.

The present study sets out to document the incidence of various post traumatic sequelae in discoloured anterior teeth. The treatment need based on the periapical index (PAI) score and the endodontic treatment difficulty encountered in patients attending the Dental Hospital of the Obafemi Awolowo University, Ile-Ife, Nigeria.
Methods

One hundred and sixty eight (168) traumatized discoloured anterior teeth in 165 patients (95 males and 70 females) were studied. Their ages ranged from 20-56 years (mean age $\pm$ SD 31.3$\pm$8.6 years). These included all patients presenting with traumatized discoloured anterior teeth between August 2003 and July 2005 at the Oral Diagnosis Unit and the Conservative Clinic of the Dental Hospital, Obafemi Awolowo University Ile-Ife, Nigeria. The traumatized discoloured teeth may or may not be the cause of presenting complaint. Discoloured teeth with root canal treatment were excluded from the study, so also were discoloured teeth with no history of injury/trauma.

Information extracted from the patients include the history of the discoloured tooth, was there any previous injury/trauma to the tooth? If yes, how long ago was it? How long after the injury/trauma was the discolouration first noticed? Is the discolouration increasing? Has there been any other associated symptom such as Pain, swelling, discharge from the gum around the tooth? Is the tooth shaking? On examination, any fracture or loss of tooth structure, intrusion or extrusion was recorded. The gum around the tooth was examined for sinus tract. Results of sensibility test and radiographic examinations were also recorded. Was there obliteration of the pulp canal space, and/or apical radiolucency? Was the root formation complete or incomplete? Partial obliteration was recorded when the pulp chamber or root canal was not discernible or reduced in size on radiographs, total obliteration was recorded when pulp chamber and root canal were not discernible. The apical radiolucency was assessed using the ‘periapical index’ (PAI) with an ordinal scale of five scores ranging from ‘healthy’ to ‘severe periodontitis with exacerbating features’$^{14}$. (PAI 1, normal periapical structures;
PAI 2, small changes in bone structure; PAI 3, changes in bone structure with some mineral loss; PAI 4, periodontitis with well defined radiolucent area, and PAI 5, severe periodontitis with exacerbating features.)

The diagnosis of pulpal status was based on a combination of coronal discolouration, sensibility test, clinical symptoms, and radiographic evaluation. Patients with teeth having PAI scores of 1 or 2 without any associated symptom were placed under observation, while those having PAI scores of 2 with associated symptoms and those having PAI 3, 4 or 5 were treated appropriately. Difficulties encountered in the course of treatment were documented.

Data were subjected to descriptive and statistical analyses using SPSS for windows statistical software package Version 11.0. A significance level p<0.05 was defined as statistically significant.
Results

All the discoloured teeth included in this study had histories of some form of traumatic injury leading to fracture of the dental hard tissues in 38(22.6%) of cases, concussion in 53(31.6%) of cases and subluxation in 77(45.8%) of cases. Causes of injuries were domestic accidents/sports, road traffic accidents (RTA), fights, assault, and epileptic seizures (Figure 1). The discolourations resulting from the traumatic injuries were first noticed 4-24 months (mean = 13.2 months and median = 11.0 months) after injury and the discolourations increased with time. The age of the patients at the time of injury ranged from 7 to 30 years (mean age ± SD 14.2±6.1 years). About 60.1% of injuries had occurred by age 12.

Of the 168 traumatized discoloured anterior teeth (167 maxillary incisors; 150 centrals, 17 laterals and 1 mandibular central incisor), 133(79.2%) had obliteration of the pulp canal spaces; partial obliteration in 80(47.6%) of cases, and total obliteration in 53(31.6%) of cases. Thirty-five (20.8%) had necrosis of the pulp out of which 29 had closed apexes and 6 had open apexes (Table 1). Table 2 shows that concussion and subluxation injuries resulted more in obliteration of the pulp canal space, while fracture of the teeth resulted in more pulpal necrosis. The differences were statistically significant (p<0.001). Partial obliteration of the pulp canal space occurred more frequently from all the injury types than total obliteration, the differences were not statistically significant (p>0.05), Table 2. In 72(42.9%) of cases, the injury to the teeth was sustained during the first decade of life, while in 32.7% and 24.4% of cases, the injury occurred during the 2nd and 3rd decade of life respectively. Obliteration of the pulp canal space was more frequent in teeth that were traumatized during the 1st and 2nd decade of life, while pulpal necrosis
was more frequent in teeth traumatized during the 3rd decade of life. The differences were statistically significant (p<0.001), Table 3. Pulpal necrosis occurred more frequently in fractured teeth. Fracture, secondary to road traffic accident (RTA) resulted to pulpal necrosis more in teeth traumatized during the 3rd decade of life.

The PAI scores of the traumatized discoloured teeth are shown in Table 4. Teeth having PAI scores of 1 and 2 were not symptomatic, while those having PAI scores of 3, 4, and 5 had symptoms ranging from spontaneous pain to pain on percussion, slight swelling to discharging sinus. None of the teeth were mobile. The majority (70.0%) of teeth with partial obliteration of the pulp canal space required treatment (PAI scores of 3 and 4), while the majority (73.5%) of teeth with total obliteration were placed under observation (PAI scores of 1 and 2). The differences were statistically significant (p<0.001). Nineteen (54.3%), 14(40.0%), 2(5.9%) of teeth with necrosis of the pulp had PAI scores of 3, 4 and 5 respectively.
Discussion

To determine the frequency of calcific metamorphosis in traumatized teeth, it would have been better to follow-up traumatized teeth for a long period of time. However, from our experience, response to recall and follow-up visit is very poor. Therefore, it was decided to look into the incidence of calcific metamorphosis and pulpal necrosis in patients presenting with discoloured anterior teeth secondary to traumatic injuries.

The prognosis of symptomatic teeth with calcific metamorphosis treated with conventional root canal treatment has been sparsely investigated with a reported success rate of 80%\textsuperscript{15}. There had been no studies on the relative success rate of symptomatic teeth with total pulp canal obliteration treated using the surgical procedures\textsuperscript{10}. While the present study looked into the incidence of the various type of calcific metamorphosis in discoloured teeth secondary to traumatic injuries and the treatment need based on the periapical index (PAI) score, the second part will compare the relative success rates of symptomatic teeth with partial pulp canal obliteration and total pulp canal obliteration treated with conventional root canal therapy and surgical procedures respectively.

In the discoloured traumatized anterior teeth presented in this study, subluxations were the most frequent trauma type (45.8%), followed by concussions (31.6%) and fractures (22.6%). These were contrary to the findings of Petti et al.\textsuperscript{16} in which fractures (enamel, 67%; enamel-dentine, 19.3%) were the most frequent trauma type followed by concussions (8.3%). Also Rocha and Cardoso\textsuperscript{17} reported fractures (51.4%) to be more frequent than luxation (48.6%). The differences are to be expected since the present study dealt with discoloured teeth secondary to trauma and not a survey of all the traumatized anterior teeth. It may be that patients who sustained severe injury to their teeth resulting
in serious fractures had earlier sought treatment, hence the low frequency of fractures in this study. Also it is widely accepted that moderate injuries such as concussions and subluxations most of the time go unnoticed. Patients with such injuries usually presents later with discoloured teeth.

The reactions of the dental pulp to traumatic injuries can be extremely varied. They ranged from almost immediate pulp death to long-term slow pulp canal obliterations. In the sequelae of calcific degeneration, the clinical crown frequently becomes discoloured. In this study, obliteration of the pulp canal space was more frequent in concussion and subluxation injuries, while pulpal necrosis was more frequent in fractures. The differences were statistically significant p<0.001. However, the differences in the frequency of partial or total obliteration of the pulp canal space were not statistically significant (p>0.05) in relation to the injury type. In the present study, pulpal necrosis occurred in 9.4% of teeth subjected to concussions. This is much higher than the 3.0% reported by Andreasen and Vestergaard Pedersen. The authors could not proffer any reason for this. Injuries sustained during the 1st and 2nd decade of life resulted more in obliteration of the pulp canal space, while injuries sustained in the 3rd decade resulted in more pulpal necrosis. The differences were statistically significant (p<0.001). It was observed that road traffic accident (RTA) was the major cause of injuries in the 3rd decade of life leading to enamel-dentine fractures.

Opinion differs among practitioners as to whether to treat cases of calcific metamorphosis upon early detection or to observe them until symptoms or radiographic signs of pulpal necrosis are detected. In this study, the decision of whether to treat or not was based on a combination of the PAI score and the presence or absence of symptoms.
Although prophylactic endodontic treatment in teeth displaying pulp canal obliteration on a routine basis does not seem justified, it has been reported that the incidence of pulpal necrosis increases over the course of time\textsuperscript{19}. The incidence of attending periapical disease should indicate to the clinician that some form of treatment is required\textsuperscript{20}. In this study, the majority (70.0\%) of teeth with partial obliteration of the pulp canal space showed pathologic periapical changes (PAI scores of 3 & 4) thus requiring treatment (conventional root canal therapy). However, this runs contrary to the findings of Jacobsen and Kerekes\textsuperscript{21} who reported normal periapical conditions in all teeth with partial obliteration. The preferred treatment in cases of total pulp obliteration with periapical disease is surgical endodontics, while those without symptoms and periapical lesions are best left untreated (placed under observation)\textsuperscript{22}. In the present study, 26.4\% of teeth with total obliteration showed pathologic periapical changes (PAI scores of 3 & 4). This is in partial agreement with the findings of Jacobsen and Kerekes\textsuperscript{21} in which 21.0\% of teeth with total obliteration developed pathological periapical changes. Surgical endodontics with retrograde filling using super EBA was carried out for teeth in this group. Although, in 3 teeth originally diagnosed to have total obliteration of the pulp canal space on radiograph, it was possible to locate and negotiate the pulp canals using sizes 08, 10 and 15 files. They were later recorded and analyzed as teeth with partial calcification. An earlier study had suggested that increase in the amount of calcification may lead to partial or complete radiographic but not microscopic obliteration of the pulp chamber and root canals\textsuperscript{23}.

All the teeth with pulpal necrosis required treatment (PAI scores of 3, 4 and 5). About 17.1\% of this had open apexes indicating that the injury and pulp necrosis
occurred before the completion of root formation. In such cases a hermetic apical seal cannot be guaranteed therefore surgical endodontics with retrograde filling using super EBA was carried out. Even with that, preparing the root end to receive the root end filling posed some challenges. If the patients had presented before severe inflammation sets in or before the formation of an abscess, apexification/apexogenesis would have been less invasive and preferable alternative treatment. The other teeth with pulpal necrosis in which the apexes were closed had conventional root canal therapy.
Conclusions

Calcific metamorphosis developed more in teeth with concussion and subluxation injuries. Before embarking on surgical endodontics in teeth with total obliteration on radiographs, an attempt should be made at locating the canals.
Competing interests

The author(s) have no financial or non-financial competing interests.
Authors’ contributions

AOO conceived of the study, participated in the design and collection of data, performed the statistics, and participated in the initial draft and final write up of the manuscript.

CAA participated in the design and collection of data, participated in the initial draft and final write up of the manuscript.
**Acknowledgements**

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<table>
<thead>
<tr>
<th>Post traumatic sequelae</th>
<th>Number</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partial obliteration</td>
<td>80</td>
<td>(47.6)</td>
</tr>
<tr>
<td>Total obliteration</td>
<td>53</td>
<td>(31.6)</td>
</tr>
<tr>
<td>Pulp necrosis</td>
<td>35</td>
<td>(20.8)</td>
</tr>
<tr>
<td>Total</td>
<td>168</td>
<td>(100.0)</td>
</tr>
</tbody>
</table>
Table 2: Injury type and post traumatic sequelae.

<table>
<thead>
<tr>
<th>Injury type</th>
<th>A^ Partial obliteration</th>
<th>B^ Total obliteration</th>
<th>C^ Pulpal necrosis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No (%)</td>
<td>No (%)</td>
<td>No (%)</td>
</tr>
<tr>
<td>Fracture (n=38)</td>
<td>8 (21.0)</td>
<td>6 (15.8)</td>
<td>24 (63.2)</td>
</tr>
<tr>
<td>Concussion (n=53)</td>
<td>28 (52.8)</td>
<td>20 (37.7)</td>
<td>5 (9.4)</td>
</tr>
<tr>
<td>Subluxation (n=77)</td>
<td>44 (57.1)</td>
<td>27 (35.1)</td>
<td>6 (7.8)</td>
</tr>
</tbody>
</table>

(A+B) vs C: $\chi^2 = 53.4$, df=2, p=0.00; A vs B: $\chi^2 = 0.22$, df=2, p=0.9
Table 3: Age at time of injury and post traumatic sequelae.

<table>
<thead>
<tr>
<th>Age group (yrs)</th>
<th>^APartial obliteration</th>
<th>^BTotal obliteration</th>
<th>^CPulp necrosis</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No (52.8)</td>
<td>No (40.3)</td>
<td>No (6.9)</td>
<td>72 (100)</td>
</tr>
<tr>
<td>1 – 10</td>
<td>38</td>
<td>29</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>11 – 20</td>
<td>29</td>
<td>17</td>
<td>9</td>
<td>55 (100)</td>
</tr>
<tr>
<td>21 – 30</td>
<td>13</td>
<td>7</td>
<td>21</td>
<td>41 (100)</td>
</tr>
</tbody>
</table>

(A+B) vs C: χ² = 31.57, df = 2, p = 0.00; A vs B: χ² = 1.07, df = 2, p = 0.59
**Table 4: Assessment of treatment needs**

<table>
<thead>
<tr>
<th>Periapical index (PAI) scores</th>
<th>PAI 1</th>
<th>PAI 2</th>
<th>PAI 3</th>
<th>PAI 4</th>
<th>PAI 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Post traumatic sequelae</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A Partial obliteration</td>
<td>9 (11.3)</td>
<td>15 (18.7)</td>
<td>36 (45.0)</td>
<td>20 (25.0)</td>
<td>-</td>
</tr>
<tr>
<td>B Total obliteration</td>
<td>27 (50.9)</td>
<td>12 (22.6)</td>
<td>9 (17.0)</td>
<td>5 (9.4)</td>
<td>-</td>
</tr>
<tr>
<td>C Pulpal necrosis</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>19 (54.3)</td>
<td>14 (40.0)</td>
</tr>
</tbody>
</table>

AvsB: $\chi^2=30.30$, df=3, p=0.00.
References


growth in the root canal of immature permanent teeth after traumatic

13. Ngeow WC, Thong YL: Gaining access through a calcified pulp chamber: a

for radiographic assessment of apical periodontitis. *Endod Dent Traumatol*
1986, 2:20-34.

15. Cvek M, Granath L, Lundberg M: Failures and healing in endodontically
treated non-vital anterior teeth with post traumatically reduced pulpal

anterior tooth trauma in children 6 to 11 years old. *Minerva Stomatol* 1996,
45:213-218.

17. Rocha MJ, Cardoso M: Traumatized permanent teeth in Brazilian children at
the Federal University of Santa Catarina, Brazil. *Dent Traumatol* 2001,
17:245-249.

18. Feiglin B: Dental pulp response to traumatic injuries—a retrospective

19. Robertson A, Andreasen FM, Bergenholtz G, Andreasen JO, Noren JG: Incidence of pulp necrosis subsequent to pulp canal obliteration from

20. Torneck CD: The clinical significance and management of calcific pulp


Legend

Figure 1. Causes of trauma

Figure 2. Distribution of teeth according to periapical status

Figure 3a. Discoloured traumatized tooth 21

Figure 3b. Partial pulp calcification of tooth 21

Figure 4a. Discoloured traumatized 21 with a discharging sinus

Figure 4b. Partial pulp calcification of tooth 21 with PAI score of 3

Figure 4c. Working length determination

Figure 4d. Root filled tooth 21

Figure 5a. Discoloured traumatized tooth 11

Figure 5b. Total pulp calcification of tooth 11

Figure 6a. Discoloured traumatized tooth 21

Figure 6b. Tooth 21 showing open apex and a large apical radiolucency
Figure 2

Periapical Status

- Partial Obliteration
- Total Obliteration
- Pulp necrosis
Figure 6