REVIEW ARTICLE

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Conventional wisdom and the surgical exposure of impacted teeth

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Structured Abstract
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Objectives – To provide evidence against the notion that direct contact between the crown of an impacted tooth and alveolar bone is an impediment to orthodontically assisted eruption of teeth.
Setting and Sample Population – The Department of Orthodontics at the Hebrew University-Hadassah School of Dental Medicine, in Jerusalem, Israel, and the private practices of the authors.
Materials and Methods – Patients reported were those affected by impacted teeth, including individuals who were normal healthy patients, with and without resorption of the adjacent incisor roots, as well as individuals suffering from Cleidocranial dysplasia and increased bone density, and individuals with autogenous and synthetic bone grafts. A closed eruption surgical technique was used in which only a small window was opened into the dental follicle of the impacted tooth, leaving a maximum amount of bone covering much of the crown surface. Orthodontic extrusion forces were then applied.
Results – For all teeth, enamel-to-bone contact did not prevent a rapid response to the extrusive forces.
Conclusion – Radical removal of bone during the exposure of an impacted tooth is unnecessary and potentially may be harmful in terms of the periodontal prognosis of an otherwise successfully treated outcome.

Key words: closed surgical exposure; impacted teeth; orthodontic traction

Introduction

It is well established that the dental follicle plays an integral role in the normal eruption of a tooth through alveolar bone, oral mucosa and gingival tissue, and into the oral cavity. Two unique processes are necessary:

1) Bone resorption by the follicle creating an eruption pathway.
2) Fusion of the follicle with the oral epithelium to create an opening into the mouth.

Research has shown that an unerupted tooth that has been surgically deprived of its dental follicle is destined to remain in place because the

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enamel-to-bone interface does not stimulate the resorption of bone (1). Conventional Wisdom has it that not only will the tooth not erupt by itself, but it will not respond to mechanically applied orthodontic traction except by a slow, pressure-generated pathologic resorption of alveolar bone. It is on this assumption that wide-ranging and comprehensive ground rules have been laid down regarding the surgical exposure of impacted teeth. The procedure advocated involves the following elements (2):

1) Removal of enough bone until the diameter of the resulting opening exceeds the greatest diameter of the tooth, so that crown enamel will not come into contact with alveolar bone during the intended eruption process.
2) Removal of the bone must be taken to the cemento-enamel junction (CEJ) which, by inference, means clearance of all residual follicular tissue.
3) Ensuring that adjacent soft and hard tissue does not heal over the exposed tooth.

In other words, the recommendation calls for a radical, open exposure, surgical procedure.

On the face of it, the argument that is presented in support of this conventional wisdom appears to be pertinent, logical, and compelling. Nevertheless, clinical research performed over the past 30 years has demonstrated that a radical open exposure approach is potentially harmful to the periodontal outcome of the resolved impaction. The research also illustrates that a more conservative alternative is available, producing successful outcomes in terms of both health and appearance (3–23).

While with both approaches the attachment itself may be healthy, with keratinized gingiva adjacent to the tooth and a normal gingival pocket depth, the difference lies in *where* this attachment is located on the tooth. Thus, open exposure of a palatally impacted maxillary canine typically leaves a long clinical crown on the palatal side of the tooth, because of a recessional defect on the palatal aspect of the tooth at the end of treatment. Comparing the treated with the untreated sides, one can see that the attachment on the treated side is well beyond the CEJ, leaving a varying portion of the root surface exposed (Fig. 1). This is indicative of a compromised periodontal outcome and, depending on its extent, may lead to the early demise of the tooth. Similarly, following the completion of treatment for a tooth which had been impacted buccally, the use of an open surgical approach will leave the labial aspect of the tooth compromised, even if an apically repositioned open procedure is performed as recommended by Vanarsdall and Corn (24). Again, following either surgical approach, the gingiva is healthy and conventional periodontal parameters will not fault the open approach over the closed. However, open surgery will often leave a long clinical crown with a gingival contour that is unaesthetic, and the added prospect of vertical relapse of the canine alignment (16).

The criteria for success in the resolution of impaction of a tooth include artistic alignment, normal crown length and gingival contour, in addition to the achievement of a good periodontal status. In other words, creating a situation in which the treated side is clinically and radiographically indistinguishable from the untreated side at the end of treatment, and par-

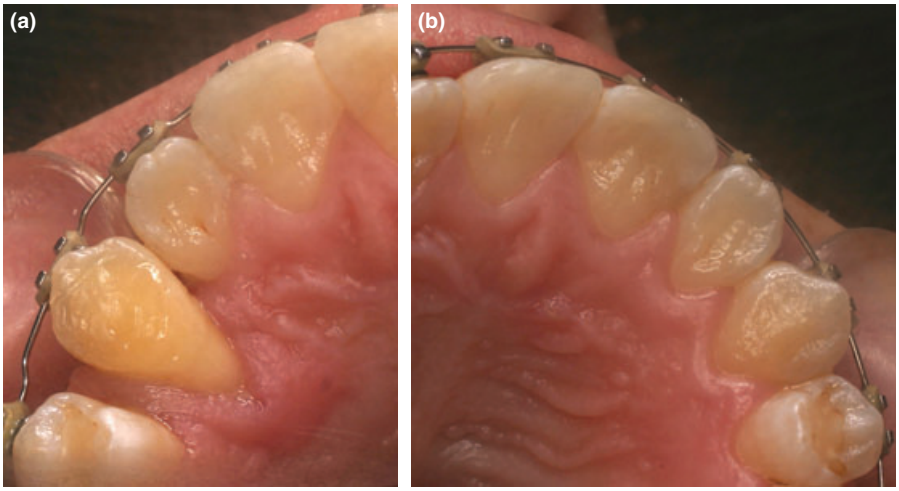

Fig. 1. Resolution of a palatally impacted right canine following an open surgical exposure (a) shows the gingival attachment several millimeters of denuded root surface beyond the CEJ, compared with the untreated side (b). Previously published (27); republished by permission, Informa Healthcare.

ticularly in the long term follow-up period. The long list of studies referenced above strongly indicates that for this to occur, the surgical aspect needs to involve a closed surgical procedure for all but the most superficial impactions. This dictates the removal of a minimum of bone, only enough to provide the most modest access adequate for the task of bonding of a small attachment under conditions of good moisture control. Following the placement of the attachment, the full flap is sutured back to close off the area as hermetically as possible.

The present intention is to illustrate that clearance of bone around the impacted tooth is irrelevant to the issue of resolving the impaction and is not a prerequisite for the avoidance of pathologic sequelae. In some instances, adherence to such principles may impede the successful execution of otherwise sound treatment, while in others, unnecessary collateral damage may be inflicted on adjacent structures.

Scenario 1. Surgical exposure less than the maximum circumference of the tooth

In the case shown in Fig. 2, only a small area of the crown of the impacted maxillary canine was exposed and no attempt was made to remove any additional hard or soft tissue. Despite the fact that bone removal created an opening much smaller than the crown of the tooth, and alveolar bone was in the direct path of the bare enamel, this tooth was erupted through the palatal tissue in under three months. In cases such as this, the tooth emerges through the bone to create a considerable bulge in the thick palatal tissue, which it may or may not penetrate. If it is not penetrated, minor surgical clearance of a small portion of the superficial mucosa covering the crown tip will permit the tooth to erupt freely and rapidly.

In the 2.2 years of post-treatment follow-up, corresponding to 4 years post-surgery, radiographs show

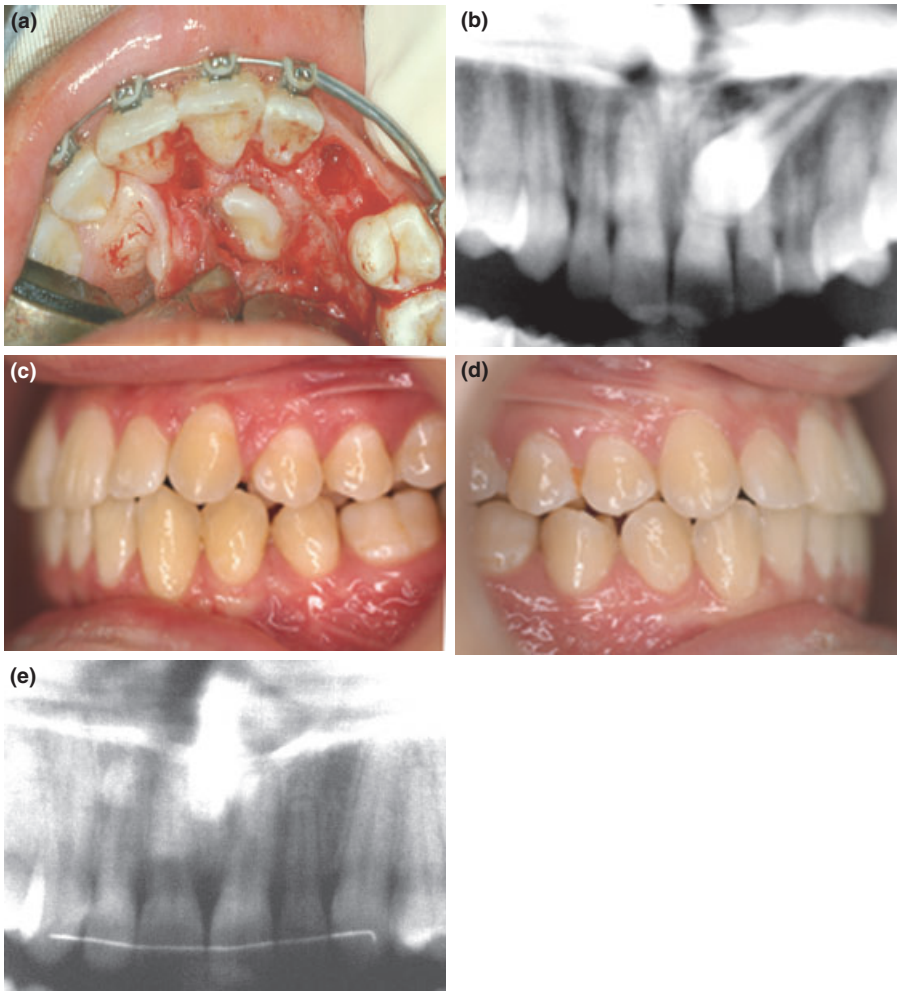

Fig. 2. (a) At exposure, the distal portion of the palatal surface of the left canine is exposed, while the mesial half and the other sides remain within the bony crypt. (b) The anterior portion of the panoramic view of the initial condition. (c, d) intra-oral views of the treated and untreated sides, respectively, at 4 years post-surgery. Previously published (27); republished by permission, Informa Healthcare.

normal trabeculation and excellent bone levels, while the clinical pictures show good gingival contour and normal clinical crown length, similar to that of the adjacent, untreated teeth.

Scenario 2. Deeply embedded teeth in which it is difficult to avoid healing over and bone regeneration

Crescini advocates a closed surgical method aimed at maximum conservation of alveolar bone during and following the surgical exposure of the impacted tooth, mimicking the normal eruption process as closely as possible (14, 21–23). This is performed by drawing the tooth through the vacated socket of the extracted deciduous canine. It will be appreciated that this may be performed only for a tooth that is close to the general alignment of the dental arch (not displaced too far palatally or buccally), but vertical positioning is not a limitation. The surgical approach is from the buccal side and the buccal bridge of bone is left in place. As in any closed exposure technique, the attachment is bonded at the time of surgery and a twisted steel ligature or gold chain is passed through the vacated socket of the simultaneously extracted tooth, exiting through its occlusal end (Fig. 3). The keratinized gingival flap, formerly encompassing the deciduous tooth, is fully replaced. No supplementary widening of the socket is made for the wider permanent canine crown.

In the months that follow, the tooth descends, resorbing the walls of the former socket as it goes. Only during the first few weeks of traction that this channel may be considered to be 'open'. Under the conditions provided by the closed surgical procedure, a blood clot forms within the deciduous tooth socket, and new bone is laid down to fill and remodel the socket. The tooth is then drawn through this new bone by what can only be a process of resorption. Given efficient mechanics, the tooth advances rapidly, to produce a final result characterized by a good bony profile around the erupted tooth (Fig. 3). The gingival and the periodontal indices are normal and the trained eye has difficulty differentiating this tooth from its normally erupted neighbors.

Can such a favorable outcome be reasonably explained if the traction and alignment mechanotherapy had been accompanied by a pathologically generated pressure necrosis? Superb periodontal and esthetic results may be achieved routinely using this method (14, 21–23).

Scenario 3. Teeth exposed by a closed surgical technique and left untreated for many months, with the regeneration of bone

In a typical orthodontic office, a small proportion of patients will disappear in the middle of their treatment and not be seen again for several months. This has

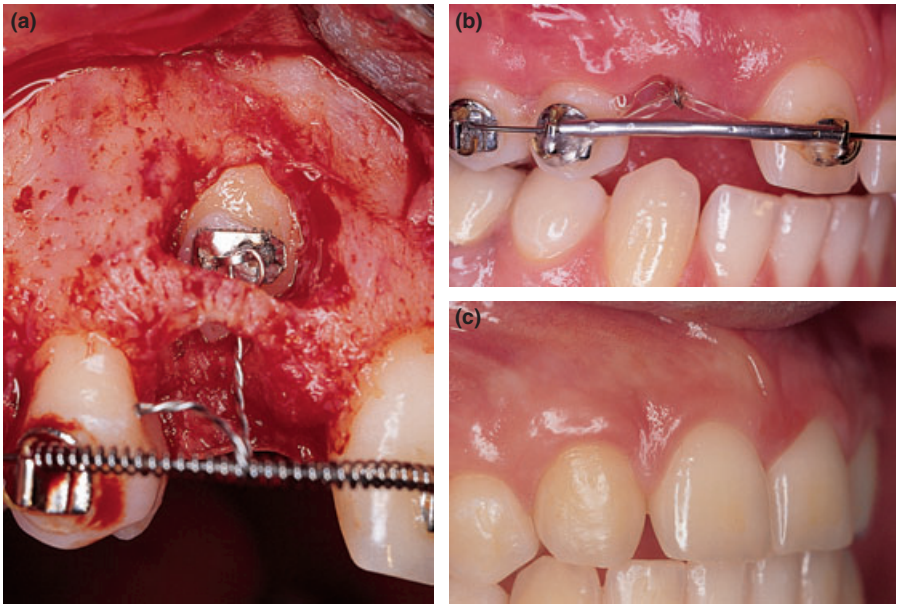

Fig. 3. (a) Crescini's 'tunnel' technique. The deciduous canine has been extracted, the crown of the permanent canine exposed and an attachment placed. The twisted steel ligature is drawn through the socket of the extracted tooth. (b) following full closure of the surgical flap, elastic traction is applied to the steel ligature to erupt the tooth. (c) the treated result 3 years post-surgery, showing excellent periodontal health and no recession. Previously published (27); republished by permission, Informa Healthcare.

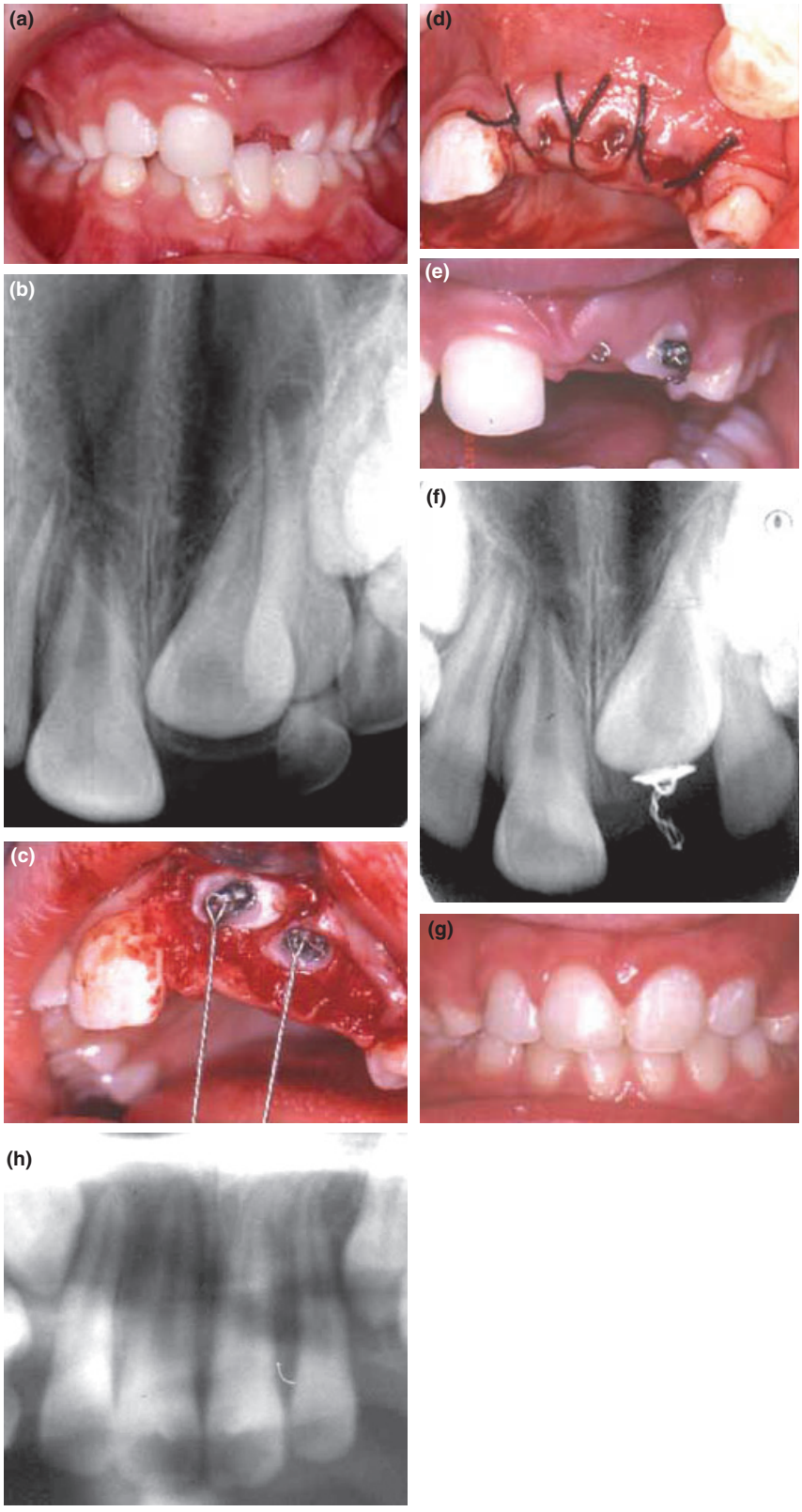

Fig. 4. (a, b) Intra-oral clinical view and periapical radiograph showing unerupted left central and lateral incisors. The tiny mesiodens is not distinguishable on this view. (c, d) At surgery, only enough bone has been removed from the labial aspect of both teeth to permit bonding of an eyelet attachment and the surgical flap is fully sutured back. (e) No active traction was applied, yet 3 months later the lateral incisor erupted spontaneously. (f) Periapical view made 9 months post-surgery shows no movement of the central incisor and the regeneration of alveolar bone around its crown. (g, h) intra-oral and panoramic (anterior section only) radiographic view of the completed result after orthodontic traction was applied to the central incisor. Additional surgery was not undertaken.

been true in certain instances of patients immediately after the completion of a closed surgical exposure procedure and before traction is applied to the impacted tooth.

In the patient shown in Fig. 4, it was considered that once the tiny mesiodens was removed, there was a good chance that the teeth would erupt autonomously and hence orthodontic treatment could be avoided.

However, the orthodontist was not prepared to waste the opportunity of surgical access when the mesiodens was removed. Attachments were immediately bonded to the unerupted central and lateral incisors so that in the event of non-eruption, a second surgical procedure would be rendered unnecessary and orthodontic traction could be initiated. With this patient, the lateral incisor erupted spontaneously and rapidly, despite the obvious presence of bone in the eruption path and in the absence of a follicle in the area where the attachment had been bonded. Notwithstanding this encouraging success for the lateral incisor, the central incisor remained *in situ* at the 9 months post-surgical visit. New radiographs made at that stage showed the presence of regenerated bone around the crown of the tooth. Nevertheless, the application of simple orthodontic traction resulted in its eruption a few months later.

In other patients, traction is sometimes applied in an inappropriate direction, with no progress in the resolution of the impaction observed. Many of these cases will continue in treatment for months or years before the practitioner decides to change direction or the patient transfers to another orthodontist.

Similar circumstances may be created when a patient with an impacted tooth is referred first to the oral surgeon, who obligingly exposes the tooth and bonds an attachment, before the patient has been seen by an orthodontist (Fig. 5). It may then be several months before an orthodontic appliance is placed and several months more, through the series of necessary archwire changes, before that appliance may provide the needed rigidity to act as the anchor base for the application of traction.

These events have one thing in common. The exposed tooth had remained in its place for a very long time and, if it was originally encased in bone – even partially, then the closed exposure procedure will have provided the ideal circumstances for the regeneration of bone around the circumference of the created portal of access to the tooth, reducing its diameter considerably. In cases where the tooth is deeply embedded in the palatal area or elsewhere, bone may also re-form to completely cover the crown. Does this mean that the

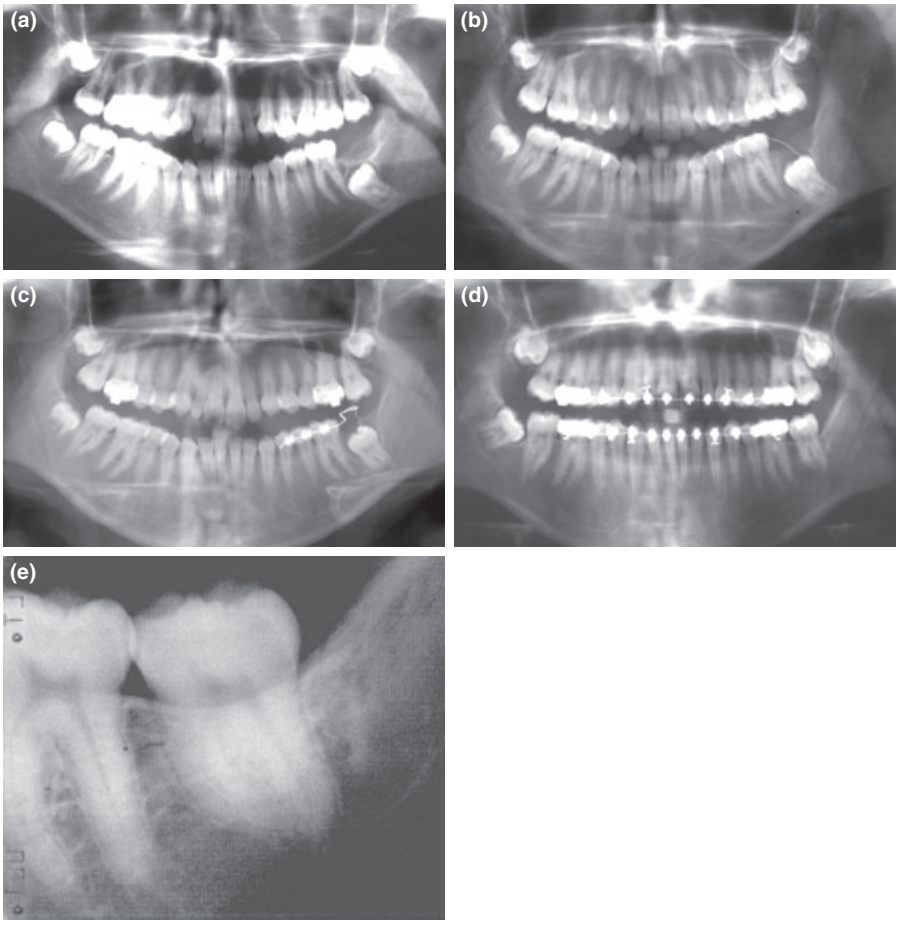

Fig. 5. (a) An obscure cystic lesion appears to be the cause of the unerupted second permanent molar, which has been displaced close to the lower border of the mandible. (b) Surgeon removed a benign pathologic entity and bonded a small attachment to a small area of the buccal surface of the tooth, leaving the tooth well invested with surrounding bone. (c) Traction initiated 7 months post-surgery. (d) Eruption after 10 months of traction. (e) 3.5 years follow-up. Previously published (27); republished by permission, Informa Healthcare.

patient must now be subjected to a new surgical procedure to provide the crown of the tooth with a clear and unimpeded path to the exterior? These two cases demonstrate that clearing a path is unnecessary.

Scenario 4. Cleidocranial dysplasia (CCD) and increased bone density

It has been pointed out that the character of the bone and cementum in CCD patients is different from normal and these differences have been related to the absence of tooth eruption leading to multiple impaction of teeth deep down in basal bone. The bone has been described as being largely compact, with little or no medullary component, thus presenting an impediment to normal eruption (25, 26). Elsewhere the histology of bone morphology has been described as aberrant with a virtual absence of cellular cementum and a partially hyperplastic acellular cementum in the permanent teeth (25, 26). With a varying number of unerupted supernumerary teeth and the teeth of the normal series developing very deep in the basal bone areas, attempts to perform an open eruption exposure will result in the removal of a majority of the already reduced alveolar bone height in the jaw concerned, with the potential danger of pathologic fracture (27). Even allowing for regeneration of bone that accompanies tooth eruption, the final result will show a much reduced bone height and a poor periodontal prognosis of the newly erupted teeth. Employing a very conservative closed eruption procedure, much bone will be

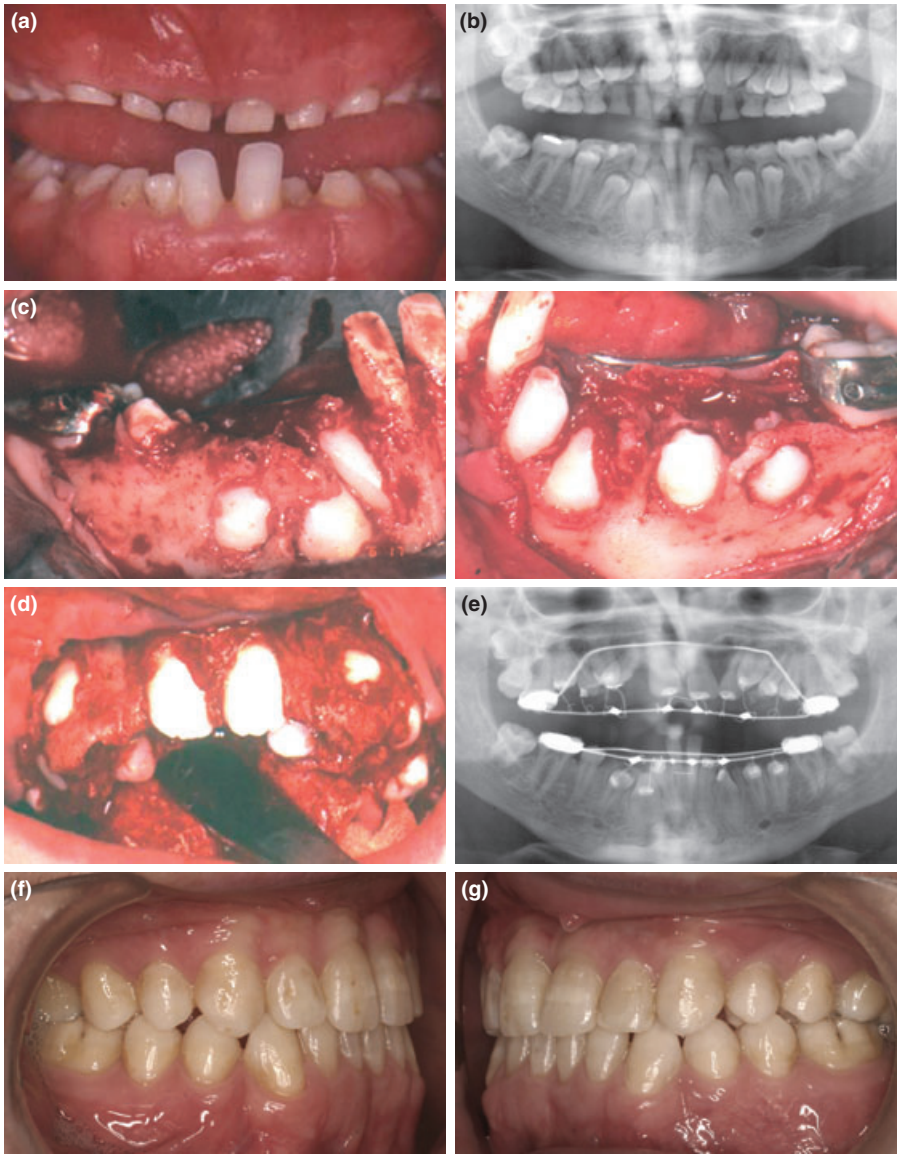

Fig. 6. (a, b) Cleidocranial dysplasia initial condition. (c, d) Minimal surgical exposure, leaving bone covering all surfaces except the buccal aspect. (e) Panoramic view of the immediate post-surgical condition, with attachments in place and active extrusive force applied. N.B. alveolar bone covers much of the crowns of the teeth. (f, g) Clinical views of the case 6.3 years after eruption of all teeth.

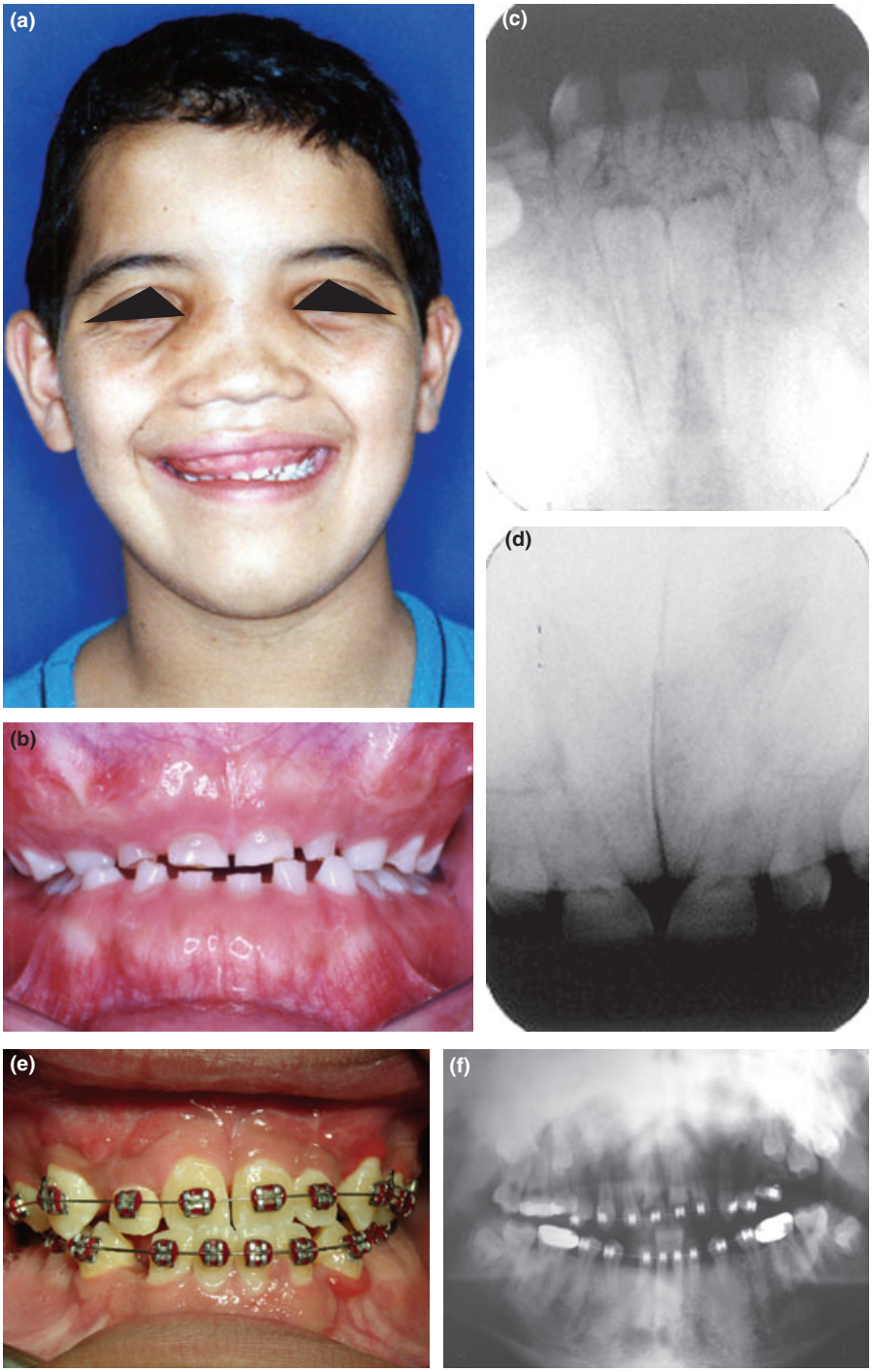

Fig. 7. (a, b) Increased bone density: full face and anterior deciduous dentition. (c, d) Periapical views of anterior teeth to show extreme bone density. (e, f) Clinical and panoramic progress views after 3.1 years of treatment.

left in the direct path of the tooth in its passage toward eruption into the oral cavity. Given efficient biomechanical means, the aided eruption of such impacted teeth has been very rapid (Fig. 6), despite the intimate relationship of the crowns of these teeth to the surrounding bone.

Similarly, in conditions of impaired osteoclast activity there is an increased bone density with few marrow spaces and an overriding abundance of compact bone (28). As may be expected, these patients suffer from multiple impacted teeth. The case illustrated in Fig. 7 shows a young male treated by the closed exposure approach with minimum bone removal. Eruption of the teeth was slow, but the tissue response was positive and the teeth were erupted uneventfully.

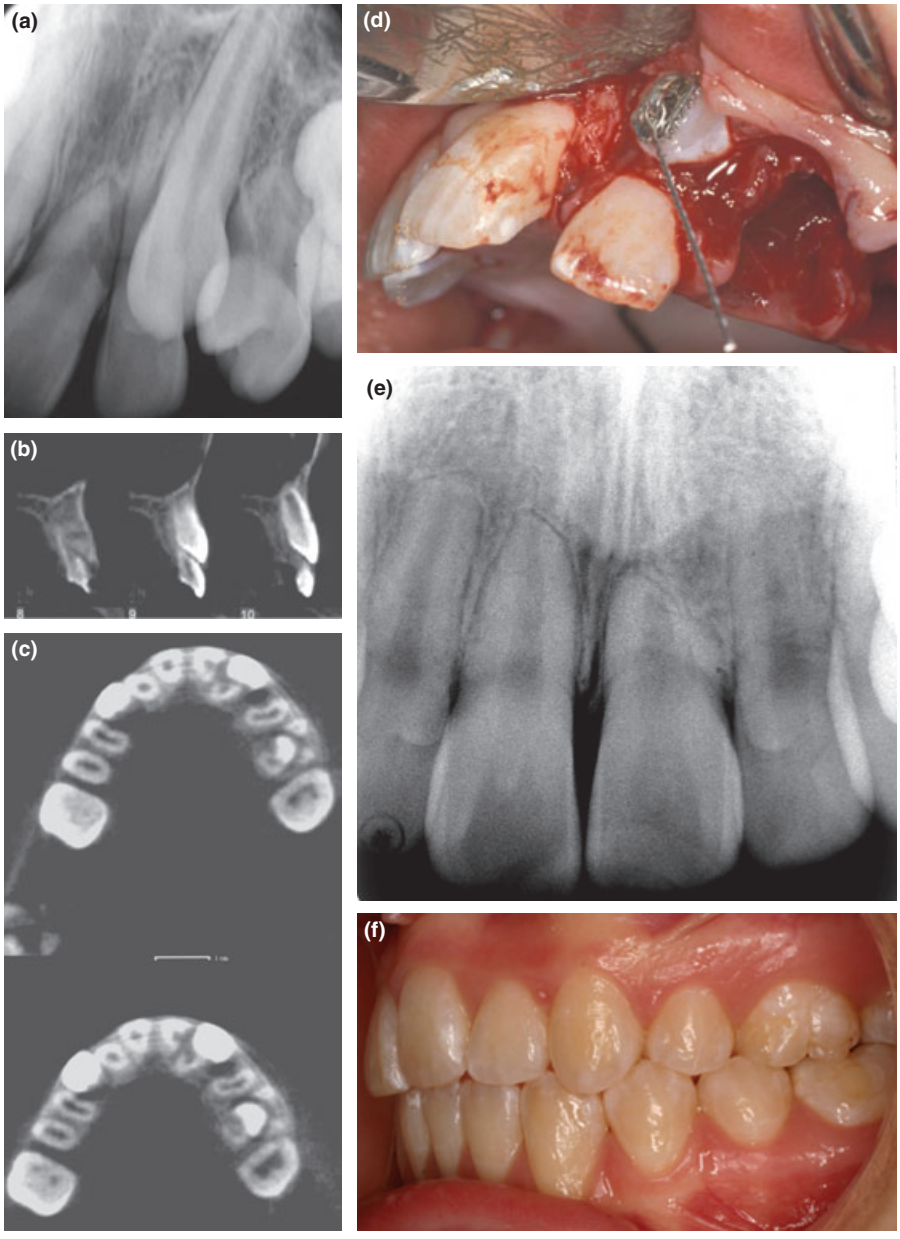

Fig. 8. (a–c) Periapical and CBCT views of severe root resorption of lateral and central incisor roots associated with labial canine impaction. (d) Clinical view of surgical exposure and attachment bonding. (e) Periapical view of the completed case showing arrest of resorption process. (f) Final clinical result, showing excellent alignment and periodontal outcome. Previously published (27); republished by permission, Informa Healthcare.

Scenario 5. Impacted maxillary canine associated with severe resorption of the roots of the adjacent lateral and/or central incisors

The approach to treatment in such cases presents a major dilemma. In the first place, the condition is progressive and often rapid. To not recognize existing radiographic evidence of the diagnosis or to delay treatment will result in further damage to the root of the affected incisor, heightening the danger of losing the tooth altogether. Notwithstanding, the Conventional Wisdom doctrine dictates that the entire crown of the impacted tooth must be laid bare and cleared of surrounding bone. This is impossible to achieve without inflicting considerable surgical damage to that part of the intimately associated and resorbing roots of the incisors. These teeth would potentially be devitalized and, depending on the site, extent and form of the resorption lesion, it could well precipitate their demise.

The closed exposure technique offers a way out of this difficult situation (Fig. 8). Careful diagnosis of the tooth's position will determine the direction that

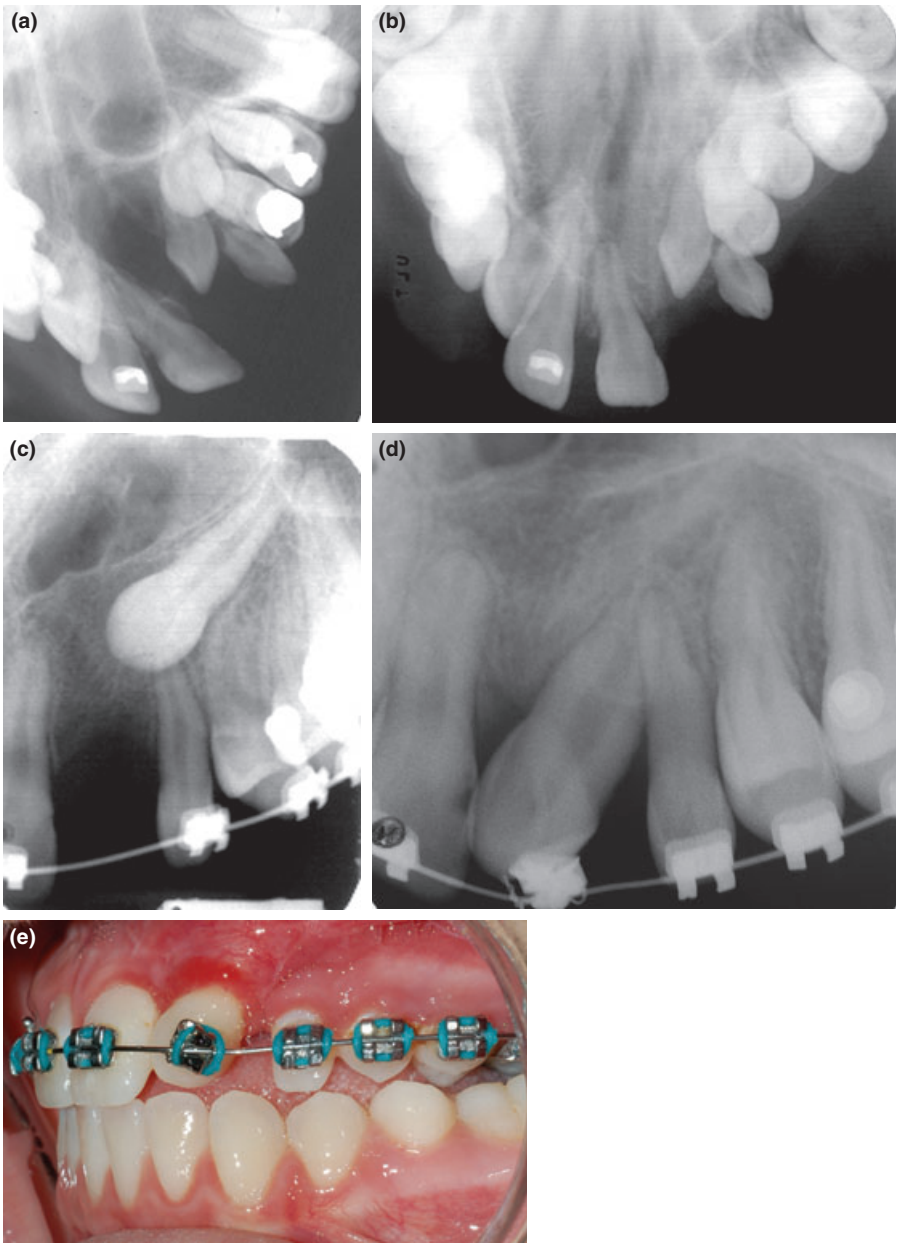

Fig. 9. (a, b) Unilateral cleft palate/alveolus; periapical views immediately pre- and post-surgical views of bone graft (N.B. canine/lateral incisor transposition). (c) Periapical view showing space opening of transposed lateral incisor into canine location, prior to canine exposure. (d, e) Periapical and clinical views of erupted canine.

orthodontic traction must be made and, derived from this, the most convenient surgically accessible aspect of the tooth to which a small attachment may be bonded. In line with the principles of closed surgical exposure, no additional hard or soft tissue is removed, the resorbing root ends are carefully avoided and the whole area sealed off from the oral environment with the full replacement of the surgical flap, permitting healing by primary intention.

Once the impacted tooth has been distanced from the active area of incisor root resorption, it has been shown that this destructive process ceases (29). Additionally and in many ways just as significant, it becomes possible to orthodontically move the affected incisor into place, relatively free of the risk of further, orthodontically generated, root resorption (29).

Scenario 6. Erupting an impacted tooth through autogenous or synthetic bone graft

Left palate patients are often treated with the placement of an autogenous bone graft into the cleft to restore the integrity of the maxillary alveolus. Within the

adjacent bone there is frequently an unerupted canine which then needs to be erupted into its place in the arch, often in the grafted area. If the canine is not in a location and/or orientation from which it may erupt spontaneously, the tooth will need to be exposed and brought into place. The question then arises as to whether the canine can be drawn through grafted bone following a closed surgical procedure, and whether this bone will resorb in response to the enamel-graft contact, in the same way as we have seen to occur with normal bone. Figure 9 shows successful treatment in these circumstances, without adverse sequelae.

Space-occupying pathological entities in the alveolar process, such as odontomes or tumors, often displace adjacent erupted and unerupted teeth and, following their surgical excision the surgeon will often need to restore the defective boney architecture using a bone graft. In a case report by Danan's group (30) in France, an unerupted maxillary canine had been displaced superiorly by a large odontome. Following removal of this large mass of dental tissue, the resulting space was filled with a synthetic bioapatite and resorbable mesh graft and the flap fully sutured back in place. After 6 months, the canine showed positive signs of eruptive movement and it was then exposed using a similarly conservative surgical approach. Orthodontic traction was subsequently applied, the tooth successfully drawn through the synthetic graft and erupted into the arch in the normal manner.

Conclusions

This presentation has shown that tooth enamel-to-bone interface is not an impediment to the orthodontically generated eruption of impacted teeth and neither is there evidence that this situation causes more pathologic tissue reactions than other forms of orthodontic movement. When exposing unerupted teeth, there appears to be no justification, neither surgical nor orthodontic, for removing more bone than is adequate to the task of bonding a small (preferably eyelet) attachment and pursuing a closed eruption surgical course. On the contrary, removing additional bone and soft tissue has been shown to be detrimental to the quality of the outcome of the treatment, in terms of crown length, gingival appearance and periodontal prognosis.

Clinical relevance

Conventional wisdom dictates that the presence of direct crown enamel-alveolar bone contact is an impediment to mechanically driven resolution of an impacted tooth. Consequently, a radical open surgical exposure of the tooth is widely recommended. Nevertheless, open surgery of this type has been blamed in the literature for poor periodontal outcomes in otherwise successfully treated cases. The present article refutes this conventional wisdom by describing the widest spectrum of clinical conditions in which a minimal, closed eruption procedure leads to rapid results, excellent periodontal support and natural appearance.

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