Transient Apical Breakdown in Subluxated Maxillary Incisor

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Abstract: Although there have been numerous reports of rebascularization of pulp in cases of luxation injury to teeth with immature roots, it rarely occurs in teeth with complete root formation. This phenomenon is known as transient apical breakdown (TAB) and pulp canal obliteration (PCO) which occurs following it, but there have been few reported cases. We here report the course of a case in which TAB occurred in a central maxillary incisor diagnosed as being subluxated.

The patient was a 24-year-old man. He presented at our hospital with a chief complaint of pain in the central maxillary incisor and bleeding from the gingiva after being struck by a child’s hand in the incisor region. Because he was undergoing orthodontic treatment at the time, no displacement of the tooth or avulsion from the alveolar socket was evident. Subluxation was diagnosed, and patient condition was monitored without any endodontic treatment. When he was examined at the Department of Endodontics, discoloration of the crown was evident and vital reaction of the pulp was absent, but two months later, crown discoloration and pulp vital reaction recovered. Radiography nine months later showed pulp canal obliteration, which was regarded as following the course of TAB, and the patient currently remains under observation.

This case suggests that regeneration of the vasculature may occur even in teeth with complete roots, if the severity of traumatic injury is low.

Key words: subluxation, transient apical breakdown, pulp canal obliteration, endodontic therapy, revascularization

亜脱臼した上顎前歯にみられた Transient Apical Breakdown

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要旨：根未完成歯の脱臼性外傷において、歯髄の脈管再生が起こることは多く報告されているが、歯髄完成歯で起こることは少ない。この現象は Transient Apical Breakdown （TAB）とその後に生じる歯髄腔の狭窄（PCO）として知られているが報告例は少ない。今回、亜脱臼と診断された上顎中切歯において TAB の経過を辿った症例について報告する。

患者は 24 歳の男性。子供の手が上顎の前歯部に当たり、上顎中切歯の疼痛と歯肉からの出血を主訴として来院した。矯正治療中であったため歯の変位や歯槽突からの脱落は認めなかった。亜脱臼と診断し、歯内療法処置は行わず、経過観察を行うこととした。歯内療法科来院時には、歯冠の変色と歯髄の生活反応の欠如を認めだが、2か月後には歯冠の変色と歯髄の生活反応は回復した。9か月後にはエックス線写真上で歯髄腔の狭窄が見られるようになり、TAB の経過を辿っているものと判断し、現在も経過観察を行っている。

今回の症例から、歯根完成歯であっても外傷による傷害程度が低ければ、脈管系の再生が起こる可能性があることが示唆された。

索引用語：亜脱臼，一時の根尖破壊，歯髄腔狭窄，歯内療法処置，脈管再生
Introduction

In the event of severe displacement of teeth with complete roots as a result of incomplete luxation due to trauma, ischemic changes to the pulp due to rupture of the vasculature in the apical region lead to pulp death in almost all cases. Although early endodontic treatment is required in such cases\(^1\), in the event of subluxation or other relatively mild luxation injury, pulp vitality may subsequently recover in teeth that exhibit signs of pulp necrosis immediately after injury, with widespread pulp canal obliteration (PCO) occurring over time as part of the healing process.\(^2\) This sequential healing process is known as transient apical breakdown (TAB), but few cases have been reported to date.\(^3-5\) We here report a case in which a central maxillary incisor with a complete root diagnosed as being subluxated due to trauma exhibited signs of pulp necrosis immediately after injury, but crown color and pulp vital reaction recovered over time. The patient consented to the publication of this case report.

Case report

The patient was a 24-year-old man who presented at our hospital complaining of pain in the maxillary incisor region. He had been struck by a child’s hand in the incisor region, and pain and bleeding from the gingiva were evident, but as he was undergoing orthodontic treatment at the time, the incisors were secured with a wire and bracket and no tooth avulsion was evident. As the maxillary right central incisor exhibited bleeding from the gingival crevice and pain on percussion, the orthodontic appliance was adjusted by a dental orthodontist. The patient’s condition was subsequently monitored, and although subjective and objective symptoms had disappeared after one month, the crown was discolored and the patient was therefore referred to the Department of Endodontics.

On visual examination, discoloration of the crown of the maxillary right central incisor was apparent. Dental X-ray revealed widening of the periodontal ligament space at the apex of the right central maxillary incisor (Fig 1). Subluxation of the right central maxillary incisor was diagnosed. As a treatment strategy, patient condition was monitored without endodontic treatment. During monitoring, the following parameters were tested: (1) changes in crown color over time, using intraoral photographs and a colorimeter (ShadeEye NCC; Shofu, Kyoto, Japan); (2) X-ray diagnostic imaging; and (3) pulp vital reaction testing by electric pulp testing (Pulp Tester, Analytic Technology, Lexington, Kentucky, USA). As for the measurement by ShadeEye NCC, colorimetry did a part 1 mm away from the gingiva of the tooth crown.

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\(\text{Fig 1} \) One month after injury: The maxillary right central incisor was clearly discolored. Dental X-ray showed slight widening of the periodontal ligament space at the apex.

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Although discoloration of the crown was evident and there was no vital reaction on electric pulp testing when the patient was referred to the Department of Endodontics one month after injury, the fact that his condition would continue to be monitored was explained to the patient and his consent was obtained. Recovery of crown discoloration (Figs 2, 3) and vital reaction on electric pulp testing were apparent from two months after injury (Table 1). Pulp canal obliteration (PCO) was evident on dental X-rays from nine months after injury, with signs of resorption at the apex (Fig 4), but there were no changes in crown color or pulp vital reaction. PCO had progressed one year after injury, and a clear difference in pulp canal size between the left and right central incisors was visible (Fig 5). Two years after injury, PCO had continued to progress, but crown color and pulp vital reaction were both normal (Fig 6). Based on this course,

![Fig 2](image1) Two months after injury: Crown color of the maxillary right central incisor had recovered, with almost no difference between it and the left central incisor. Dental X-ray showed widening of the periodontal ligament space at the apex.

![Fig 3](image2) Four months after injury: There were no differences in crown color between the left and right maxillary central incisors. Dental X-ray showed widening of the periodontal ligament space at the apex.

**Table 1** ShadeEye NCC values and EPT values for the maxillary left and right central incisors.

<table>
<thead>
<tr>
<th></th>
<th>L*</th>
<th>a*</th>
<th>b*</th>
<th>EPT</th>
<th>L*</th>
<th>a*</th>
<th>b*</th>
<th>EPT</th>
<th>ΔE*ab</th>
</tr>
</thead>
<tbody>
<tr>
<td>After injury</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 M</td>
<td>58.2</td>
<td>2.7</td>
<td>5.0</td>
<td></td>
<td>71.2</td>
<td>0.7</td>
<td>9.9</td>
<td>36</td>
<td>14.3</td>
</tr>
<tr>
<td>2 M</td>
<td>70.2</td>
<td>-0.1</td>
<td>11.1</td>
<td>55</td>
<td>75.3</td>
<td>-1.0</td>
<td>12.3</td>
<td>36</td>
<td>5.3</td>
</tr>
<tr>
<td>4 M</td>
<td>72.9</td>
<td>-0.3</td>
<td>10.9</td>
<td>32</td>
<td>74.8</td>
<td>-0.9</td>
<td>10.7</td>
<td>17</td>
<td>2.0</td>
</tr>
<tr>
<td>9 M</td>
<td>65.9</td>
<td>0.5</td>
<td>11.3</td>
<td>39</td>
<td>67.7</td>
<td>-0.8</td>
<td>9.6</td>
<td>19</td>
<td>2.8</td>
</tr>
<tr>
<td>1 Y</td>
<td>66.3</td>
<td>0.6</td>
<td>11.0</td>
<td>45</td>
<td>69.5</td>
<td>-0.7</td>
<td>9.0</td>
<td>32</td>
<td>2.9</td>
</tr>
<tr>
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<td>0.8</td>
<td>12.7</td>
<td>47</td>
<td>67.6</td>
<td>-0.1</td>
<td>11.5</td>
<td>14</td>
<td>2.0</td>
</tr>
</tbody>
</table>

On assessment by ShadeEye NCC, L* indicates brightness, a* reddening, and b* yellowing. A comparison of the left and right central incisors one month after injury found a decrease in L* and a* values for the affected tooth, with the crown being a reddish-brown color. A difference in color compared with the opposite tooth (ΔE*ab) of ≥2 is considered to be visible to the naked eye. Although the difference in color was ≥5 up to two months after injury, from four months after injury it had decreased to around 2, and there were almost no differences with the opposite tooth. Two months after injury, pulp vital reaction with electric pulp test (EPT) had started to recover.
we judged that the maxillary right central incisor was following the course of TAB, and are currently continuing to monitor patient condition.

**Discussion**

Luxation injury encompasses a range of conditions, from shaking to avulsion, but rupture of the vascula-
ture at the apex occurs in most cases other than the mildest shaking. If the tooth root is still immature, the vasculature may regenerate through the wide apical foramen. In teeth with complete roots, however, vascular regeneration is extremely rare, and pulp necrosis occurs in most cases. However, there have been reports of the healing process known as TAB in cases of subluxation due to trauma.

This comprises transient resorption of the root and bone at the apex, enlarging the apical foramen sufficiently for vascular regeneration to occur, with the resulting recovery of pulp vitality. Gradual calcification of the regenerated tissue then occurs, causing PCO, but pulp vitality is maintained. This series of healing processes also includes the gradual recovery of crown color following injury-induced discoloration. In the present case, tooth discoloration and loss of pulp reaction were both evident one month after injury, as if pulp necrosis was occurring, but two months after injury both crown color and pulp vital reaction had started to recover, and PCO gradually began to appear on dental X-rays from nine months after injury. Normally, pulp necrosis is suspected and root canal treatment is started in almost all cases when a change in crown color is evident and pulp vital reaction is absent, but conservative monitoring must also be considered in light of factors such as patient age, type of injury and patient consent. When change of a crown color and absence of the vital reaction of a pulp continue six months or more or accept the radiolucency of the apical area to continue to it, a necrosis of pulp is considered, and it is thought that root canal treatment should be started immediately.

In the present case, not only was the patient subjectively aware of a change in crown color, but this was also measured and objectively compared using a ShadeEye NCC. On assessment by ShadeEye NCC, \( L^* \) indicates brightness, \( a^* \) reddening, and \( b^* \) yellowing. Generally, a decrease in the value of \( L^* \) implies a change in color due to increased blackness. An increase in the value of \( a^* \) indicates a change in color due to engorgement, while an increase in the value of \( b^* \) indicates a color change due to pulp necrosis following pulp obliteration. A comparison of the left and right central incisors one month after injury found a decrease in \( L^* \) and \( a^* \) values for the affected tooth, with the crown being a reddish-brown color, as evident on the intraoral photographs shown in the figures. A difference in color compared with the opposite tooth \((\Delta E^*ab)\) of \( \geq 2 \) is considered to be visible to the naked eye. Although the difference in color was \( \geq 5 \) up to two months after injury, from four months after injury it had decreased to around 2, and there were almost no differences with the opposite tooth.

The PCO that occurred after injury is regarded as being due to the addition of osteodentin derived from pulp tissue, but its mechanism is unclear. Shimizu et al. reported a possibility that during the healing process of pulp after tooth replantation, in some cases, tertiary dentin is formed within the pulp whereas in others the pulp is replaced by bone tissue, with the latter healing process more commonly followed. Goldberg et al. reported that pulp contains cells of at least two different origins, those of neural crest origin and mesodermal origin. Therefore, they reported a possibility that pulp may be described as a hybrid tissue, containing neural crest cells with the potential to differentiate into odontoblasts and cells of mesodermal origin with the potential to form bone. And differentiation of these potentially bone-forming cells is suppressed in healthy pulp, but it is conjectured that the signal balance that controls the differentiation of both types breaks down if pulp is damaged due to trauma, inducing the formation of osteodentin. Although PCO progresses until the cavity is no longer visible on X-rays, a narrow root canal is always evident histologically. This suggests that nerve regeneration may occur alongside vascular regeneration. Although the method of splinting teeth may also affect PCO, in the present case, the tooth was already flexibly splinted as part of orthodontic treatment, meaning that the healing process was probably unaffected by splinting.

Factors in the recovery of crown color and pulp vital reaction by TAB in the present case probably included the comparatively young age of the patient, the fact that the tooth was anchored by an orthodontic appliance and avulsion from the alveolar socket was
therefore avoided, and that the injury did not result in anything more serious than subluxation.

Such the a series of healing process from TAB to PCO is regarded as reproduction ability and the protective reaction in vivo. However, it is not elucidated about the association currently.

In the event of subluxation or other relatively mild luxation injury, if the tooth root is still immature, the vasculature may regenerate through the wide apical foramen. However, if injury degree is low, vascular regeneration may occur similarly even in teeth with complete roots such as the present case by the condition at the time of the injury. It is reported that this healing process is caused within six months. From these things, in the case of a slight luxation injury, it was suggested that the early endodontic therapy should be avoided.

Conclusion

In subsuxation of a root completion tooth, resulting in pulp necrosis is almost the case. However, this case is suggested that it is possible for vascular regeneration to occur and pulp vitality to recover, even in teeth with complete roots if the severity of injury is low due to the conditions at the time of trauma. From these, it was thought that early endodontics therapy had to avoid in the case of a subluxation.

References


11) Ohshima H: Considerable subjects to understand repair responses of dental pulp after tooth injury from a biological point of view. in Japanese. JJEIA 26, 103–107, 2005


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