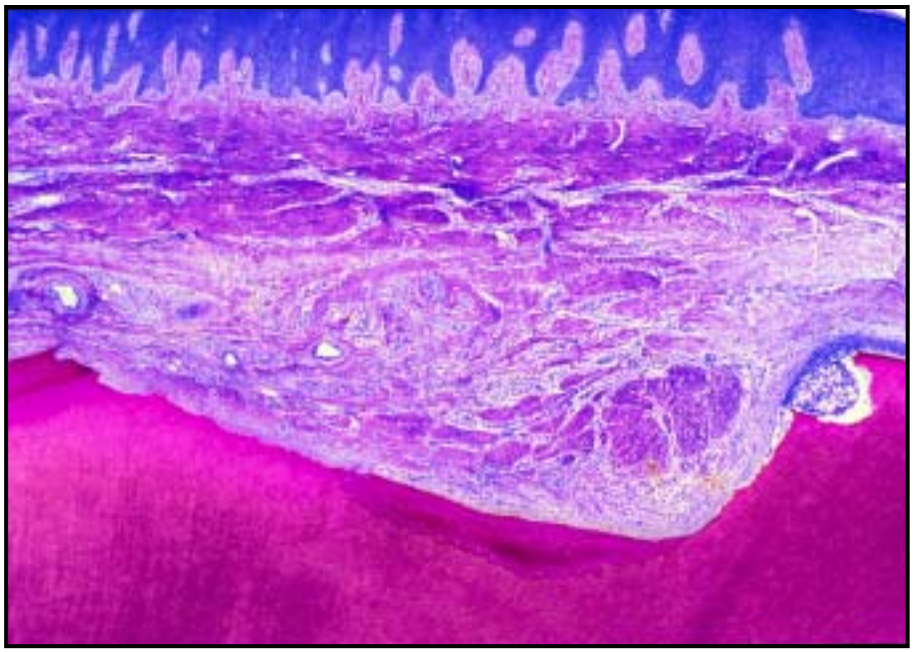

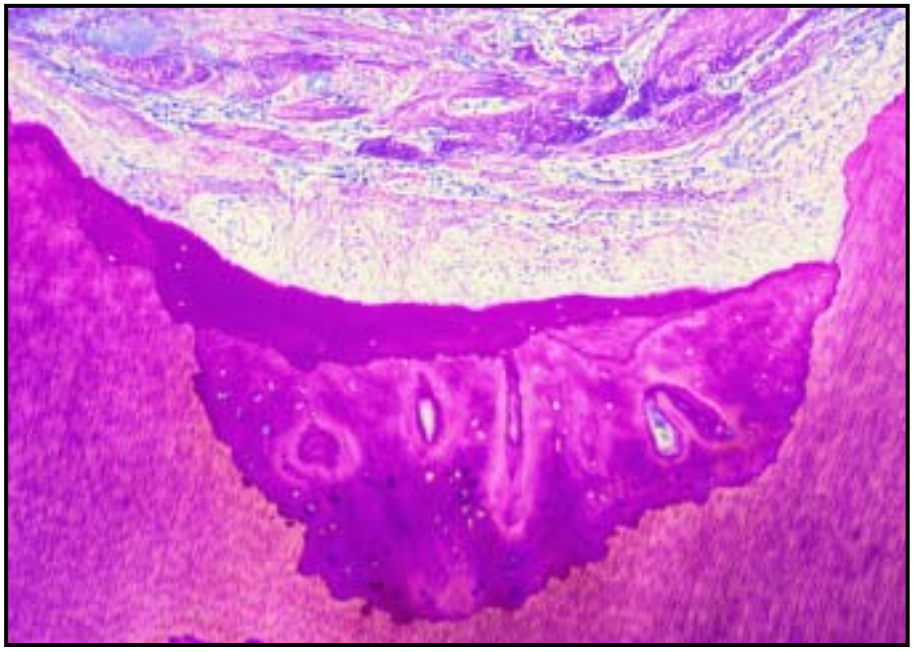

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Root Resorption Associated with a Subepithelial Connective Tissue Graft for Root Coverage: Clinical and Histologic Report of a Case

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This article reports on a case of root resorption following a clinically successful root coverage procedure with a subepithelial connective tissue graft on a maxillary lateral incisor. Two years after the graft procedure was performed, the tooth was extracted in conjunction with the buccal attachment apparatus. Histologic examination of the specimen revealed signs of active resorption of the dentinal surface and bone formation in the deepest portion of the resorption cavity. Possible causative factors of the root resorption process are discussed. (Int J Periodontics Restorative Dent 2003;23:391–398.)

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The subepithelial connective tissue (CT) graft is a periodontal plastic surgical procedure[1] primarily used for the coverage of previously exposed root surfaces and augmentation of edentulous ridges. The root coverage technique with CT grafts was first described in 1985,[2] and modifications of the basic surgical procedure have been proposed by others.[3,4] The CT graft quickly became a popular modality of surgical root coverage because of its degree of success and predictability.[5,6] Moreover, as compared to the free gingival graft for root coverage, the CT graft presents the advantages of better color match with the gingiva around the recipient site and a decreased degree of discomfort originating from the donor area.

Successful root coverage implies not only the coverage of the previously exposed root surface to the level of the cementoenamel junction (CEJ), but also the establishment of a biologic attachment between the grafted tissue and root surface.[7] The successful coverage of a root surface with a soft tissue graft in the absence of attachment

between the grafted tissue and root surface will result in the formation of a periodontal pocket, which may create an impairment for proper oral hygiene and lead to ongoing attachment loss. To obtain a biologic attachment between the root surface and grafted tissue, preparation of the root surface is important. The goal of such a preparation is to achieve a surface that is recognized as biologically compatible by cells from the periodontium. Therefore, the complete elimination of all calculus and contaminated cementum is achieved mechanically, via scaling and root planing. Chemical treatment of the root with acidic agents to eliminate the smear layer has been proposed,[8] but appears not to be a determinant factor in achieving successful root coverage with free gingival or CT grafts.[9,10]

Clinically, the endpoint for completely successful root coverage is a gingival margin positioned at the CEJ and a sulcus depth ≤ 2 mm. Little information is available regarding the nature of the attachment present between the grafted tissue and root surface. Histologic reports of successful root coverage with CT grafts revealed that the graft–root surface interface may consist of a long junctional epithelium, a true CT attachment, or a combination of both.[11,12] A study using an epithelialized gingival graft[13] reported the complete regeneration of the periodontal unit, including alveolar bone, following a clinically successful root coverage case.

Root resorption is an undesirable outcome of periodontal regenerative procedures. Unfortunately, there is very limited information about the mechanism involved in triggering periodontal cells into recognizing the tooth structure as foreign and inducing the activation of resorptive cells. Once the root resorption process is initiated, it is difficult to control and may result in pulpal involvement and tooth loss. Root resorption has been reported as a possible outcome of iliac crest grafts used for the treatment of intrabony defects.[14,15] It is, however, a rare occurrence associated with other modalities of osseous grafts or techniques used in periodontal regeneration. Root resorption has been reported following root coverage with a pedicle flap in a dog model.[16] To the authors' knowledge, no report of root resorption following root coverage with a soft tissue graft is available in the literature.

The purpose of this article is to report on the histology of a root resorption case following successful clinical root coverage with a CT graft, and to discuss the possible etiology of this undesirable outcome of the surgical procedure.

Method and materials

Clinical case report

A 57-year-old woman in good general health presented for treatment in the Periodontal Clinic at the School of Dentistry, State University of Londrina, Brazil. She was taking no medications and did not smoke. No contraindications to periodontal therapy were diagnosed. At the time of the examination, the patient was wearing a removable partial denture to replace her missing maxillary teeth. Her main complaint was of sensitivity to temperature on the maxillary left lateral incisor. Clinical examination of the tooth revealed it to be vital. On its buccal aspect, the lateral incisor presented with approximately 3 mm of recession, 3 mm of attached gingiva, and a 1-mm sulcus depth (Fig 1). Cervical abrasion, 2 mm deep in the pulpal direction and probably resulting from aggressive toothbrushing, was present on the most apical portion of the exposed root surface. The gingival tissues presented with little clinical inflammation. Despite the fact that the teeth adjacent to the lateral incisor were missing, the soft tissue on the mesial and distal edentulous ridges was at the CEJ level. Therefore, the recession present was classified as Miller Class I,[17] and complete coverage with a soft tissue graft was anticipated.

Therapy consisted of scaling and root planing and oral hygiene instructions. Two months after completion of phase-one therapy, a reevaluation was performed and the

Fig 1 (left) *Preoperative view of maxillary left lateral incisor. The buccal aspect presents with 3 mm of recession, 3 mm of attached gingiva, and a 1-mm sulcus depth. Note the presence of a cervical abrasion on the most apical portion of the exposed root surface. The soft tissue on the mesial and distal edentulous ridges is at the CEJ level, classifying the buccal recession as Miller Class I.*

Fig 2 (right) *Root coverage procedure. Prior to the elevation of a buccal split-thickness flap, the exposed root surface of the tooth is mechanically prepared with scaling and root planing and chemically treated with citric acid for 3 minutes.*

surgical procedure was planned. Following mechanical scaling and root planing of the exposed root surface and the subgingival portion of the root coronal to the bottom of the clinical sulcus, 50% citric acid, pH 1.0 (Drogamais), was rubbed against the root surface for 3 minutes with cotton pellets. Cotton pellets were changed every 30 seconds. The area was then rinsed continuously with sterile saline solution for approximately 1 minute (Fig 2).

The CT graft described by Langer and Langer[2] was the technique of choice. Flap design in the recipient site consisted of two horizontal incisions made at the proximal CEJ levels, which were extended about 2 mm in both the mesial and distal directions. Two vertical incisions were placed at the mesial and distal ends of the horizontal incisions and extended beyond the mucogingival junction, followed by the elevation of a split-thickness flap. A CT graft was obtained from the maxillary left palate by making three incisions in a trap-door fashion in the second premolar/first molar area. A split-thickness flap was elevated, and the underlying CT (approximately 1.5 mm thick, full-thickness to bone) was harvested, followed by suturing of the flap with 4-0 silk. A marginal collar of epithelium was not included in the graft. The CT was secured in place with 5-0 gut sutures. Interrupted sutures were used along the horizontal and vertical incisions. One periosteal suture was placed in a horizontal mattress fashion and anchored around the cervical constriction of the lateral incisor to provide a close adaptation between the graft and root surfaces. The flap was sutured over the CT graft with interrupted 4-0 silk sutures to cover most of the graft surface (Fig 3). The CT graft, however, was left uncovered in the area of the previously existing recession.

Postoperative care consisted of rinses with 0.12% chlorhexidine gluconate twice daily for 3 weeks. Analgesic medication (ibuprofen 600 mg four times per day) was prescribed and taken by the patient as necessary. Silk sutures in the donor and recipient areas were removed at 1 week. Mechanical oral hygiene of the grafted area was not initiated until the end of the third postoperative week. Both donor and recipient areas healed uneventfully.

Clinical examination of the grafted area 6 months postoperative revealed root coverage to the CEJ level, a sulcus depth of 1 mm, and 6 mm of attached gingiva. The lateral incisor was asymptomatic, and the sensitivity to cold had completely disappeared. The patient attended periodontal recalls every 4 months for the next 18 months.

Fig 3 (left) *CT graft is secured with 5-0 gut and flap is sutured over graft with 4-0 silk. Graft is left exposed in the area of the previous recession by positioning the flap at its original position.*

Fig 4 (right) *Healing of grafted area 2 years postoperative. Note the increase in apicocoronal dimension of attached gingiva (now 6 mm) and complete root coverage. Minimal signs of soft tissue inflammation, but extensive root resorption on previously exposed area revealed by horizontal penetration of periodontal probe.*

Approximately 2 years after the CT graft was performed, a combination of restorative and endodontic problems on other maxillary teeth arose, and it was determined that the most appropriate restorative treatment for the patient was a maxillary complete denture. The results obtained with the surgical procedure on the maxillary left lateral incisor were stable at 2 years postoperative (Fig 4). However, under local anesthesia, careful exploration of the subgingival area revealed the presence of a cavity on the root surface. The walls of the cavity were hard to penetration of a sharp explorer, suggesting a clinical diagnosis of root resorption. The patient consented to have the tooth extracted with the buccal attachment apparatus. The extraction socket was filled with a xenograft (Bio-Oss, Osteohealth) and covered with a collagen membrane (Bio-Gide, Osteohealth), followed by suturing of the flap. Healing was uneventful, and a maxillary complete denture was fabricated.

Histology

The extracted tooth was placed in 10% formalin and shipped to the University of Bern, Switzerland, for histologic processing. Specimen preparation consisted of dehydration in step gradients of alcohol, decalcification in formic acid, embedding in paraffin, and sectioning at 5-µm intervals. Sections were stained with toluidine blue–basic fuchsin and examined under a Zeiss light microscope with magnifications ranging from 2× to 25×.

Microscopic examination of a middle section of the specimen (mesiodistal direction) is shown in Figs 5 and 6. A 2× magnification of that section showed that the root surface under the grafted area had undergone pronounced resorptive activity, and a deep cavity had formed in dentin (Fig 5). Figure 6, a higher magnification of the deepest area of the resorption cavity shown in Fig 5, shows evidence of bone being formed in the deepest portion of the cavity. There was also evidence that a previously formed resorptive canal was later filled concentrically with lamellar bone. The description here is similar to that of ankylosis, but without connection to the surrounding alveolar bone.

Figures 7 and 8 show a section of the mesial area of the resorption (mesiodistal direction). The view in Fig 7 is similar to that in Fig 5. A resorption canal the size of an osteon could be visualized in the most coronal area of the resorption cavity. A higher-magnification view of that area (Fig 8) showed that the junctional epithelium ended at the level of the above-mentioned resorption canal, which is located in the most coronal half of the resorption cavity. Interestingly, mineralized tissue formation was observed in the deepest area of the apical half of the resorption cavity. Staining of this mineralized tissue, consistent with bone, was somewhat more intense than that of the dentin underneath and distinct from cementum staining.

Fig 5 (left) *Buccolingual section of maxillary left lateral incisor, middle area (mesiodistal direction). Note the formation of mineralized tissue, suggestive of bone, on the deepest area of the resorption cavity (toluidine blue–basic fuchsin stain; original magnification × 2).*

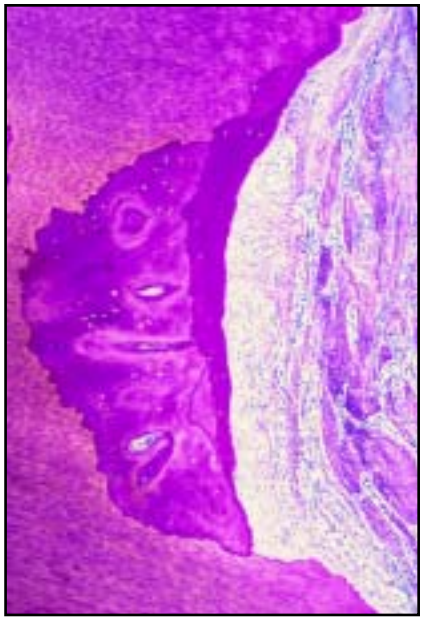

Fig 6 (right) *Buccolingual section of lateral incisor, middle area (mesiodistal direction). Higher magnification of the deepest area of the resorption cavity, shown in Fig 5. Note the formation of bone on the surface of the existing dentin. In the most apical area of the cavity, there is evidence of a previous resorption canal that was later filled concentrically with lamellar bone. The pattern of root resorption has been termed replacement resorption, where tooth structure is progressively replaced by bone tissue (toluidine blue–basic fuchsin stain; original magnification × 25).*

Fig 7 (left) *Buccolingual section of lateral incisor, mesial area (mesiodistal direction). Observe a resorption canal the size of an osteon in the most coronal aspect of the resorption cavity, suggesting active osteoclastic activity at the time of tooth extraction (toluidine blue–basic fuchsin stain; original magnification × 2).*

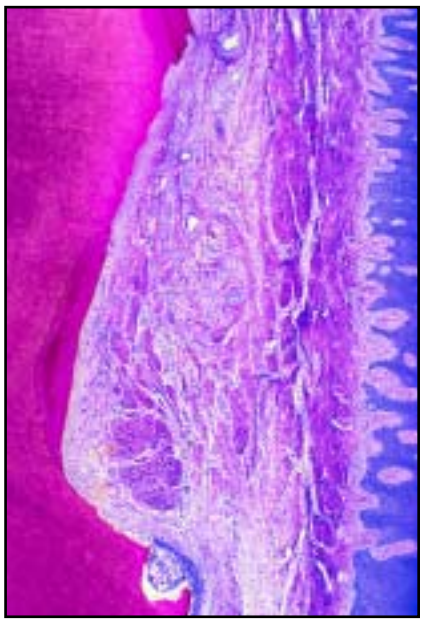

Fig 8 (right) *Buccolingual section of lateral incisor, mesial area (mesiodistal direction). Higher magnification of the section described in Fig 7. Note the apical end of the junctional epithelium at the level of the resorption canal seen in the most coronal end of the resorption cavity. Mineralized tissue formation is observed in the deepest area of the resorption cavity (toluidine blue–basic fuchsin stain; original magnification × 12.5).*

Discussion

The case reported in this article clearly shows that root resorption can occur following the successful clinical outcome of a CT graft. This is important information to clinicians because the CT graft is a widely used modality of root coverage therapy, and areas of resorption may be difficult to diagnose early in their development. It is also known that root resorption is difficult to control and may result in tooth loss. Unfortunately, little is known about the etiology of external root resorption. There are no established models to study root resorption, and it usually occurs on an isolated tooth under the least-expected conditions; these factors make clinical studies with larger sample sizes difficult to conduct. Therefore, comments on the possible mechanisms involved in root resorption as observed in this reported case are speculative in nature.

The first point of interest to the clinician is related to the ability to diagnose subgingival root resorption. When the patient whose case is reported in this article presented for extraction of her maxillary teeth, including the left lateral incisor, the clinical appearance of the grafted area was excellent, with no signs of inflammation. The extraction of the tooth with the buccal tissues was originally planned to investigate the nature of the attachment formed between the root surface and the graft. It was not until careful probing of the grafted area that the resorption cavity was diagnosed by horizontal penetration of the periodontal probe. A possible explanation for the fact that the resorption area was not diagnosed in recalls performed during the 2 years after the surgical procedure is the geometry of the root where the soft tissue graft was placed. The action of aggressive toothbrushing over an exposed root surface, combined with root planing prior to grafting, resulted in a flat surface with a sharp angle, often approaching 90 degrees, between the anatomic crown and the root at the level of the CEJ. To detect postoperative pocket depth or root resorption such as in this case, the probe needs to be inserted first in the horizontal direction and then given the necessary vertical angulation to move in the apical direction. The straight vertical placement of the probe at the gingival margin would invariably translate into minimal sulcus depth and the inability to diagnose root-associated pathology. It is therefore important not only for the surgeon to understand the need to modify his or her probing technique, but other dental professionals who perform periodontal maintenance on patients who receive root coverage procedures must also be aware of such a need.

The wound healing dynamics that will lead to root resorption after a soft tissue graft for root coverage may be similar to the cellular events described in a study of the healing of periodontitis-affected roots placed into gingival CT.[17] Cells from the gingival CT do not have the ability to form cementum and/or a functional periodontal ligament. Therefore, the type of attachment previously described[11–13] between the grafted tissue and the covered root, in the form of a combination of junctional epithelium and new attachment, is likely to be a result of partial coronal migration from the periodontal ligament cells and apical migration of epithelial cells from the flap and/or graft. It is possible that this modality of wound healing occurs in most cases. In what is thought to be a small number of cases, such as the one described in this report, it is likely that cells from the gingival CT graft succeeded in populating the root surface and therefore induced the root resorption.

Another possibly relevant wound healing aspect in cases of root resorption may be related to the inclusion of periosteum in the graft, creating a similar situation to the one described by Karring et al.[18] The direct contact between a root deprived of its periodontal ligament and bone is susceptible to "replacement resorption,"[19] a term descriptive of resorption of the root surface followed by deposition of bone, consistent with what was observed in this case report. In patients with thin palatal tissue, the harvested graft may include the entire thickness of the palatal CT, whereas a partial-thickness graft may result in those with thicker palates. Periosteal cells are known to be extremely active in bone

formation and resorption and may be induced to differentiate into osteoclasts by recognizing dentin as a foreign tissue. This may also explain the formation of bone in the resorption cavity, as seen in this case. It is conceivable that cells from the periosteum, once given the time to create the space and conditions to physiologically function, will then differentiate into osteoblasts and deposit bone. That may indeed be a likely explanation for the bone formation observed in the resorption cavity, since there was no other source of bone cells close to the previously exposed root surface.

The potential role of root surface mineralization with acidic agents in inducing resorption also deserves attention. Ben-Yehouda[20] reported on a case of root resorption following a periodontal regenerative procedure in an intrabony defect where tetracycline HCl was applied to the root. That author suggested that demineralization of the root surface enhances its colonization by gingival CT cells and prevents epithelial and periodontal ligament cells from migrating into the gingival tissue–root surface interface. Both epithelial and periodontal ligament cells are thought to exert a protective mechanism on mineralized surfaces against the resorptive action from the gingival CT. It is possible that citric acid conditioning of the root in the case reported in this article did play a role in promoting the direct cellular colonization of the root surface and the CT graft, facilitating resorption as suggested by Nyman et al.[17]

Clinical management of root resorption is difficult. Exposure of the resorbed area by crown lengthening and restoration of the root surface is a possibility in cases where the resorption is mild to moderate in the apical direction. More advanced cases may not allow for apical positioning of the gingival tissues, and the restoration of the resorption cavity may end up in the subgingival space, which will result in the formation of a pocket. There is preliminary evidence that an ionomer-resin restoration will allow for a biologic attachment of the gingival tissues,[21] but more studies are necessary to establish the success and predictability of such a treatment modality. Advanced cases of root resorption may also require endodontic therapy, since the pulp may be involved. Unfortunately, root resorption dictates tooth extraction in several situations.

Root resorption is a possible complication that clinicians must be aware of following root coverage procedures with soft tissue grafts. While the mechanisms of root resorption are not well understood, careful periodic examination of the treated area is important in diagnosing root surface changes. The earlier the diagnosis of such changes is made, the greater are the chances of successful intervention. Fortunately, root resorption appears to be a rare complication of root coverage. It could be, however, a condition that is underdiagnosed and under-reported.

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