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Calcific healing of a crown root fracture of a maxillary central incisor evaluated with spiral computed tomography and hounsfield units: a case report

CASE REPORT

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Abstract – Trauma to anterior teeth results in crown root fracture in 5% of cases. Calcific healing of a complicated oblique crown root fracture is rarely reported in literature. This article highlights the calcific healing of a traumatized maxillary central incisor with crown root fracture. This unique observation of healing following trauma was confirmed with the use of spiral computed tomography and Hounsfield units.

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Traumatic injuries of teeth and their supporting structures occur commonly in young patients and varies in severity from enamel fractures to avulsions (1). Maxillary incisors are prone to fracture, comprising mostly crown fractures (2). The common etiologic factors are injuries caused by falls, bicycle and automobile accident and foreign bodies striking the tooth (3). Fracture of the anterior tooth is mostly caused by direct trauma and 5% of traumatic injuries to anterior teeth result in crown root fractures (4).

Crown root fracture is defined as a fracture involving enamel, dentin and cementum. The fracture line mostly begins a few millimeters incisal to the marginal gingiva on the facial aspect of the crown, following an oblique course below the gingival crevice palatally. The fragments usually exhibit mild displacement and the coronal fragment is held in place mostly by the periodontal fibers in the palatal aspect. Crown root fracture of the anterior teeth can be of two types: those with and those without pulpal involvement (5). Communication from the oral cavity to the pulp and periodontal ligament in these fractures permits bacterial invasion and consequent inflammation. The sequelae of root fracture may be (i) healing with interposition of hard tissues; (ii) healing with interposition of bone and soft tissue between the fragments; (iii) healing with interposition of soft tissue(PDL); and (iv) Non-healing of the fractured fragments (6). The union is usually assessed by an intra oral periapical radiograph, but the mode of healing can be confirmed only by histologic analysis. Radiographic examination of crown root fractures may not clearly demarcate the fracture extent, pattern and may not confirm the clinical diagnosis, as the oblique fracture line is almost perpendicular to the central beam. Oblique root fracture will be more clearly visible if the central beam is directed within a maximum range of 15–20 of the fracture plane. By taking two radiographs, one with a +15 and another with −15 to the original angulation can help observe the fracture pattern much better (4).

Use of Spiral Computed Tomography has started a new epoch in dentistry. It is being used for various applications like analyzing the canal anatomy (7, 8), extent of a periapical lesion, assessment of root canal preparation with various Ni-Ti file systems (9), the level of fracture of bone (10) and measuring the bone mineral density (11). Spiral CT is also used for *in vitro* studies and in volumetric measurements (12). It has the advantage of analyzing the tooth in axial, transverse and longitudinal sections, which other wise is possible only by extracting and sectioning the tooth. With the aid of spiral CT, measurement of CT units also known as Hounsfield units (HU) is possible (13). The Hounsfield scale was invented in 1972 by Godfrey Newbold Hounsfield. His scale is a quantitative measure of radiodensity and is used to evaluate CT scans. Pixels in an image obtained by CT scanning are displayed in terms of relative radiodensity. The pixel value is displayed according to the mean attenuation of the tissue that it corresponds to on a scale from −1024 to +3071 on the Hounsfield scale. Water has an attenuation of 0 HU, while air is −1000 HU, bone is typically +400 HU or greater depending on the nature of bone, blood and soft tissue has +56 HU (13). This is a valuable tool to compare the composition of one tissue with that of another (to differentiate between air, soft tissue and calcified tissue). Use of Hounsfield units for diagnosis has not been reported in dental literature. This paper reports a case of calcific healing of a crown root fracture in a maxillary central incisor, evaluated using Spiral Computed Tomography and Hounsfield scale.

Case report

A 24-year-old male came to our dental department in the month of January 2006, with the complaint of fractured maxillary right incisors following a motorbike accident. The patient was asymptomatic. On taking the history, it was found that the accident had occurred 4 years previously. After the trauma, the maxillary anterior teeth were mobile and were splinted immediately in a nearby dental clinic. The radiographs from the private dentist were not traceable. On clinical examination, a broken splint extending from maxillary right canine and left canine was observed. The teeth were splinted with a coaxial wire and composite resin. The crown of maxillary right lateral incisor was fractured (Ellis type V). A fracture line was observed in the right central incisor in the cervical region of the crown (Fig. 1a). Periodontal examination revealed normal healthy peridontium. The vitality of pulp for maxillary right and left incisors was checked using electric pulp tester (Parkel) and thermal tests. Maxillary right lateral incisor showed negative response to both tests, whereas maxillary right central incisor showed negative response to thermal tests, but gave vital response at value 5 to electric pulp tester. The left upper central incisor showed a response at value 4 for electric pulp testing.

Intra oral periapical radiographic examination revealed loss of coronal tooth structure with periapical radiolucency in maxillary right lateral incisor (Fig. 1b). This tooth was later endodontically treated followed by cast metal post and core and ceramic crown restoration.

Radiographically maxillary right central incisor showed two radiolucent lines in the cervical region of crown and 2 mm apical to the crest of the alveolar bone. The lamina dura was continuous and intact throughout

Fig. 1. (a) Preoperative photo showing fractured tooth 12 and 11 with broken splint. (b) Preoperative radiograph. (c) Palatal view showing that the fracture extent in tooth 11 is subgingival. (d) Postoperative view in which tooth 12 and 11 are restored.

the root surface and there was no periodontal widening (Fig. 1b). On the basis of radiographic findings, we had assumed that maxillary right central incisor had oblique crown root fracture. The splint was removed and the tooth was assessed for mobility. Surprisingly, the tooth was not mobile even after the removal of splint. As there was a lack of mobility, we considered that the fracture pattern of right central incisor could either be two individual fractures without communication or a comminuted fracture of the facial surface alone.

Prior to treating the right central incisor, a spiral computed tomography was taken to confirm the nature of fracture and the mode of healing in maxillary right central incisor. Informed consent was obtained from the patient for taking the spiral CT. From the various sections taken, it was inferred that maxillary right central incisor had an oblique crown root fracture, which showed radiopaque region in the pulp chamber and cervical part of root canal (Fig. 2). The Hounsfield unit of the radiopaque region was measured using SIENET

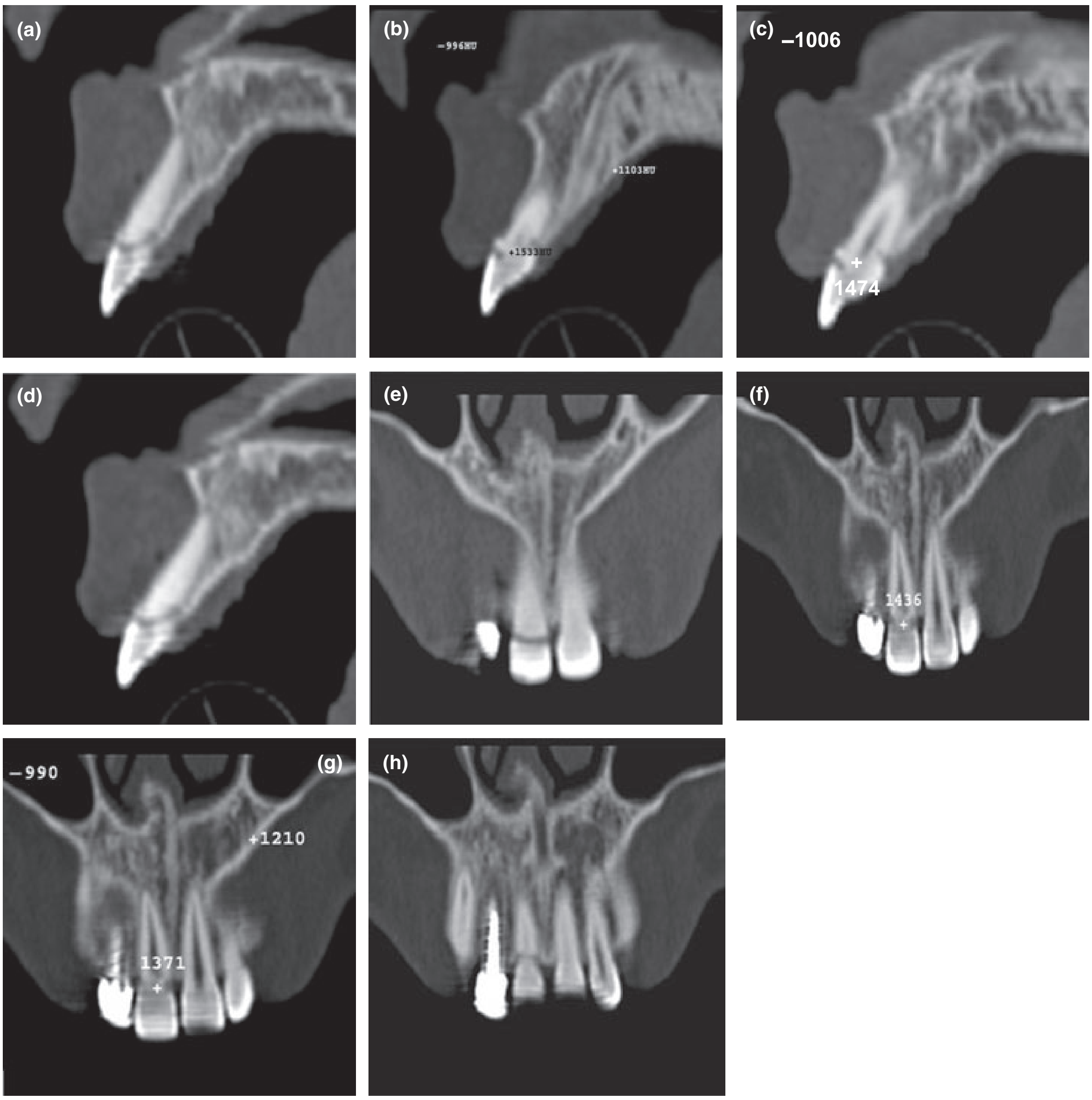

Fig. 2. (a) CT section showing a radiolucent fracture line extending from labial to palatal surface in mesial section of 11. (b) CT section showing separate radiolucent fracture lines in labial and palatal surface with radio opaque area with 1534 HU in pulp chamber and canal in mid mesial section of 11. (c) CT section showing separate radiolucent fracture lines in labial and palatal surface with radio opaque area with 1474 HU in pulp chamber and canal in mid distal section of 11. (d) CT section showing a radiolucent fracture line extending from labial to palatal surface in distal section of 11. (e) CT section showing a radiolucent fracture line (cervical) extending from mesial to distal surface in labial section of 11. (f) CT section showing separate radiolucent fracture lines in mesial and distal surface with radio opaque area with 1436 HU in pulp chamber and canal in mid labial section of 11. (g) CT section showing separate radiolucent fracture lines in mesial and distal surface with radio opaque area with 1371 HU in pulp chamber and canal in mid palatal section of 11. (h) CT section showing a radiolucent fracture line (subgingival) extending from mesial to distal surface in palatal section of 11.

Sky – DICOM viewer with a window width of 890 and length of 3255. The CT images along with Hounsfield scale showed that the crown root fracture of maxillary right central had healed, in the center by calcification of the pulp. As the patient was asymptomatic, endodontic treatment was deferred and the fracture site was restored with bilayered restoration (Glass ionomer cement and resin composite), and kept under observation. The patient was kept under observation for a year and half, and was found to be asymptomatic (Fig. 1d).

Discussion

The classical study conducted by Andreasen et al. in 2004 has shown that the overall healing rate of root fracture with hard tissue is 30% (14). Another study by Cvek et al. has shown that 14% of oblique cervical root fracture heals with calcification (15). But the literature assessing the healing of crown root fracture is minimal. Losee and Lindemann (16) have quoted that repair of the crown root fracture by deposition of osteo-dentin along the fracture line is extremely rare. Generally, healing events following root fracture are initiated at the site of pulpal and periodontal ligament. These processes apparently occur independently of each other and are sometimes even competitive in their endeavor to close the injury site with either pulpal or periodontally derived tissue. If the pulp is intact with only mild stretching and no bacterial contamination, fracture healing with ingrowth of cells originating from the apical half of pulp ensures hard tissue bridge, which will unite the apical and coronal fragments within 2–3 months (4). This bridge forms the initial callus, which will stabilize the fracture. Callus formation is followed by deposition of cementum derived by in-growth of tissue from the periodontal ligament at the fracture site first centrally and gradually obliterating the fracture site.

When the pulp is severely stretched and without bacterial contamination, the healing is predominated by ingrowth of cells originating from the PDL and results in the interposition of the connective tissue between the two fragments. A factor with significant influence in the healing process is the presence or absence of communication of the fracture site with oral environment. Healing does not occur, if there is a communication between fracture site and oral cavity because of the bacterial contamination from the gingival sulcus (17). The prognosis is considered to be poor in case of crown root fracture because of a short mobile coronal fragment, with less probability of healing with hard tissue and possible bacterial contamination of necrotic pulp tissue from the coronal fracture line.

In our reported case, it was seen that the tooth was not mobile even after splint was removed. The various sections of spiral CT scan showed that the tooth had fractured obliquely, but the segment coronal to the fracture was still held to the tooth by a central calcified mass. The HU of the mass holding the apical and coronal segments were found to be in the range between +1350 and +1550 HU. Hounsfield units for calcified tissue are mostly above 250 (13). By comparing the values obtained from the tooth and the standard values, we were able to conclude that the central mass had calcified because of trauma and was holding the tooth intact.

Andreasen and Cvek have quoted various factors for calcific healing of the root fractures, which may be attributed to the healing of crown root fracture also. The stage of root development, displacement, mobility of segments, diastasis between the fragment and the extent of stretching of pulp can influence the healing of root fractures. The lesser the diastasis and stretching of the pulp, the better the chance of calcific healing of the fracture (14, 15).

Even though the calcific healing of crown root fracture is not mentioned as a common occurrence in literature, here we have reported a rare case of calcific healing of crown root fracture. The probable reason could be that the pulp would have stretched mildly on trauma and was splinted in that position. The mild stretching of pulp and the relative absence of inflammation might have triggered the pulpal cells to calcify. The impact of prolonged splinting in the fracture healing in this case cannot be confirmed. But the study conducted by Cvek has shown that the duration of splinting does not play a role in the pattern of healing (15).

The use of spiral CT in this case has proven that it is not only a valuable diagnostic aid, but also helps in determining the type and extent of fracture but has also proven that crown root fracture can heal with calcific union.

Conclusion

In this case report, Spiral Computed Tomography has enabled the confirmation that the tooth had an oblique crown root fracture and assessment of the fracture three dimensionally. By measuring the Hounsfield, unit we were able to assess the mode of healing of the crown root fracture.

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