





Replacement resorption can receive implants, and the osseointegration will be normal

Alberto **Consolaro**

PEOPLE WITH TEETH PRESERVED IN THEIR function and aesthetics may have tooth loss, which is usually associated with dental trauma. This is because there was a root fracture or traumatic injury induced alveolodental ankylosis followed naturally by tooth resorption by replacement (Fig. 1 and 2).

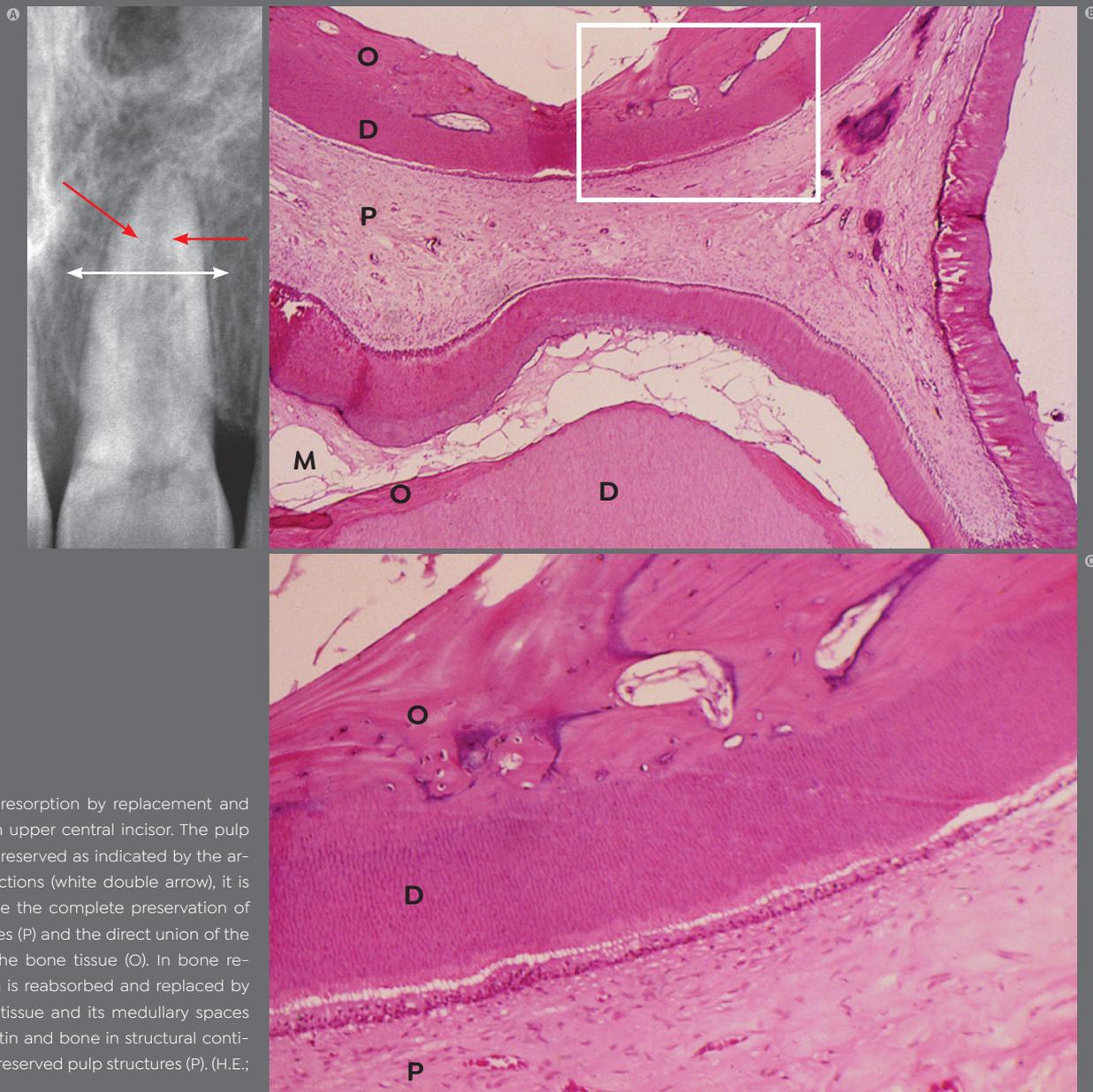


Figure 1: Dental resorption by replacement and pulp vitality in an upper central incisor. The pulp boundaries are preserved as indicated by the arrows. In cross-sections (white double arrow), it is possible to notice the complete preservation of the pulp structures (P) and the direct union of the dentin (D) with the bone tissue (O). In bone remodeling, dentin is reabsorbed and replaced by trabecular bone tissue and its medullary spaces (M). C shows dentin and bone in structural continuity, as well as preserved pulp structures (P). (H.E.; B=40X e C=100X)

DIFFERENTIATING IS FUNDAMENTAL!

Dental trauma should be differentiated from occlusal trauma and orthodontic treatment and its variables.

- 1) **In dental trauma**, the forces on the teeth are sudden and severe, “suddenly”, rapid, of short duration and with a very large potential for destruction by ruptures of collagen fibers, vessels and nerves, in addition to damage to mineralized tissues. The effects are overwhelming, as is the passion on the human soul! Due to the induced signs and symptoms, sudden and destructive dental trauma are referred to as subluxation, dislocation and avulsion, and the patient almost always seeks the professional in outpatient clinics and offices.

However, the vast majority of dental injuries are represented by their milder form, called concussion, which, clinically, is asymptomatic and without signs. But it can be oligosymptomatic with, at most, painful discomfort and bearable for 1 to 3 hours on the affected tooth and which passes with or without pain reliever. There is no increase in tooth mobility or gingival changes.

The possibility of the patient not reporting the occurrence of concussion in the consultations of an aesthetic, rehabilitation, orthodontic or other specialty treatment is very great, as he did not value the event, which was completely asymptomatic. Concussion is not valued by the patient, who does not know its aggressive potential and does not even remember what happened.

Concussion - and also other dental trauma - can occur:

- A) **Total or partial rupture of the apical vessels and nerves**, with pulp necrosis and calcium metamorphosis of the pulp, respectively, and clinically characterized by dental darkening in an apparently healthy tooth; and
- B) **Destruction of Malassez’s epithelial remains in some part of the periodontal ligament.** Without them in place, the bone approaches and joins the tooth to then include the mineralized dental tissues in its remodeling processes of constant bone resorption and apposition. Thus, alveolodental ankylosis and tooth resorption by substitution are characterized, respectively.

2) In occlusal trauma, the forces on the teeth are much lighter when compared to dental trauma and they gradually and repeatedly occur, without causing rupture of vessels, nerves or pulp necrosis. The action period tends to be long, with years of duration, and, over time, inflammatory external apical resorption can be observed.

3) In orthodontic treatment, the forces are considerably lighter than in occlusal trauma and dental trauma, in addition to being dissipating over the days. Orthodontic forces are not able to rupture vessels, nerves, nor cause ischemia, pulp necrosis or calcium metamorphosis of the pulp.

WHY AND HOW ALVEOLODENTAL ANKYLOSIS AND TOOTH RESORPTION BY SUBSTITUTION

After dental trauma to the periodontal ligament, the epithelial remains of Malassez may disappear. In the form of cords or islets 4 to 8 cells thick and 20 cells long, they form a net with a basketball basket design between the collagen fibers, vessels and nerves of the periodontal ligament.

Malassez's epithelial remains constantly release EGF - Epithelial Growth Factor - a mediator or sub-

stance that, when diffused through the periodontal ligament, stimulates alveolar bone resorption and keeps the bone at an average tooth distance of 0.25mm or 250 micrometers or 25% of a millimeter.

When dental trauma occurs, Malassez's epithelial remains disappear (die or necrotize) in areas where the tooth, compulsorily, contacts the alveolar walls. This can occur in subluxations, dislocations, intrusions, replantations, transplants, dental displacements and, especially, in concussions.

Why especially in concussions? Because the patient does not report and the teeth seem to remain in a normal way, without mobility after minor trauma and have a sensitivity of 1 to 3 hours easily controlled by common and not always necessary analgesics. After a few months or years, these affected teeth may darken due to channel obliteration resulting from calcium metamorphosis or pulp necrosis or may even present with tooth resorption by replacement.

After the dental trauma has elapsed, if the region is not contaminated by microorganisms, the inflammation will soon evolve to the repair phase, and the surrounding bone cells, along with fibroblasts and cementoblasts, will participate in the peri-

odontal reconstruction. But, without the presence of Malassez's epithelial remains, there will be bone neoformation in the periodontal space with union to the tooth, characterizing alveolodental ankylosis.

Alveolodental ankylosis integrates the tooth in the process of constant bone remodeling. The bone, and now the tooth, will be constantly reabsorbed and newly formed (Fig. 1 and 2). However, mineralized dental tissues, such as cementum and dentin, will not be newly formed and redeposited, but will be reabsorbed and replaced by bone tissue. There will be no dentine integration or cementointegration. Hence the terminology of tooth resorption by replacement.

Replacement resorption on unerupted teeth! The focal disappearance of Malassez's epithelial remains can also occur in the atrophied periodontal ligament of unerupted teeth long after their normal period of tooth eruption. Without dental function, the thickness of the periodontal ligament can "dangerously" become very narrow, and bone-producing bone cells can lodge on the cement surface, among cementoblasts, "dodging" the now quiescent and tiny epithelial remains of Malassez.

ROOT FRAGMENTS WITHIN THE BONE TISSUE: ANOTHER EXAMPLE OF A DESIRABLE OCCURRENCE OF REPLACEMENT RESORPTION

When fractures occur in vitalized teeth in which apical fragments remain isolated inside the maxillary bone, if the pulp vitality continues or the pulp necrosis is aseptic, it can occur:

- a) ankylosis in the root fracture line** and a slow process of resorption by substitution for months and years begins, until the complete disappearance of the root fragment;
- b) injury of the periodontal ligament in extraction** and ankylosis involving almost the entire surface of the root fragment. Replacement resorption will promote the elimination of remaining dental tissues in the context of bone remodeling in a shorter period of time;
- c) repair of the periodontal ligament** in the fracture line with replacement of cement and layer of cementoblasts, including maintenance and formation of epithelial debris from

Malassez. In this situation, the root fragment will remain in place indefinitely; or

d) contamination of the root fragment with bacteria lodging in the dentinal tubules and in the remaining root canal, promoting acute or chronic inflammatory injury. When acute, exudate drainage can occur and the fragment can be eliminated via a fistula or alveolus. In cases of chronic injury, periapical granuloma and/or apical periodontal cyst may, eventually, be diagnosed in occasional imaging studies, as they are asymptomatic.

DECORATED TEETH: RESORPTION BY REPLACEMENT IS THE IDEAL CONSEQUENCE!

In decoronation without the application of osseointegrated implants, the root portion remains inside the bone. This was (historically before the emergence of osseointegrated implants) performed in pre-prosthetic planning and/or in cases of traumatized teeth, to maintain the volume of the alveolar process. This procedure was also known as "burial" of roots or submerged roots.

The following situations occurred with the root portion in these cases:

a) maintenance of pulp vitality after repair, as in a pulpotomy;

b) aseptic pulp necrosis which, very slowly, will induce an asymptomatic chronic inflammatory lesion to be treated endodontically when diagnosed;

c) ankylosis in the root fracture line and a slow process of resorption by substitution for months and years begins, until the complete disappearance of the root fragment;

d) lesion of the periodontal ligament in the surgical procedures of decoronation and ankylosis involving almost the entire surface of the root fragment. Replacement resorption will promote the elimination of remaining dental tissues in the context of bone remodeling in a shorter period of time;

e) repair in the root cut line and periodontal ligament, with replacement of cement and layer of cementoblasts, including maintenance and formation of Malassez epithelial remains. In this situation, the root fragment will remain in place indefinitely; or

f) contamination of the root fragment with bacteria lodging in the dentinal tubules and in the remaining root canal, promoting acute or chronic inflammatory injury. The decoronation did not reach its planned objective.

**DECORATED TEETH FOLLOWED
BY THE APPLICATION OF
OSSEOINTEGRATED IMPLANTS!**

Currently, the teeth are decorated and then, at the same surgical moment, the osseointegrated implant is applied. In this situation, it occurs:

- a) **Maintenance of the pulp** vitality of pulp remnants at the site;
- b) **Primary mechanical imbrication of the implant**, with bone present in areas previously occupied by dental tissues;
- c) **Osseointegration at the bone-implant interface**, as normally occurs in implants applied without prior decoronation;
- d) **injury to the remnants of the periodontal ligament** in the surgical procedures of decoronation and implant application. Ankylosis will involve any root fragment and resorption by replacement will promote the exchange of remaining dental tissues in the context of bone remodeling in a shorter period of time and, at the same time, osseointegration will occur on the implant surface; and
- e) **contamination of the root fragment** with bacteria lodging in the dentinal tubules and in the remaining root canal, promoting acute

or chronic inflammatory injury. The decoronation followed by the application of an osseointegrated implant did not reach its planned objective.

**NEWLY FORMED BONE AND DENTAL REMNANTS
IN REPLACEMENT RESORPTION DO NOT HINDER
OSSEOINTEGRATION**

In tooth resorption by substitution without bacterial contamination, with pulp vitality or with appropriate endodontic treatment, the bone tissue interposes with the dentin and cementum, forming a veritable labyrinth. The root tissues and bone tissue have the same phylogenetic origin and mix seamlessly. For bone resorptive and synthesizing cells, it doesn't matter whether the tissue to be reabsorbed and replaced is dentin, cement or bone.

In the same way that bone when being reabsorbed (or biochemically disassembled by cells) releases collagen molecules, cytokines and growth factors such as BMP, dentin also has the same property. The release of these molecules from mineralized tissues during the process of clastic resorption occurs to stimulate bone neoformation in the neighboring areas or in the same area soon after the resorptive phase of the process is finished locally.

On the surface of the implants, bone neof ormation obeys the biological principles of osseointegration, regardless of whether there are areas where there are fragments of dentin and cement in-between the bone structures in the region.

The important thing is that the region is not contaminated, as well as the dentinal and cement remnants that may exist in the area where the osseointegrated implants are placed. During the osseointegration process, the fragments of dentin and cement will be remodeled and replaced with newly formed bone (Fig. 1 and 2).

When bone, dentinal and cement fragments are contaminated by bacteria and their products, the inflammatory process, via exudate, tends to abscess and carry them through the fistula to the surface, eliminating them. This does not depend on whether the fragments are dentin, cement or bone and even contaminated foreign bodies.

In summary: an ankylosed tooth and in resorption by replacement in non-contaminated areas does not prevent implant planning or worsen the prognosis of osseointegrated implants in the area. The bone that replaces teeth in the process of replacement resorption is structural and physiologically normal.

An ankylosed tooth and in resorption by substitution, when contaminated with pulp necrosis, fractures and periodontal problems, must receive the same care for the application of osseointegrated implants when at the place of application there

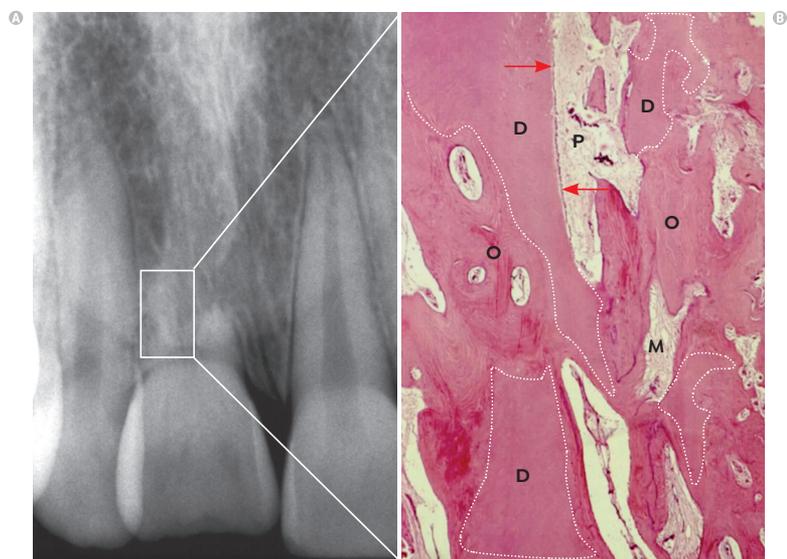


Figure 2: In tooth resorption by substitution, dental fragments (D) remain in place for long periods as they are reabsorbed in the context of bone remodeling. In some dentin fragments (D) areas with odontoblastic layer (arrow) and pulp (P) are still observed. In the other areas that have already been replaced, the bone (O) with its trabeculae and medullary spaces has normal organization and structures (M = medullary spaces) (H.E.; B=40X)

was a tooth with contaminated pulp necrosis or advanced periodontal disease.

Among these precautions are the removal of contaminated mineralized tissue fragments, surgical curettage, antibiotic coverage and postoperative control to detect the return to normality of the remaining tissues. After these procedures, an evaluation will be pertinent and the planning will generally include bone grafts, gingival and other procedures to recompose a local anatomy that favors the application of osseointegrated implants in the area.

REPLANTS AND DENTAL TRANSPLANTS DO NOT HINDER THE SUBSEQUENT PLACEMENT OF OSSEOINTEGRATED IMPLANTS

Dental replantations, when performed with appropriate protocols - in which the time outside the alveolus is a maximum of 30 minutes, stored, in this period, in milk, saliva or saline, not manipulated in its roots, necessarily submitted to endodontic treatment after 14 days, fixed to the other teeth in a semi-rigid manner and with antibiotic coverage - tend to be successful with reconstruction of the periodontal ligament.

In some special situations, late dental replantations can be indicated. In these cases, the periodontal

remnants do not resist for the time the tooth was out of the alveolus, generally longer than an hour, regardless of the type of tooth storage.

Late reimplantation aims to obtain alveolodental ankylosis as a way of fixing the tooth in the alveolus, without the need for permanent containment. Primarily, it doesn't matter that, after a few years, tooth loss occurs by resorption by replacement. The main goal is to keep the tooth in proper function and aesthetics for a few years, such as waiting for the end of the terminal growth of the jaws to then provide for the placement of osseointegrated implants.

In cases of late replantations, treatment of the root surface with fluoridated solutions seems to prolong the permanence of the replanted tooth, although alveolodental ankylosis and resorption by substitution are inevitable (Fig. 1 and 2). Endodontic treatment with materials well accepted by periodontal tissues and the complete elimination of contamination aided by antibiotics for two weeks will also contribute to a longer time of the tooth replanted late in the socket with satisfactory function and aesthetics, without compromising bone and periodontal structures as sequelae.

In cases of dental transplants - widely practiced in

Scandinavian countries, with a high success rate -, when alveolodental ankylosis occurs and resorption by substitution, the process follows the same path as traumatized and/or replanted teeth.

Dental replantations and transplants are very specific and special options to temporarily or definitively resolve tooth loss due to trauma or partial anodontia. In adolescent patients or young adults up to 22 years old for women and 24 men for men, the terminal growth of the jaws promotes a natural and harmonious displacement of the teeth.

Ankylosing teeth - the same occurs with osseointegrated implants - tend to remain "fixed" until reaching that age, without following this maxillary growth, that is, without harmonious displacement of the teeth. Ankylosing teeth and osseointegrated implants, in this situation, may reveal infra-occlusive crowns and altered gingival smile lines.

Thus, in adolescents and very young adults, dental replantation, even if late, may represent a temporary solution. The definitive solution, from the aesthetic and functional point of view, would come at the most appropriate age with the placement of an osseointegrable implant. Alveolodental ankylosis and replacement resorption, if it occurs, does not prevent osseointegration, even if there is

a need for gingival and bone grafts, especially if there is no bacterial contamination at the site.

Easy tooth extraction with replacement resorption. The inclusion of teeth with resorption by replacement in the normal occlusal plane or in over-occlusion may represent cellular stress and an additional inflammatory process, overlapping many more chemical mediators of bone remodeling at the site. The replacement of the tooth by the bone can be accelerated by the local increase in mediators of bone remodeling and, in a few weeks, the result can be a tooth fixed on the bone only by its more cervical root portion, facilitating its surgical removal without the need for interventions with undesirable bone loss that may lead to the need for grafting reconstructions.

ALVEOLODENTAL ANKYLOSIS AND OSSEOTEGRATION: ANALOGOUS PHENOMENA!

Osseointegration can be compared to an alveolodental ankylosis. Bone repair invades what would be the periodontal space and bone cells colonize the dental surface or the titanium or zirconia implant surface. On dental and implant surfaces, osteogenesis begins. In a short time, the tooth or implant is inserted or integrated into the bone structure.

The difference between the ankylosing tooth and the osseointegrated implant is in the involvement of mineralized dental tissues in bone remodeling or turnover. In implants, clasts cannot interact with the surface, much less dismantle the metal structure, whereas they do with the mineralized dental structure. A simple comparison: alveolodental ankylosis evolves to resorption by substitution, but osseointegration does not!

FINAL CONSIDERATIONS

Root fragments of dentin and/or cement that are not contaminated by bacteria do not prevent osseointegration in implants when applied to areas where there has been (or has been) tooth resorption by replacement.

During the normal bone remodeling process and in the peri-plant repair, the dental fragments will be reabsorbed and replaced normally with bone. Osseointegration in implants will always be done with bone and not dentin and/or cementum.

RECOMMENDED READING:

Consolaro A. Reabsorções dentárias nas especialidades clínicas. 3ª ed. Maringá: Dental Press; 2012.

ALBERTO CONSOLARO

1. Full professor at FOB-USP (Bauru) and at FORP-USP (Ribeirão Preto).

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