Discussion on Forensic Identification of Tooth Injury Accompanied by Periodontal Disease — With Three Case Reports

Yufang Wang[1], Bobo Song[1], Yanchen Hou[2], Yanfei Chen[3], Ying Fan[1], Jie Jia[1]

[1]DI'AN Regional Forensic Science Institute (Nei Mongol), Hohhot 010000, Inner Mongolia, China

[2]Criminal Investigation Brigade, Public Security Bureau of East Ujimqin Banner, Xilingol League 026000, Inner Mongolia, China

[3]Traffic Accident Brigade, Traffic Management Detachment, Public Security Bureau of Xilingol League 026000, Inner Mongolia, China

Abstract: Gingival disease refers to a group of pathological changes occurring in the gingival tissue, including inflammation of the gingiva and manifestations of systemic diseases in the gingiva. It can lead to inflammation of the supporting tissues of the teeth (gingiva, periodontal ligament, alveolar bone, and cementum), formation of periodontal pockets, progressive attachment loss, and alveolar bone resorption, eventually resulting in tooth loosening and loss. Tooth injury is one of the more common injuries encountered in forensic identification. The main imaging examination methods include periapical X-rays, panoramic radiographs, and CBCT (cone-beam computed tomography). Based on different imaging manifestations, the influence of varying degrees of periodontal disease on tooth injury is described, and viewpoints are proposed on the application of periodontal disease severity in forensic practice, with the aim of providing reference for fellow forensic examiners.

***Keywords*:** forensic clinical medicine; tooth injury; periodontal disease; identification

1. Introduction

Gingival disease refers to a group of pathological changes occurring in the gingival tissue, including inflammation of the gingiva and manifestations of systemic diseases in the gingiva. It can lead to inflammation of the supporting tissues of the teeth (gingiva, periodontal ligament, alveolar bone, and cementum), formation of periodontal pockets, progressive attachment loss, and alveolar bone resorption, eventually resulting in tooth loosening and loss. Tooth injury is one of the more common injuries encountered in forensic identification. The main imaging examination methods include periapical X-rays, panoramic radiographs, and CBCT (cone-beam computed tomography). Based on different imaging manifestations, the influence of varying degrees of periodontal disease on tooth injury is described, and viewpoints are proposed on the application of periodontal disease severity in forensic practice, with the aim of providing reference for fellow forensic examiners.

2. Anatomy and Classification

2.1 Physiological Anatomy and Function

The tooth structure consists of three calcified hard tissues — enamel, cementum, and dentin — and one soft tissue, the dental pulp.Enamel: It covers the surface of the crown and is the most highly calcified and hardest part of the tooth. It is semi-transparent, milky white to yellowish in color, and its appearance is related to the degree of calcification. The higher the degree of calcification, the more transparent the enamel; when the calcification is lower, the enamel appears milky white and opaque. Deciduous teeth have a lower degree of calcification and therefore appear milky white.Cementum: It covers the surface of the root, is light yellow in color, and its hardness is similar to that of bone. It is thinner at the cervical area and thicker near the root apex and the bifurcation of molar roots.Dentin: It forms the main body of the tooth and lies beneath the enamel and cementum. It is light yellow in color, with hardness lower than enamel but slightly higher than bone. The pulp chamber at the center of dentin is filled with the soft connective tissue of the dental pulp.Dental Pulp: It is a loose connective tissue located within the pulp chamber and surrounded by dentin. The blood vessels, nerves, and lymphatic vessels of the pulp connect with the periodontal tissues through the apical foramen and the apex of the root.

2.2 Classification

According to the tissues involved, periodontal disease can be divided into two major categories: gingival disease and periodontitis. Gingival disease refers to a group of pathological changes occurring in the gingival tissue, including inflammation of the gingiva and manifestations of systemic diseases in the gingiva. Gingival diseases generally do not invade the deeper periodontal tissues. At the 1999 World Workshop on the Classification of Periodontal Diseases, gingival diseases were classified into two types: plaque-induced gingival diseases (such as chronic gingivitis, puberty gingivitis,

pregnancy gingivitis, and drug-induced gingival hyperplasia) and non–plaque-induced gingival diseases (such as gingival diseases caused by viruses or fungi, manifestations of systemic diseases in the gingiva, and hereditary lesions).Periodontitis is a chronic infectious disease of the periodontal tissues caused by dental plaque biofilm, leading to inflammation of the supporting tissues of the teeth (gingiva, periodontal ligament, alveolar bone, and cementum), formation of periodontal pockets, progressive attachment loss, and alveolar bone resorption, eventually resulting in tooth loosening and loss.

Even within the same type of periodontal disease, clinical manifestations may vary. Generally, the tooth surface is covered with large amounts of calculus, and the gingiva exhibits varying degrees of chronic inflammation—bright red or dark red in color, soft in texture, loss of stippling, and edematous. Probing often causes bleeding or even pus discharge. In the early stage, periodontal pockets and alveolar bone resorption are already present, but to a mild extent, and teeth are not yet loose. In the late stage, deep periodontal pockets form, teeth become loose, chewing becomes weak or painful, and acute periodontal abscesses may occur.

3. Radiographic Findings and Grading

3.1 Radiographic Findings

Imaging examination methods for periodontal disease include periapical X-rays, panoramic radiographs, and CBCT (cone-beam computed tomography). Among them, CBCT is significantly superior to panoramic radiographs in assessing buccal (labial) and lingual bone resorption as well as furcation lesions.

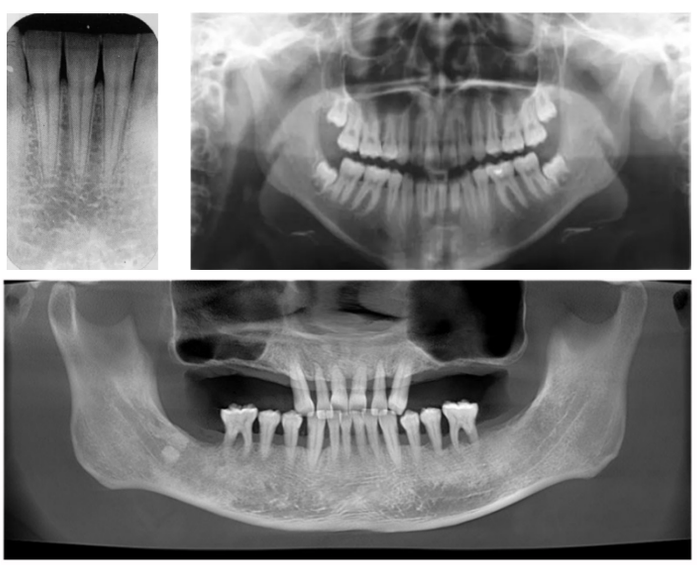

Figure 1. Illustration of imaging examination methods

Types of alveolar bone resorption include horizontal resorption, vertical resorption, and mixed resorption.

Horizontal resorption is characterized by a reduction in the height of the alveolar bone from the crest toward the root apex in a horizontal direction, affecting multiple teeth or even the entire dentition. The degree of resorption is generally uniform and consistent. In the early stage, the cortical plate of the alveolar crest becomes blurred or disappears. Subsequently, the alveolar crest in the anterior region changes from sharp to flat, while in the posterior region it changes from a trapezoidal shape to a concave one, with indistinct, rough, and moth-eaten margins. As the disease progresses, the alveolar bone gradually resorbs toward the root apex.

Vertical resorption is characterized by localized bone loss on one side of the alveolar bone or the interalveolar septum, extending toward the root apex along the long axis of the tooth. In the early stage of the lesion, resorption of the alveolar bone wall occurs, the cortical plate disappears, and the periodontal ligament space widens. With further progression of the disease, vertical alveolar bone resorption becomes more evident, forming a wedge-shaped defect. When both the mesial and distal sides of the same tooth exhibit vertical resorption, the alveolar bone may show an arcuate resorption pattern, which is most commonly seen in first molars with juvenile periodontitis.

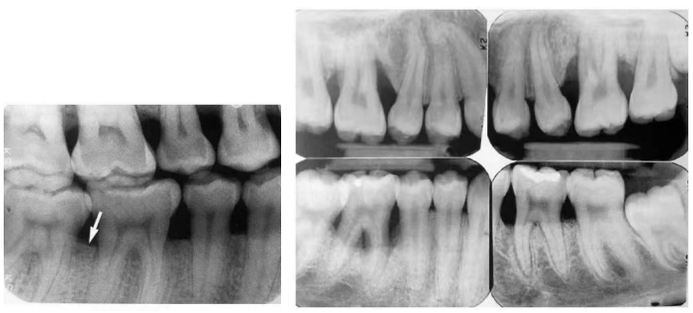

Figure 2. Illustration of alveolar bone resorption types

Classification of alveolar bone morphology after resorption:
A. Alveolar bone equivalent to that of a dentate jaw;
B. High and wide alveolar bone;
C. High and narrow alveolar bone;
D. High and sharp alveolar bone;
E. Low and wide alveolar bone;
F. Completely resorbed alveolar bone.

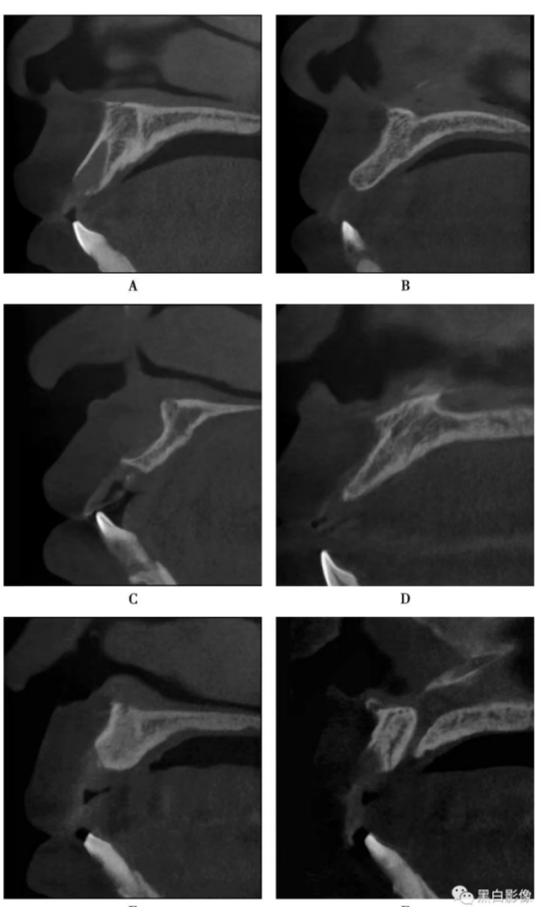

Figure 3. Classification of alveolar bone morphology after resorption

3.2 Grading

Clinically, chronic periodontitis can be classified as localized or generalized according to the extent of attachment loss and bone resorption. When the number of sites with attachment loss and bone resorption involves less than 30% of the total dentition, it is classified as localized; when more than 30% of sites are affected, it is classified as generalized.

The severity of periodontal tissue destruction is determined based on the depth of periodontal pockets, the degree of connective tissue attachment loss, and the extent of alveolar bone resorption:

① Mild: Gingival inflammation and bleeding on probing are present. Probing depth < 4 mm, attachment loss of 1–2 mm. X-ray shows alveolar bone resorption not exceeding one-third of the root length. Halitosis may or may not be present.

② Moderate: Gingival inflammation and bleeding on probing are present, possibly with pus discharge. Probing depth < 6 mm, attachment loss of 3–4 mm. X-ray shows horizontal or angular alveolar bone resorption exceeding one-third but not more than one-half of the root length. The tooth may exhibit slight mobility, and multirooted teeth may have mild furcation involvement.

③ Severe: Pronounced gingival inflammation or periodontal abscess formation. Probing depth > 6 mm, attachment loss > 5 mm. X-ray shows alveolar bone resorption exceeding one-half of the root length. Teeth are mobile, and posterior teeth exhibit Class II or Class III furcation involvement.

4. Forensic Clinical Identification

4.1 Identification and Determination of Injury Severity

According to the Standards for the Assessment of Human Body Injury Degrees, dental injuries include loosening, dislocation, and fracture of teeth, accompanied by pain, gingival swelling, and masticatory dysfunction. Tooth fractures include fractures of the crown and root. The term “tooth fracture” in this context refers to root fractures, crown-root fractures, or crown fractures that expose the dental pulp. Tooth loss includes cases where teeth with mobility of degree III or above cannot be preserved. In the presence of a clear history of facial trauma, clinical examination alone can confirm the diagnosis. This category of tooth loss or fracture includes permanent teeth, deciduous teeth, and implant-supported teeth in fixed prostheses, but does not include damage to fixed prostheses that do not require surgical replacement or repair of the prosthetic components.

Criteria for Identification:

(1) A clear history of facial trauma;

(2) Clinical examination findings of gingival injury or bleeding, and the presence of fresh blood clots covering the alveolar socket;

(3) Imaging examination of the alveolar socket and alveolar bone conditions (preferably imaging obtained at the time of injury).

4.2 Case Studies

4.2.1 Case 1

(1) Excerpt from the outpatient medical record of the examinee Dong, People's Hospital of a certain coastal city, March 5, 2022:

Special examination: The patient's facial symmetry is generally normal. Mouth opening degree and pattern are normal. A laceration of approximately 2 cm is observed on the left lower lip, with irregular edges and depth reaching the muscle layer, without active bleeding. Another laceration of about 1 cm is seen in the vestibular groove on the inner side of the left lower lip, with irregular edges and no active bleeding. Teeth 11, 12, 21, 22, 24, 31, and 41 are missing, with fresh blood clots covering the alveolar sockets. Teeth 32 and 42 show grade III mobility, and tooth 23 shows grade II mobility.

Preliminary diagnosis:1.Lip laceration;2.Tooth dislocation.

(2) Excerpt from the outpatient medical record of the examinee Dong, People's Hospital of a certain coastal city, March 7, 2022:

Chief complaint: Dental trauma for 3 days.

Special examination: The patient's facial symmetry is normal. Mouth opening degree and pattern are normal. Slight swelling of the lower lip; sutures are in place at the laceration site, and a small amount of exudate is observed upon pressure. Blood clots remain in the alveolar sockets of teeth 11, 12, 21, 22, 24, 31, and 41, and no obvious gingival bleeding is noted. Teeth 32 and 42 exhibit grade III mobility, tooth 23 grade II mobility with percussion pain (++), and no pain to cold stimulus. No other obvious abnormalities detected.

Discharge diagnosis:(1) Lip laceration;(2) Periodontal disease;(3) Acquired tooth loss (11, 12, 21, 22, 24, 31, 41).

Imaging findings: Mixed alveolar bone resorption throughout the dentition, extending to 1/2–2/3 of the root length. Teeth 18, 14, 32, and 42 show resorption up to 1/3 of the root apex. Alveolar sockets of teeth 11, 12, 21, 22, 24, 31, and 41 are visible and relatively shallow. An irregular high-density shadow is observed within the alveolar socket of tooth 22. Residual roots noted in teeth 16 and 25, and tooth 45 is mesially inclined.

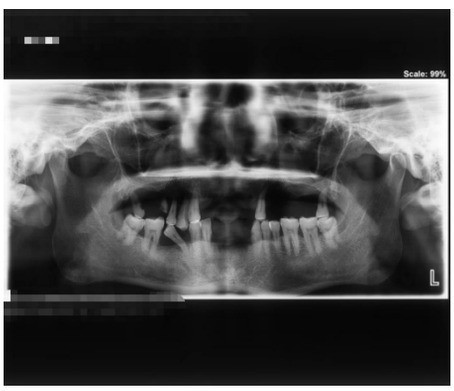

Figure 4. Imaging findings of Case 1

Conclusion:

In this case, the examinee had a clear history of trauma related to the loss of teeth 11, 12, 21, 22, 24, 31, and 41. Imaging revealed blurred alveolar bone margins, disorganized trabecular patterns, reduced and rounded alveolar crests, and bone resorption exceeding two-thirds of the root length, presenting as mixed-type resorption involving more than 30% of the sites—radiographic features consistent with generalized mixed-type severe periodontitis.The injured individual exhibited progressive attachment loss and increased tooth mobility, resulting in decreased resistance to external forces. Under minor external force, multiple teeth were dislodged, which aligns with the forensic characteristics of patients with periodontal disease—namely, teeth easily falling out under trauma with only mild surface and periodontal tissue injury manifestations. Therefore, the extensive tooth loss in this case was caused by mild external force acting on a background of generalized periodontitis and should not be classified for injury severity assessment.

4.2.2 Case 2

(1) Excerpt from the outpatient medical record of the examinee Du, People's Hospital of a certain Left Banner, May 2, 2023:

Physical examination: No cranial deformities. Injury and bleeding present anterior to the right ear. Swelling and tenderness (+) of the right eye. Swelling of the lips and oral mucosa; multiple teeth mobile, with four teeth lost. Blurred vision in the right eye. Swelling of the temporal region. Soft tissue injury in the neck.

(2) Excerpt from the outpatient medical record of the examinee Du, Affiliated Hospital of a Medical University, May 4, 2023 (Medical record no.: 0020496206):

Physical examination: Teeth 17, 12, 11, 21, 22, 24, 25, 26, 27 are missing. Tooth 13 exhibits grade II mobility; teeth 23, 31, 41, and 42 exhibit grade III mobility.

Preliminary diagnosis: (1) Traumatic tooth loss (12, 11, 21, 24); (2) Tooth dislocation (traumatic mobility of 31, 41, 42); (3) Periodontal disease (severe)

Imaging findings: Alveolar bone of both maxilla and mandible shows varying degrees of resorption, generally extending to one-third of the root apex, and in severe cases reaching the root apex. Alveolar sockets of teeth 12, 11, and 21 appear empty. Teeth 17, 12, 11, 21, 22, 24, 25, 26, and 27 are missing.

Figure 5. Imaging findings of Case 2

Conclusion: In this case, the examinee experienced loss of teeth 12, 11, 21, and 24, and dislocation of teeth 31, 41, and 42, with a clear history of trauma. Imaging showed varying degrees of alveolar bone resorption in both the maxilla and mandible, with reduced alveolar crest height, resorption exceeding two-thirds of the root length, presenting as mixed-type resorption involving more than 30% of sites—radiographic features consistent with generalized mixed-type severe periodontitis.The injured individual exhibited progressive attachment loss and increased tooth mobility, resulting in decreased resistance to external forces. Under minor external force, multiple teeth were dislodged, consistent with the forensic characteristics of periodontal patients—namely, teeth easily falling out under trauma with only mild surface and periodontal tissue injuries. Therefore, the extensive tooth loss in this case occurred due to minor external force acting on a background of generalized periodontitis and should not be assessed for injury severity.

4.2.3 Case 3

(1) Excerpt from the outpatient medical record of the examinee Li, Central Hospital, August 31, 2024 (Outpatient no.: R6353036002):

Special examination: Tooth 21 shows grade I mobility with positive percussion pain (+); teeth 22 and 23 show grade III mobility with positive percussion pain (+). Slight swelling of the upper left lip, without obvious laceration.

(2) Excerpt from the outpatient medical record of the examinee Li, Affiliated Hospital, September 1, 2024 (Medical record no.: 0022022523):

Physical examination: Permanent dentition, poor oral hygiene. Full exposure of tooth cervical regions, gingival recession. Teeth 11 and 21 are mesially rotated in a V-shape. Tooth 11 shows no obvious mobility or percussion pain; tooth 21 shows grade II mobility; teeth 22 and 23 show grade III mobility, with positive percussion (+). When tooth 21 is mobilized, teeth 21 and 22 move together. Superficial mucosal erosion and swelling observed on the upper lip mucosa, without obvious exudate; a small amount of gray-white pseudomembrane covers the area, and no obvious laceration is detected.

Preliminary diagnosis: (1) Tooth fracture (teeth 22 and 23, apical one-third root fracture); (2) Tooth dislocation (tooth 21, incomplete dislocation); (3) Periodontal disease (severe); (4) Lip contusion (upper lip).

Imaging findings: Slight widening of the periodontal ligament at the apex of tooth 21 and on the labial side; continuity of tooth structure and alveolar bone maintained. Teeth 22 and 23 show significant alveolar bone resorption: labial alveolar bone resorption reaches approximately one-half of the root length, palatal alveolar bone resorption reaches one-third of the root length. A linear discontinuity is visible at the apical one-third of the roots, slightly below the palatal alveolar crest. Teeth 11 and 21 are mesially rotated. Overall alveolar bone resorption throughout the dentition is less than one-half of the root length.

Figure 6. Imaging findings of Case 3

Conclusion: In this case, the examinee sustained tooth fractures (teeth 22 and 23, apical one-third root fractures) and tooth dislocation (tooth 21, incomplete dislocation), with a clear history of trauma. Imaging showed slight widening of the periodontal ligament, continuity of tooth structure and alveolar bone, and alveolar bone resorption affecting less than 30% of sites—radiographic features consistent with localized early-stage periodontitis.Based on the specialized examination and clinical findings such as partial dislocation of adjacent teeth, it can be determined that external force was the primary cause of the tooth fractures, indicating a direct causal relationship. According to the principles for assessing injury–disease relationships in the Standards for the Assessment of Human Body Injury Degrees, the injury severity in this case can be evaluated according to the applicable provisions.

5. Conclusion

According to the principles for handling injury–disease relationships (Section 4.3): major or normal injuries are assessed as given; equivalent injuries are downgraded; minor or slight injuries should not be assessed. In summary: (1) Situations not suitable for assessment: Cases with generalized severe periodontitis and extensive tooth loss; Cases with localized severe periodontitis and tooth loss in the affected areas. (2) Situations requiring downgraded assessment: Cases with generalized moderate periodontitis and tooth loss; Cases with localized moderate periodontitis and tooth loss. (3) Situations for direct application of provisions: Cases with generalized periodontitis and tooth fractures; Cases with localized severe periodontitis and tooth loss outside the affected areas; Cases with localized periodontitis and tooth fractures.

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