

Dental concussion: suggested protocol for controlling its consequences, treatment, prognosis and follow-up

Alberto **CONSOLARO**¹

DOI: <http://dx.doi.org/10.14436/2358-2545.5.3.010-020.end>

ABSTRACT

Dental concussion does not lead to changes in tooth anatomy or function immediately, except for occasional painful sensitivity which ceases within a few hours, with or without the use of analgesic drugs. Dental concussion exerts an intense and sudden force over the tooth and alveolar structures, but it is not capable of fracturing the tooth or alveolar process bone. Force concentrates within a small area; thus, causing local lesion. Dental trauma can be divided into two categories, particularly regarding patient's perception: 1) Clinical – luxation, avulsion, intrusion, extrusion, root displacement and fracture — with the patient seeking immediate professional care, since damage is explicit and, in patient's opinion, requires therapeutic intervention; 2) Subclinical – dental concussion and occasional

subluxation — with the patient remaining unaware of or not attaching great importance to the problem; thus, going on with his/her daily life and even forgetting about the problem. In future evaluations, it is not rare that the patient deny the occurrence of dental trauma in the region. The overall population should be aware of the importance of seeking professional care when faced with a minor trauma or hitting a tooth accidentally. Whenever faced with a dental concussion report, the practitioner must adopt a protocol for early control and diagnosis of the seven potential consequences that might arise from concussion. Thus, a checklist comprising 13 points to check and control the effects of concussion is presented in the present study.

Keywords: Dental trauma. Dental concussion. Tooth resorption. Aseptic pulp necrosis. Pulp calcific metamorphosis.

How to cite this article: Consolaro A. Dental concussion: suggested protocol for controlling its consequences, treatment, prognosis and follow-up. *Dental Press Endod.* 2015 Sept-Dec;5(3):10-20. DOI: <http://dx.doi.org/10.14436/2358-2545.5.3.010-020.end>

¹ Full professor of Pathology, Universidade de São Paulo (USP), School Of Dentistry, Undergraduate and Graduate Programs, Bauru and Ribeirão Preto, São Paulo, Brazil.

» The author reports no commercial, proprietary or financial interest in the products or companies described in this article.

» Patients displayed in this article previously approved the use of their facial and intraoral photographs.

Submitted: October 04, 2015. Revised and accepted: October 08, 2015.

Contact address: Alberto Consolaro
E-mail: consolaro@uol.com.br

Dental concussion is a type of trauma that does not lead to changes in tooth anatomy or function immediately, except for occasional painful sensitivity which ceases within a few hours, with or without the use of analgesic drugs.

Dental concussion exerts an intense and sudden force over the tooth and alveolar structures, but it is not capable of fracturing the tooth or alveolar process bone of the jaws. In cases of concussion, the force exerted by trauma is concentrated within a spot or small region; thus, causing local, significant lesion.

In order to accurately understand dental concussion and its consequences, it is key to understand that the forces resulting from concussion are completely different from forces exerted by occlusal trauma and those applied during orthodontic movement: they are three completely different situations.

Dental trauma can be divided into two categories, regarding patient's perception. In the event of luxation, avulsion, intrusion, extrusion, root displacement or fracture, the patient tends to seek immediate professional care. It is reasonable to claim that these are cases of clinical dental trauma, since damage is explicit and, in patient's opinion, requires therapeutic intervention.

However, there is also subclinical dental trauma which encompasses dental concussion and occasional subluxation, and in which the patient remains unaware of or does not attach great importance to the problem; thus, going on with his/her daily life and even forgetting about the problem. In future evaluations, it is not rare that the patient deny the occurrence of dental trauma in the region.

It is the dental community's role to make the overall population aware of the importance of seeking professional care when faced with a minor trauma or hitting a tooth accidentally. Meanwhile, whenever faced with a concussion report, the practitioner must adopt a protocol for early control and diagnosis of the seven potential consequences that might arise from concussion and affect tooth structure. Therefore, this is one of the aims of the present study.

Early concussion: 13-item check list or suggested protocol

1st) Thorough examine dental tissues to determine the existence of minimal enamel cracks or fracture at the incisal edges, which would confirm

the reported concussion. The same procedure should be performed for neighboring teeth or the area showed by the patient.

2nd) Check whether tooth mobility has increased or remains within normality.

3rd) Take photographs of the teeth for future comparison of color, aiming at reaching a diagnosis of crown darkening caused by pulp calcific metamorphosis or aseptic pulp necrosis. It should be noted that these signs are delayed, appearing later than imaging signs.

4th) Carry out periapical radiograph and/or CT scans of the affected tooth as well as neighboring teeth: analysis followed by filing, if the case is within normality, as expected.

5th) 3, 6, 9 and 12 months after dental concussion, repeat the same imaging examination, under the same conditions, for comparison with previous examination.

6th) With imaging examinations in hand, check whether pulp limits remain smooth. Any bulging, with a focal increase in ballooning-shaped limits, revealed by a homogeneous radiolucent image, is suggestive of internal resorption.

7th) Check for pulp space radiolucency homogeneity and pulp limit sharpness, so as to eliminate the possibility of pulp calcific metamorphosis. Should that be the case, pulp limits appear as if they were fading out.

8th) Check for regularity in periodontal space, continuity and regularity of lamina dura, as well as continuity and regularity of root surface, so as to rule out the presence of ankylosis or tooth resorption by replacement bone bridges.

9th) For periapical tissues, check for the presence of irregular periodontal space thickening, interruption or irregular lamina dura thickening, so as to rule out the possibility of pericoronitis or chronic apical periodontitis, suggestive of aseptic pulp necrosis.

10th) Check for the integrity of enamel-cementum limits, so as to rule out the occurrence of irregular, radiolucent areas which might be a result of external cervical resorption.

11th) Clinically, for every interval of control, thoroughly check for changes in color, with darkened crown, suggestive of pulp calcific metamorphosis or aseptic pulp necrosis, or check for the presence of pinkish spots or areas, suggestive of internal crown resorption.

12th) Submit the affected tooth as well as neighboring teeth to pulp vitality and sensitivity tests. Pulp calcific metamorphosis will test positive only to liquid nitrogen-based tests which are more intense. Affected pulps have neural threads enclosed by dysplastic dentin, which reduces the effects caused by heat and cold. Teeth with aseptic pulp necrosis will test negative to sensitivity tests. Under different conditions, pulp vitality will be present and become manifest through sensitivity to conventional tests.

13th) After one year, with follow-up sessions performed on a 3-month basis, should there be no changes, it is very likely that concussion did not affect dental tissues, so as to produce any of its seven consequences. Nevertheless, it should be emphasized that replacement tooth resorption, internal resorption and external cervical resorption might take longer to be revealed by imaging examination. For this reason, after a year, it is recommended that examination be carried out every six months for two years. After this period, imaging examinations might be performed on a yearly basis.

An important distinction between dental concussion, occlusal trauma and orthodontic movement

The following are among the causes of lesion known as occlusal trauma: occlusal interference, eccentric forces, traumatic occlusion, grinding and clenching. In those cases, force is not sudden, since the loads produced are similar and recurrent, resembling masticatory load. Meanwhile, orthodontic forces are less significant and slowly applied; thus, spreading throughout tooth and bone structures. In comparison, orthodontic movement produces less intense loads than that produced by occlusal trauma and concussion-like dental trauma.^{1,2}

Occlusal trauma and orthodontic movement forces do not have the characteristics that warrant the occurrence of rupture of fibers, vessels, nerves and tissue necrosis areas. In other words, since orthodontic and occlusal trauma forces are neither as intense nor suddenly applied, they do not lead to the same consequences of concussion-like dental trauma. The tissue lesions caused by the three aforementioned clinical conditions differ considerably.^{1,2}

The seven consequences of dental concussion affecting tooth structures

The following are among the deleterious consequences of local concentration of forces in dental concussion:¹

1 - **Internal resorption:** force exerted by concussion might lead to displacement of a small segment of odontoblastic layer, exposing the dentin to pulp connective tissue which remains with the rest of its structure unaltered. At this specific spot of dentin exposure, internal resorption might be triggered (Fig 1). Dental trauma is basically the only cause of internal resorption.

2 - **Aseptic pulp necrosis:** force concentration at the concussion site might occur at the apical level, with rupture of blood vessels that enter the pulp, nurturing it. This might lead to aseptic pulp necrosis (Fig 2). Silently, the pulp dies without the formation of pus, since no bacteria are involved in this process. Without blood supply, the pulp suffers an anemic stroke, and pulp cells as well as its extracellular matrix coagulate, remaining as such for an indefinite period of time.

3 - **Calcific metaplasia or metamorphosis of the pulp:** force might wound the vascular pulp bundle at the apex; however, this is not enough to break it and induce necrosis. Vascular bundle lesion penetrating the pulp implies the occurrence of compression and hemorrhage, which decreases pulp blood supply temporarily or definitively. Generally, as an adaptive and survival response, pulp cells change into odontoblasts and randomly deposit a dysplastic — malformed and irregular — matrix throughout coronal and/or root pulp space, which is suggestive of homogenous obliteration in radiographic and CT scans (Figs 2 and 3).

In human biology, this change of an adult cell into another equally adult cell is known as metaplasia and represents an adaptive response. The entire process of pulp space obliteration is known as calcific metaplasia or metamorphosis of the pulp, characterized by blurring of pulp limits, not by filling out of the pulp space with clear walls and boundaries, which would in fact characterize sped-up pulp aging. Dental trauma is the only cause of calcific metamorphosis of the pulp.

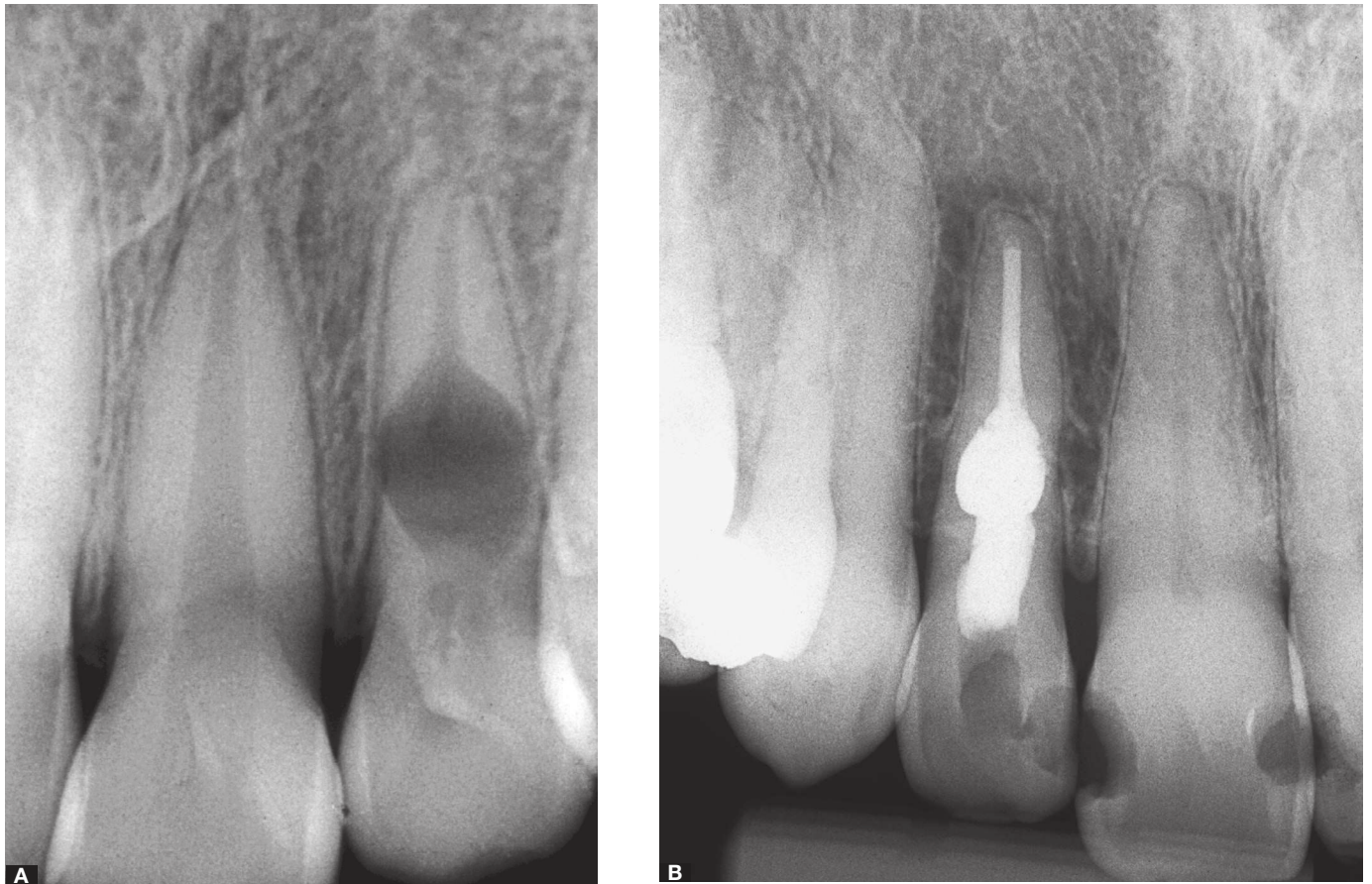


Figure 1. Internal resorption. In **A**, note the advanced stage, with weak tooth structure and potential perforation at the periodontal surface. In **B**, a case of moderate internal resorption endodontically treated after a 16-year follow-up (Source: A. Roldi, Vitória/ES and L.A. Francischone, Bauru/SP).

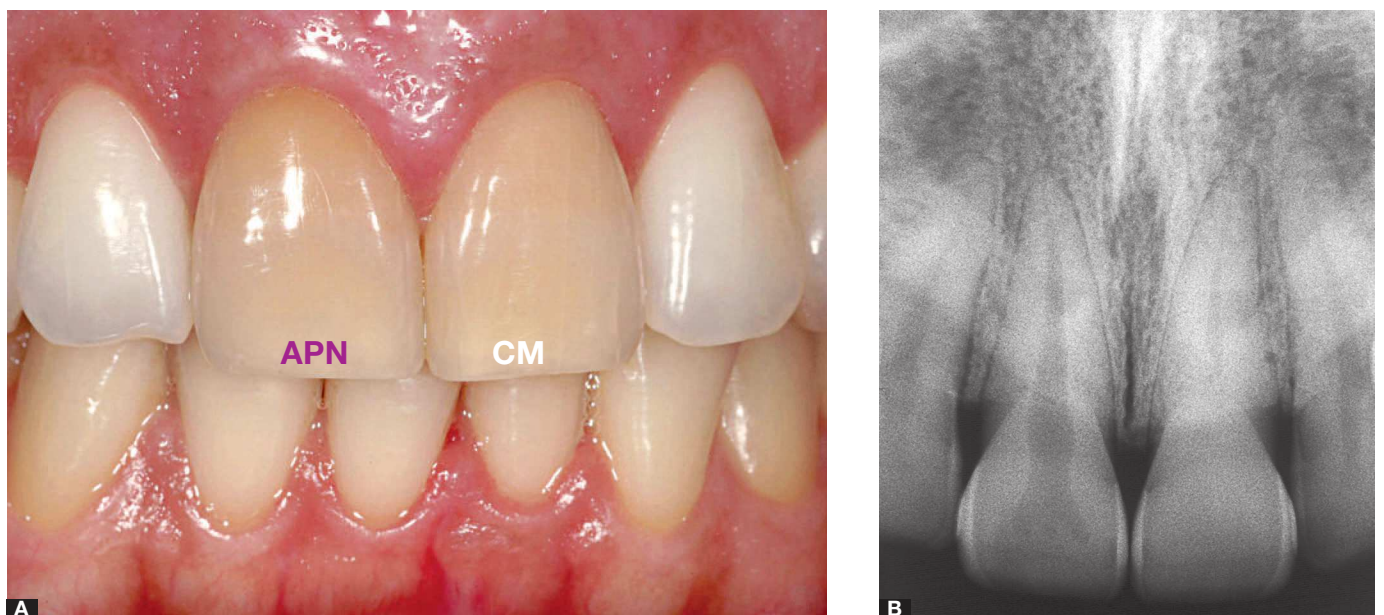


Figure 2. Asseptic pulp necrosis (APN) with clear pulp limits and darkened crown. Also with a darkened crown, there is calcific metaplasia (CM) or metamorphosis of the pulp, with blurring of pulp limits due to dysplastic dentin deposition into pulp chamber spaces and root canal.

4 – Ankylosis and replacement tooth resorption: force exerted by concussion might concentrate within a given spot of the periodontal ligament, lateral to the tooth root. At this spot, it might wound a periodontal ligament segment, with epithelial rests of Malassez death. During post-trauma reconstruction or repair processes, the bone might adhere to the tooth and lead to alveolodental ankylosis (Fig 4), which is followed by bone remodeling that ends up enclosing the cementum and dentin, both of which are slowly and gradually replaced by bone tissue; thus, initiating the process of replacement tooth resorption (Figs 4 and 5).

5 - External inflammatory tooth resorption: concussion might occasionally wound the cementoblasts layer at the periodontal ligament, thereby preserving the epithelial rests of Malassez, fibroblasts and other components. During a short period of time, a few days or weeks, mineralized root surface remains exposed and attracts clasts; thus, triggering external inflammatory tooth resorption. Once the lesion is repaired and cell as well as tissue debris have been phagocytized, inflammation ceases and cementoblasts restore the area, producing new cementum and fibers. Topographic anatomy of the root will definitively present with contour irregularities at the site, together with a periodontal space even in structure (Fig 6).

6 - External cervical resorption: concussion forces might concentrate on gingival tissue at the enamel-cementum junction area. Those people who are younger than 30 years old still have the enamel-cementum junction covered by fibrous connective tissue. Dental trauma might induce an inflammatory process at the site, with dissolution of the jelly-like extracellular matrix that hides dentin gaps or windows, pertaining to the enamel-cementum junction. External cervical resorption might then be triggered locally (Figs 7, 8 and 9). Other less common cause of external cervical resorption is intra-coronal bleaching which has been gradually and rarely carried out in modern clinical practice.

7 – Minor enamel cracks and fractures: minor enamel cracks and fractures, found at the incisal edges and their angles, might be suggestive of dental trauma (Fig 10). This type of concussion-like dental trauma consequence warrants further investigation, especially because its carriers usually categorically deny the occurrence of previous trauma.

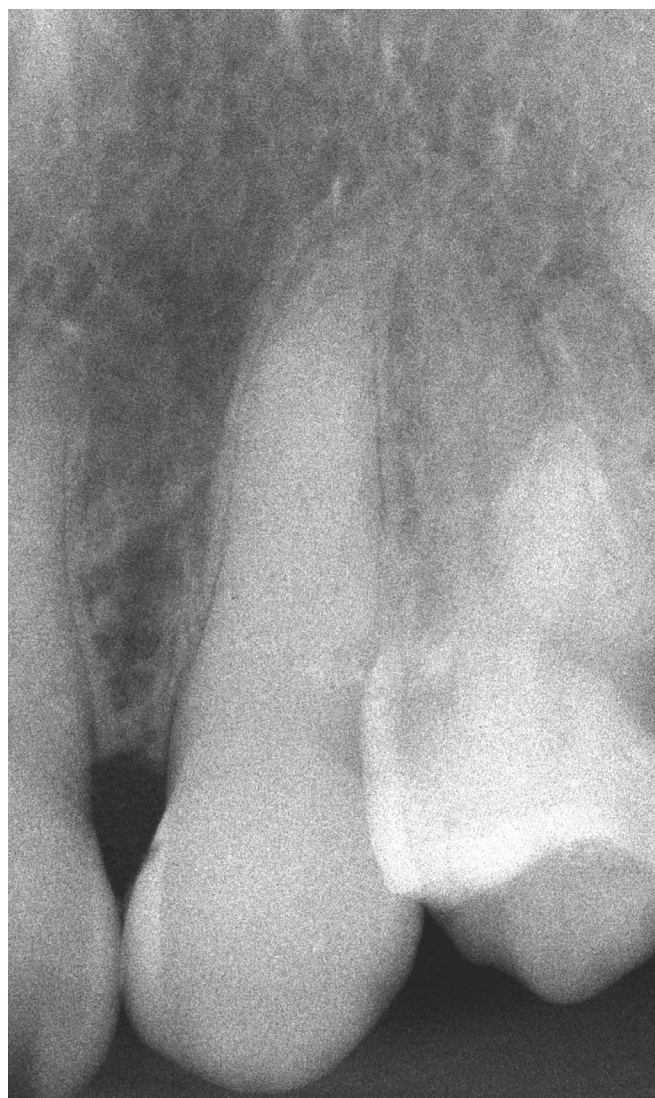


Figure 3. Calcific metaplasia or metamorphosis of the pulp induced by transoperative dental trauma resulting from maneuvers during surgically assisted luxation of an unerupted maxillary canine, subject to orthodontic traction soon after the procedure.

Protocols and prognosis for each one of the seven induced lesions: suggestion of protocols and guidelines

1 - Internal resorption: once the condition has been diagnosed and it is small- or medium-sized, the protocol consists in performing endodontic treatment. Cases in which internal resorption dangerously approaches the root surface require thorough evaluation of how weak the root surface has become.^{1,2}

As in cases of internal resorption compromising both the cervical and middle thirds and approaching

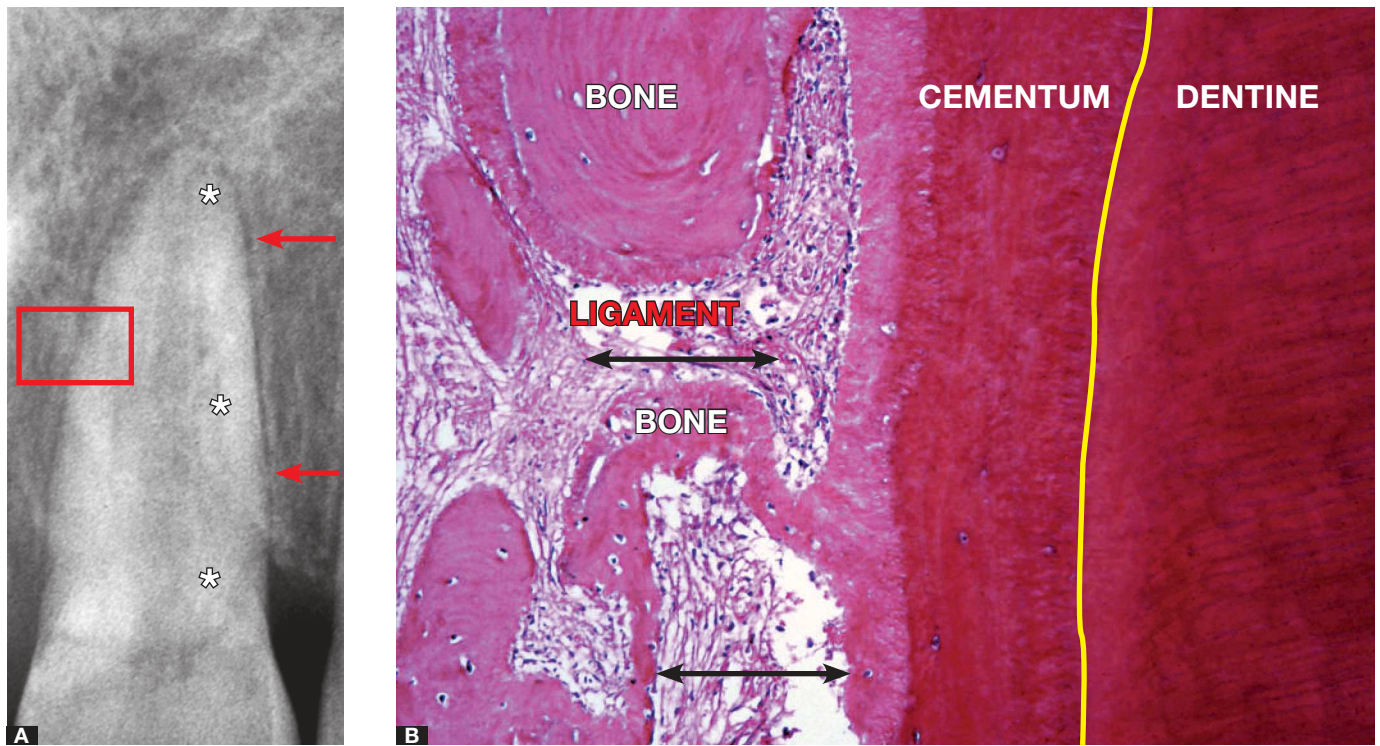


Figure 4. Replacement tooth resorption (*) after ankylosis (simple arrows). In B, a microscopic area corresponding to the rectangle: note bone bridges crossing the periodontal ligament (double arrows) and attaching to the cementum, which characterizes alveolodental ankylosis (HE 10X).

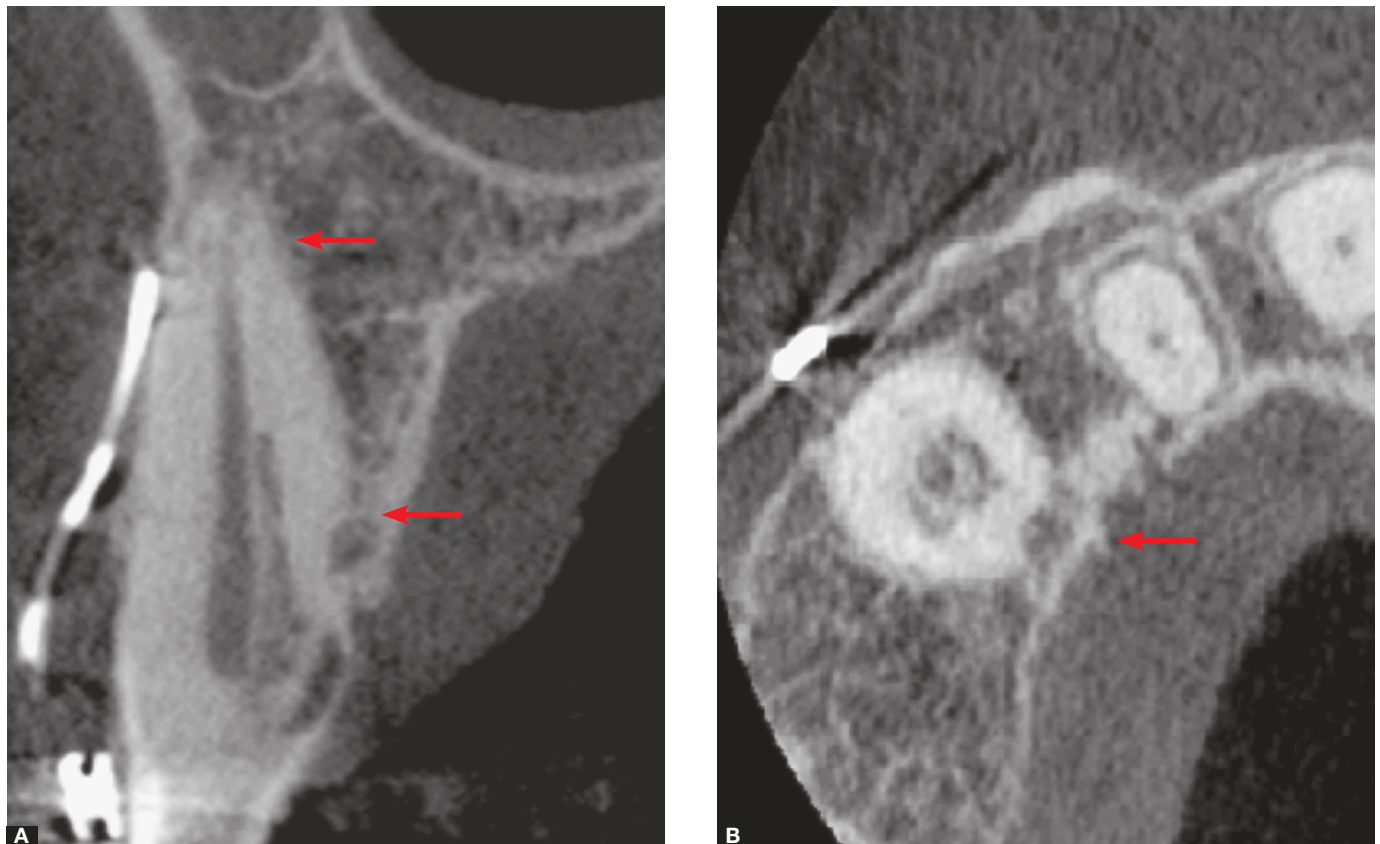


Figure 5. Replacement tooth resorption of maxillary canine, revealed by tomographic slices. Note the areas highlighted by the arrows: bone-tooth fusion, with a portion of the root structure replaced by bone, in areas without identifiable periodontal space. In the axial section, pulp limits remain preserved.



Figure 6. Stagnant external inflammatory tooth resorption probably induced by concussion dental trauma or subluxation. Note the even periodontal space width and even root surface, in spite of the sinus contour.

the root surface, therapeutic intervention might consist in osseointegrated implant replacement. Cases of more apically located internal resorption, even if near the root surface, might require apical endodontic surgery and apical third removal, before or after endodontic treatment, at clinical convenience. Cases of internal crown resorption require endodontic treatment (Fig 1), followed by restorative procedures applied to each case individually, so as to restore function and esthetics.

From a biological perspective, internal resorption cases have optimal prognosis. An unsatisfactory prognosis, with tooth loss, is generally associated with brittle structures (Fig 1). In cases of internal resorption involving perforation, with periodontal tissue intercommunication, brittleness is unavoidable. Should dental nonsurgical management be the treatment of choice, the region of periodontal root perforation must be treated as any other type of perforation, such as the accidental one. As for dental material, such as MTA and other calcium hydroxide-based material, cementoblasts colonize their surface while forming new layers of repair cementum, also known as osteocementum, which fulfills the functions of ordinary cementum while recovering the physiology of ligaments.

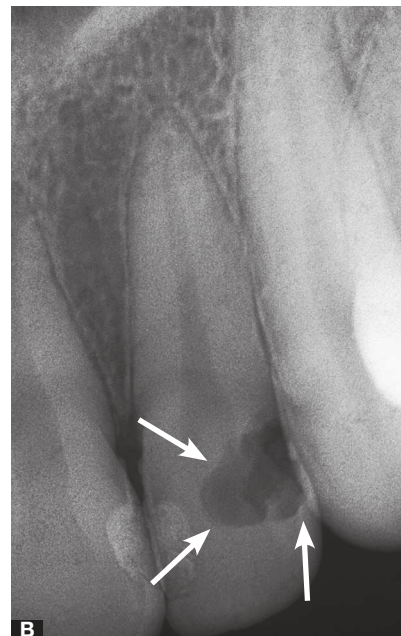
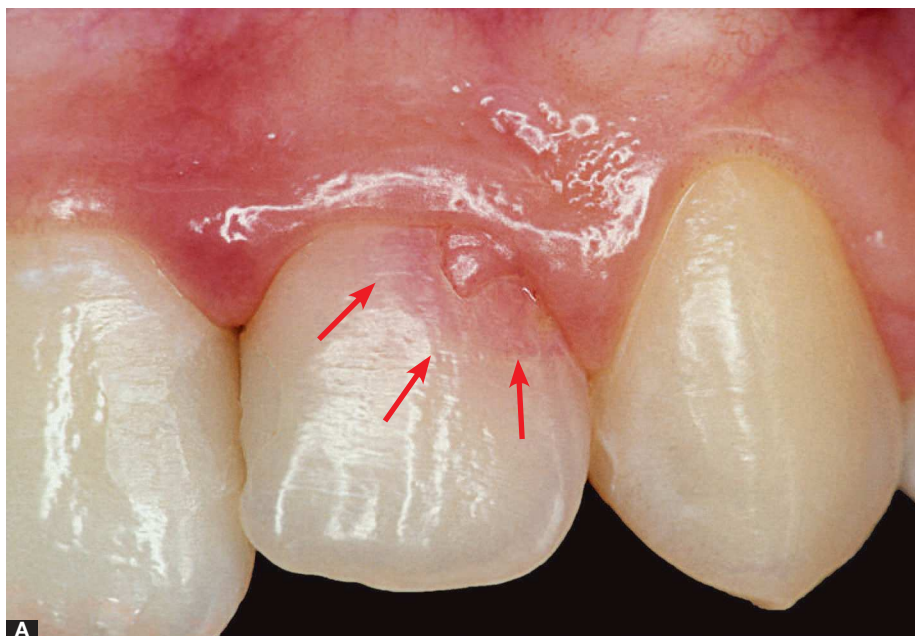


Figure 7. External cervical resorption characterized by mineralized tissue loss in the cervical region, spreading to the crown (white arrows). Radiographic examination reveals a radiolucent area with clear limits near the pulp limits (Source: C.E. Francischone, Bauru/SP).

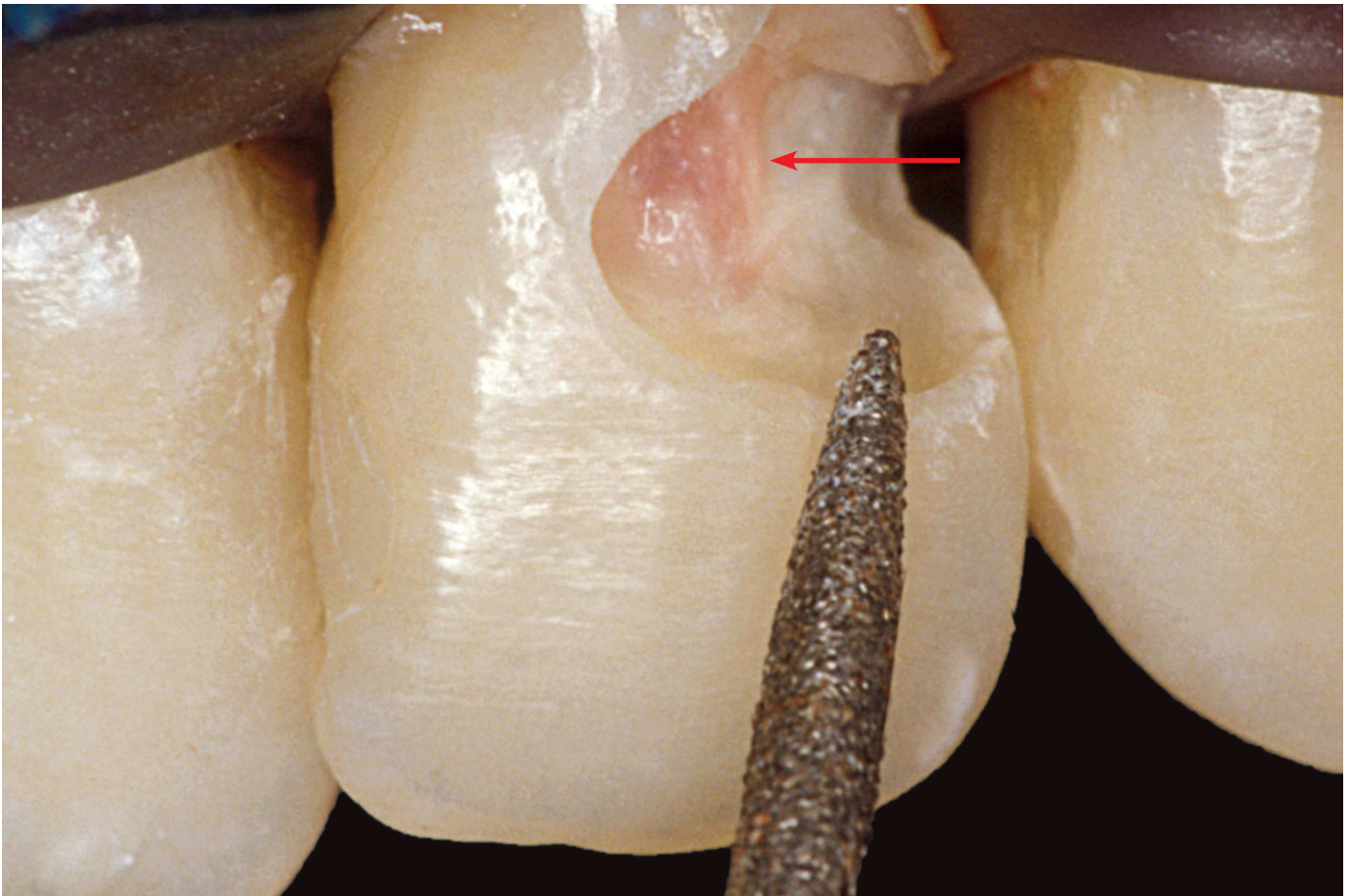


Figure 8. External cervical resorption shown in Figure 7, subject to treatment. Note (arrow) that the remaining dentin on the pulp wall reveals the reddish tone of the vital pulp to be protected by the restorative procedures. Tissues affected by resorption neither have neighboring areas softened immediately nor acquire bacterial pigments or proteolysis.



Figure 9. Clinical and radiographic aspect of maxillary lateral incisor with external cervical resorption, shown in Figures 7 and 8, three years after being subject to restorative treatment (white arrows) (Source: C.E. Francischone, Bauru/SP).

2 - Aseptic pulp necrosis: with or without chronic periapical lesion revealed by imaging examination, therapy consists in endodontic treatment. Generally, the canal with clotted necrotic pulp does not hold microbiota. Nevertheless, studies reveal that, one year after the occurrence of aseptic pulp necrosis, 50% of cases might hold microbiota inside the root canal, with bacteria reaching the site by hematogenous route.

The collection of bacteria reaching previously wounded/inflamed sites by hematogenous route is known as anachoresis. Every day, bacteria enter our organism's blood stream and within seconds are eliminated by our immune system. Those brief moments are known as transient bacteremia. Anachoresis might occasionally occur at the tooth apex with aseptic pulp necrosis, considering that the periapex holds inflammation induced by by-products of pulp tissue death. It is rare that apparently hid teeth with darkened crowns present with fistulas that could be explained by anachoresis.

Teeth with aseptic pulp necrosis subject to treatment have a very satisfactory prognosis. Darkened crowns might be treated by crown bleaching individually performed on the affected tooth.

3 - Calcific metaplasia or metamorphosis of the pulp: whenever calcific metaplasia or metamorphosis of the pulp is early diagnosed, before pulp limits are blurred, endodontic treatment will prevent tooth darkening and complete pulp space obliteration, which might render endodontic treatment unfeasible due to lack of reference to endodontic instruments. Case reports in which there was an attempt to endodontically treat teeth with calcific metaplasia of the pulp describe many episodes of root perforation lateral to the periodontal ligament.

Once the canal has been completely blocked and endodontic treatment has been rendered impossible, there are two remaining options to treat darkened crowns: outside bleaching every one or two years, with satisfactory esthetic outcomes; or the application of ceramic veneers.

Studies reveal that around ¼ of cases, over a period of 4 to 22 years, evolve to pulp necrosis with chronic periapical lesion. Apical endodontic surgery is recommended to these cases.

Endodontic treatment is the best therapeutic option for calcific metamorphosis of the pulp before

complete closure of the pulp chamber and/or the root canal (Fig 2). However, diagnosis is not always as early as it should be (Fig 3), since the suggested protocol recommended for patients reporting concussion is not spread among dental practitioners, given that patients rarely seek or report their case to a practitioner in a specific and direct manner.

Regardless of the option to treat calcific metamorphosis of the pulp and whatever its consequences might be, prognosis is highly satisfactory. From a periodontal perspective, the affected tooth should be considered as normal and even subject to orthodontic treatment, with the proviso that previously traumatized teeth might be affected by more severe resorption, if they are not considered as special and are not subject to specific care. Previous trauma is an important predictive factor of severe resorption in teeth subject to orthodontic movement. Previously traumatized teeth require special care, but it is not contraindicated that they be subject to orthodontic movement, provided they present with normal periodontal structures, as revealed by imaging examination.

4 - Ankylosis and replacement tooth resorption: in erupted teeth, ankylosis and replacement tooth resorption imply unsatisfactory prognosis and imminent tooth loss. It is then up to discussion whether the tooth will be extracted or subject to decoronation.

Endodontic treatment of teeth with replacement tooth resorption, but also with pulp vitality, does not necessarily imply late tooth loss — even if those teeth are filled with calcium hydroxide-based material. This is because there are no case reports comparing control and experimental groups well-established outcomes.

Important care should be taken in order to avoid bone loss and focal aggravation of teeth with replacement tooth resorption, including: preventing bacterial contamination via gingival tissues and/or contaminated root canal. Surgical removal of teeth with replacement tooth resorption usually implies significant bone loss at the site, requiring grafting and/or bone transplantation soon after the procedure, so as to make up for the decrease in volume and gingival tissue support. Decoronation, or coronectomy, prevents such tissue volume losses at the site.

As the root is being resorbed, the bone formed to replace it is normal and liable to receive osseointegrated implants, without having their repair capacity

affected over implant surfaces. In bacteria-free cases, teeth with replacement tooth resorption might undergo decoronation or coronectomy, and osseointegrated implants might be immediately installed at the site. This procedure preserves bone volume at the site, in addition to maintaining periodontal tissue volume and height, thereby favoring esthetics and function as well as shortening treatment time when recovering function at the site.

5 - External inflammatory tooth resorption: concussion dental trauma or severe dental trauma rarely wounds cementoblasts exclusively, without affecting the epithelial rests of Malassez. Should that be the case, resorption is temporary and lasts while trauma-induced inflammation lasts. Within a few days or weeks, it tends to undergo repair, with the affected area covered by new cementoblasts, in addition to new cementum and fibers (Fig 6). From a therapeutic perspective, there is nothing to be done but keep up with the process and obtain new radiographs every six months for two years. Thereafter, the affected teeth must be radiographed once a year.

In those cases, endodontic treatment is chosen only if pulp necrosis is triggered by any other reason. Should dental trauma have also caused aseptic pulp necrosis, in addition to resorption, endodontic treatment could also be considered; however, such concurrence of events occurring in one tooth is rather uncommon or rare for a single event of dental trauma.

6 - External cervical resorption: resorption of this nature tends to be misdiagnosed as cervical caries or other non-carious cervical lesions. Nevertheless, it has well-established causes: dental trauma and intracoronal bleaching. External cervical resorption begins at the enamel-cementum junction, in teeth with pulp vitality and a healthy pulp (Figs 7, 8 and 9), as the clasts cannot attach to non-mineralized tissues, such as predentin.

Nearly all cervical cases allow the pulp to remain healthy, from a biological perspective, without pulpitis or necrosis. The tooth is only sentenced to loss in a few cases due to having an extremely weak structure. Nevertheless, the pulp remains intact.

Should external cervical resorption not damage the structural-mechanical portion of the tooth, restorative procedures of the lost portion must begin by soft tissue curettage in absorbed areas, associated

with operative preparation, so as to allow the area to receive the restorative material and, thus, preserve the tooth (Figs 7, 8 and 9). Restorative material is usually resin- or ionomer-based, when applied to the crown; or MTA-based, when applied to the root covered by connective and periodontal tissues.

The pulp underlying that with external cervical resorption must be protected with calcium hydroxide-based material, and shall remain in normal conditions. For external cervical resorption restorative procedures, endodontic treatment will only be considered if it is technically impossible to restore the damaged tooth with the remaining dentin and enamel, which requires pulp space to be filled for mechanical or chemical purposes, as the pulp is biologically normal.

7 - Minor enamel cracks and/or fractures: restoration of minor enamel fractures aims at restoring enamel esthetic and functional appearance (Fig 10). Cracks might hinder esthetics which will be restored by sealing and/or restorative procedures. In some cases, veneers might be recommended. However, on occasion, patients might report increased dental sensitivity. The same procedures aiming at restoring esthetics also tend to decrease increased sensitivity.

Final considerations

Two major aspects of dental concussion trauma should be taken into consideration:

1st) Patients are unaware of the harm it causes and tend to forget the condition due to lack of symptoms and the frequency it occurs. As a result, they do not seek professional care and when the consequences of the condition are diagnosed, patients deny having suffered dental trauma.

2nd) Once potential consequences are established and revealed by routine examination or once the patient has sought professional care due to tooth darkening and signs of concussion advanced stage, for instance, fracture (due to weak structures), secondary contamination and gingival impairment might occur.

In many cases, the consequences of concussion might imply tooth loss, such as cases of replacement tooth resorption; however, the majority of cases have a good prognosis when properly treated.

The best way to avoid more severe effects of dental concussion is to raise awareness, so that patients will seek professional care whenever facing the most minor

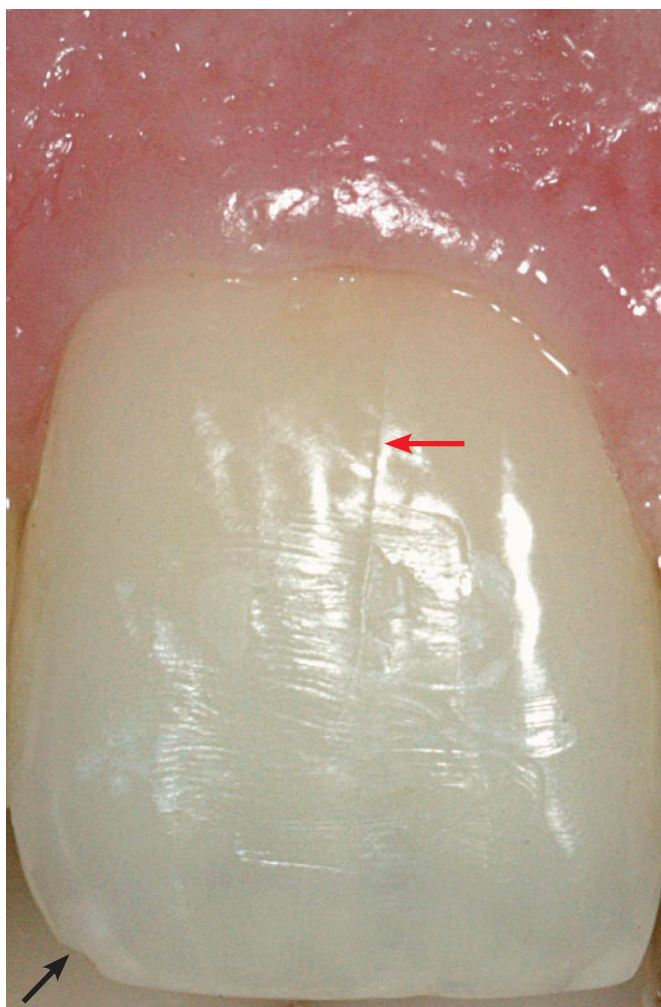


Figure 10. Enamel crack (red arrow) and fracture (black arrow), with minor tissue loss, with potential history of concussion trauma to be considered when planning other dental treatment approaches and diagnosing other consequences of concussion dental trauma.

of dental trauma. Should the practitioner apply a protocol for early diagnosis of potential consequences, potential damage will decrease considerably.

Such protocol was suggested by the present study, along with a protocol of potential therapeutic approaches for each one of the seven major consequences of concussion over the tooth structure: 1) internal resorption, 2) aseptic pulp necrosis, 3) calcific metamorphosis of the pulp, 4) ankylosis and replacement tooth resorption, 5) external inflammatory tooth resorption, 6) external cervical resorption, and 7) minor enamel cracks and/or fractures.

References

1. Consolaro A. Reabsorções dentárias nas especialidades clínicas. 3ª ed. Maringá: Dental Press; 2012.
2. Consolaro A, Furquim LZ, Francischone CE, Roldi A, Francischone LA, Cardoso MA, et al. Reabsorções radiculares inflamatórias extremas: e agora? Rev Dental Press Estét. 2015 Out-Dez;12(4):16-55.