Use of an Autogenous Cortical Graft in Combination with Guided Tissue Regeneration for Treatment of an Infrabony Defect

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Summary:

Infrabony periodontal defects are common findings encountered during complete oral examinations. Treatment options for infrabony lesions are aimed at meeting client demands as well as patient needs. Deciding on how to treat these lesions depends on the nature and degree of disease present as well as having the materials available to improve the chances of achieving the greatest clinical success. Bone grafting of an infrabony defect of the left mandibular first molar tooth of a dog using an autogenous cortical graft harvested with a reusable bone grafter in combination with guided tissue regeneration is described. ***J Vet Dent 29(3); 166-171, 2012***

Introduction

Periodontal disease is common among veterinary patients. Recent evidence suggests patients suffering from chronic periodontitis are exposed to elevated levels of C-reactive proteins. These proteins have been shown to be systemic markers of inflammation and have been linked to long-term circulation of inflammatory mediators that can have a detrimental multi-systemic effect on vital organs and may be associated with a lifetime of discomfort.[1-3] Patients often present with severe halitosis and generalized gingivitis. Moreover, older small breed dogs with severe chronic periodontitis are at greater risk of pathologic mandibular fractures than large breed dogs.[4] End-stage periodontitis coupled with the close anatomic relationship of the roots of the mandibular first molar teeth with the ventral mandibular cortex can lead to structural weakening and subsequent pathologic fracture.[5,6] Common treatment options for periodontal disease include professional scaling, non-surgical periodontal debridement, open-flap debridement, bone grafting, and guided tissue regeneration (GTR). In many cases the aforementioned periodontal therapies may be contraindicated and exodontia may be necessary. The main goal of periodontal therapy not only involves regeneration of the tissues of the periodontium destroyed as a result of periodontal disease but addressing all potential risk factors for disease so that what is gained as a result of therapy is not lost.[7] Thus, preventative measures must be implemented. Bone grafting and GTR provide treatment options for patients in which maintaining a healthy, functional periodontium of strategic teeth will contribute to overall systemic health. The use of autogenous bone grafts to promote periodontal regeneration is the optimal recommendation in osseous grafting.[6] Benefits of using an autogenous cortical graft include the formation of new attachment due to the osteogenic potential of the grafting material, biocompatibility and absorbability, lack of antigenicity, ease of handling, as well as a significant cost savings.[8] This case report describes bone grafting for the treatment of an infrabony defect of the left mandibular first molar tooth (309) of a dog using an autogenous cortical autograft with a reusable autogenous bone grafter in combination with GTR.

Case Report

A 6.2 kg, 11-year-old male/castrated Cairn terrier presented to the Dentistry and Oral Surgery Service of the Veterinary Medical Teaching Hospital at the University of Wisconsin-Madison School of Veterinary Medicine for periodontal therapy. The patient had been diagnosed with periodontal disease on oral examination based on clinical evidence of gingivitis during a semi-annual wellness examination by the patient's primary care clinician. The patient had received professional dental treatment in the past although no home care regimen had ever been established.

The patient presented bright, alert, and responsive. The temperature, pulse, and respiratory rate were within normal limits. As part of the patient's pre-anesthetic assessment a packed cell volume and chemistry panel was performed and were within normal limits. Before an anesthetic protocol had been designed, the patient's American Society of Anesthesiologist's (ASA) status was determined to be 2 based on the patient's age.[9] The patient was premedicated with acepromazine[a] (0.04 mg/kg) and hydromorphone[b] (0.2 mg/kg) IM. A 22-gauge intravenous catheter[c] was placed in the left lateral saphenous vein and an isotonic, balanced electrolyte solution[d] was administered as a constant-rate infusion at 10ml/kg/hr. General anesthesia was induced with propofol[e] (4.5 mg/kg) IV. The patient was intubated with a size 6.5-mm cuffed endotracheal tube[f] and general anesthetic requirements maintained with 1-2 % isoflurane[g] with an oxygen flow rate of 1L/min on a circle system. Pulse oxymetry[h], electrocardiogram[i], end-tidal CO_2[j] and Doppler flow[k] were continually monitored. The patient's temperature was maintained with a forced-air warming device[l].

After performing supragingival and subgingival scaling and polishing, a complete oral examination as well as evaluation of all other oral and extraoral indices was performed. Stage 4 periodontal disease was diagnosed based on the periodontal condition of the most severely affected tooth in the mouth with the aid of a periodontal probe and explorer[m] as well as a whole-mouth radiographic survey using a direct digital size 2 intra-oral sensor[n]. Clinical oral examination and intraoral radiographs revealed generalized periodontitis of varying stages with the left mandibular fourth premolar tooth (308) as well as the right mandibular first molar tooth (409) most severely affected. Tooth 409

Figure 1

Dental radiograph of the right mandibular first molar tooth showing complete loss of attachment on the distal root as well as a class III furcation exposure.

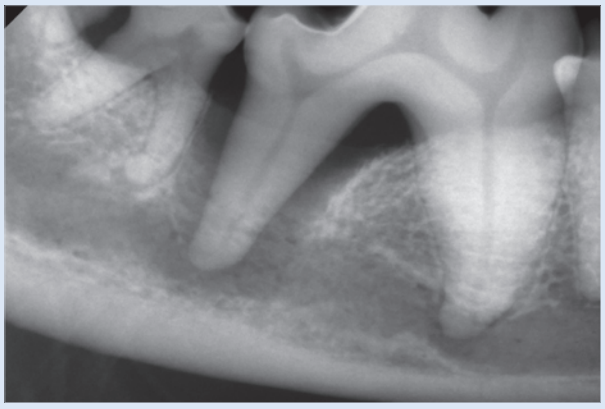
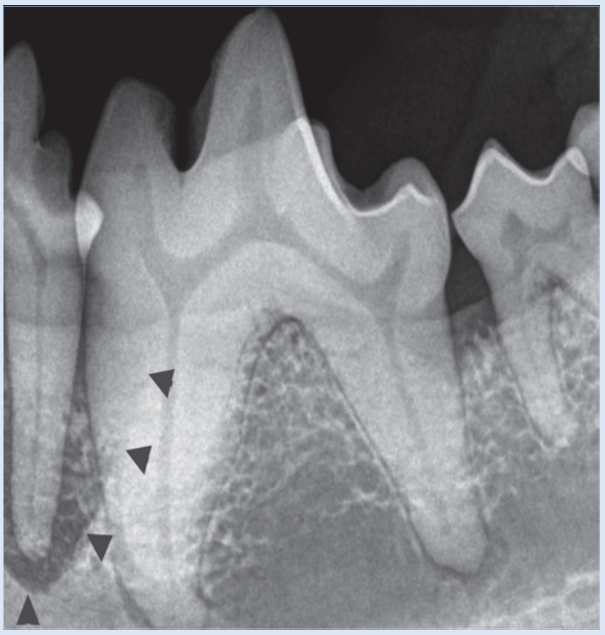


Figure 2

Dental radiograph of the left mandibular fourth premolar (308) and first molar (309) teeth showing an angular periodontal defect (arrowheads) associated with the distal root of 308 and mesial root of 309. Approximately 50 % attachment loss is noted on the mesial root of 309.



had 12-mm periodontal pockets in multiple locations around the tooth as well as a class 3 furcation exposure (Fig 1). The right mandibular second molar tooth (410) appeared to have approximately 25 % horizontal bone loss. A thin layer of alveolar bone remained along the mesial root of the tooth. The 308 showed radiographic evidence of a circumferential defect of the distal root as well as furcation involvement. The 309 also exhibited a 12-mm periodontal pocket along the mesial root. Clinical examination and intraoral radiographs confirmed approximately 50 % vertical bone loss associated with only the mesial root of the tooth. A slight vertical defect was also noted at the distal root of 309, however there was no periodontal pocketing associated with the defect at the time of clinical examination (Fig 2). A two-walled infrabony defect of the mesial root of 309 was diagnosed. Radiographic findings confirmed sufficient attachment of tooth 309 making the patient a suitable candidate for bone grafting and GTR. This treatment option was elected after counseling the client on treatment options of extraction compared with periodontal therapy.

With the patient placed in dorsal recumbency, a 30-gauge needle and tuberculine syringe containing 1.0-mg of 0.5 % bupivacaine[o] was used to administer bilateral mandibular regional anesthetic nerve blocks using an extraoral approach. The patient was draped with a sterile surgical drape so that only tooth 409 and a small area surrounding it was accessible through the surgical field. A 360º sulcular incision using a #15c surgical blade was made circumferentially around 409 to incise through the long junctional epithelial attachment. A single divergent vertical releasing incision beginning at the mesiobuccal line angle of 408 was made from the gingival margin apical to the mucogingival line in a rostroventral direction. A periosteal elevator[p] was used to create a mucoperiosteal flap on the vestibular surface of 408 and 409 to expose alveolar bone surrounding the teeth. A #331 pear-shaped carbide bur[q] on a water-cooled, high-speed handpiece was used to remove alveolar bone from the vestibular alveolar surface of the mesial and distal roots of teeth 408 and 409. A #701 crosscut fissure bur[r] was then used to section the teeth through the furcation in an apical-coronal direction. A size 4 winged dental elevator[s] was used to carefully elevate the roots of the teeth from the alveolus. Straight-handle extraction forceps[t] were used to deliver the roots from the alveolus. Curettage of granulation tissue and bone within the alveoli of the roots was performed using a spoon curette[u]. A reusable cortical bone grafter[v] was used in a modified pencil grasp with the head of the grafter at a 10-45° angle to the long axis of the bone. In a series of downward pull strokes, approximately 1-cc of ribbon-shaped shavings of cortical bone was harvested from the mandibular vestibular cortical plate ventral to the alveolar bone of 409 and away from any grossly diseased bone (Fig 3). The graft was removed from the storage well that is built into the handle of the grafter and placed in a sterile dappen dish. After graft harvest the gingival margins of the surgical site were debrided and a periosteal releasing incision was performed to close the defect ensuring a tension-free closure. The flap was sutured using 4-0 glycolide, dioxanone, and trimethylene carbonate synthetic absorbable monofilament suture[w] in a simple interrupted pattern. The patient was re-draped and a surgical approach was made to the mesial root of 309. A sulcular incision was made on the vestibular surface of 309 along with a single vertical divergent releasing incision at the mesioobuccal line angle of 309 beginning at the gingival margin apical to the mucogingival line in a rostroventral direction. A periosteal elevator was used to create the mucoperiosteal flap exposing the mesial root of the tooth. Open-flap debridement using a subgingival curette[x] was performed along the entire exposed root surface. The

Figure 3

Photograph showing the bone grafter[v] (A) in a modified pencil grasp. Bone is harvested using downward force applied perpendicular to the bone (F1) and pulled (F2) with the head of the grafter placed at 10-45° to the long axis of the bone (B). A scanning electron micrograph shows the ribbon-shaped coil of cortical bone that is planed from the donor site (C). Images reproduced with permission (Maxilon).

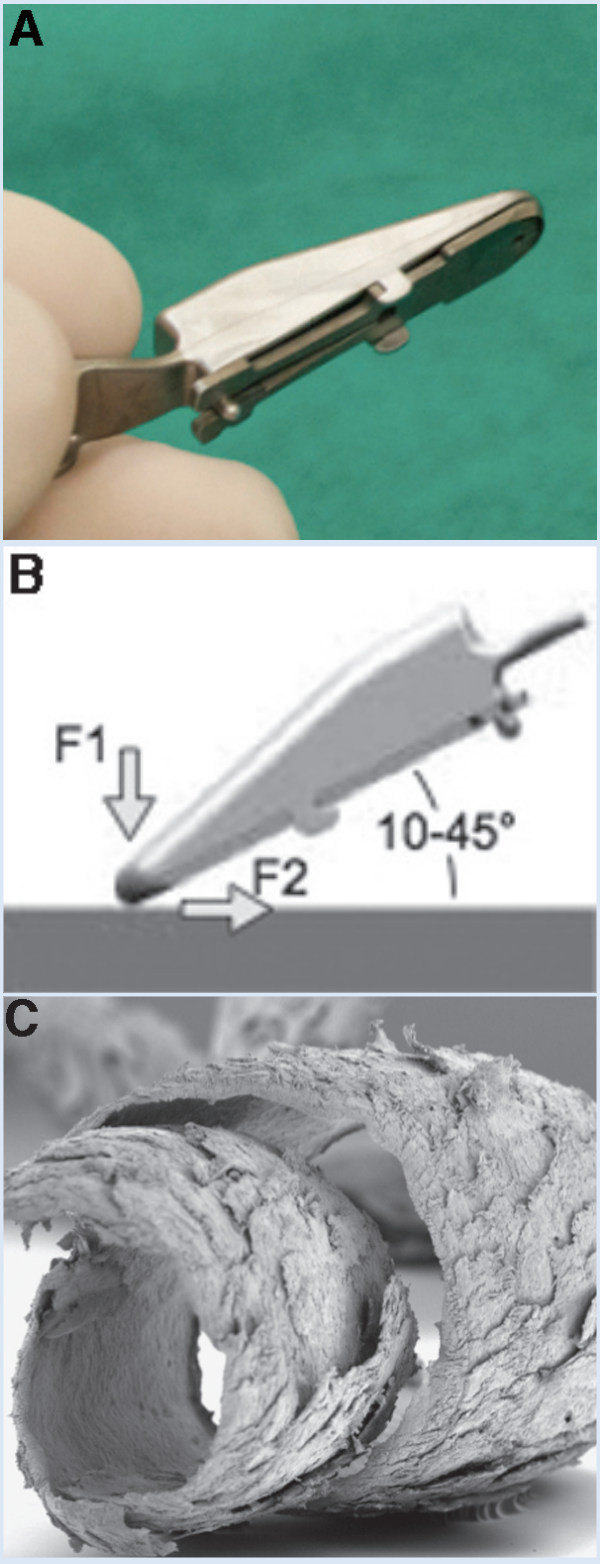
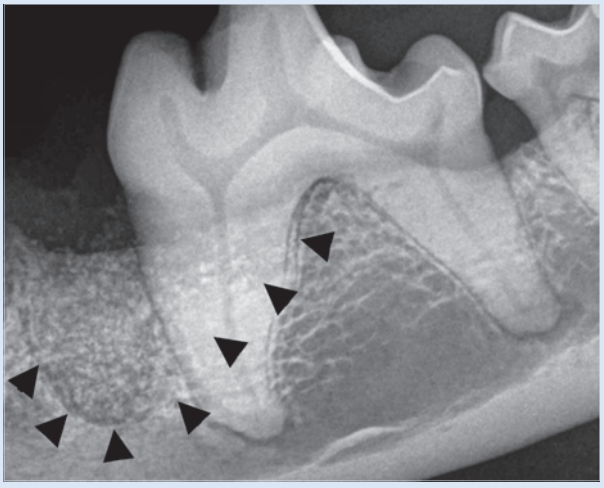


Figure 4

Dental radiograph of the left mandibular first molar tooth showing the recipient site (arrowheads) immediately after autogenous cortical graft placement.



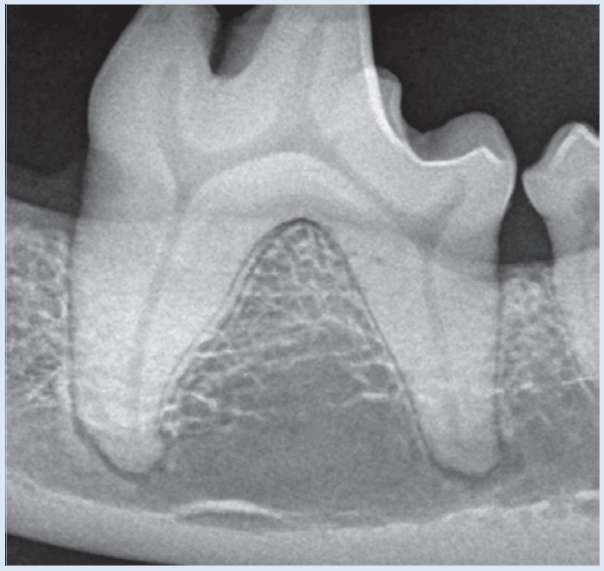
autogenous osseous-coagulum was delivered to the donor site using a surgical curette. Enough grafting material was placed at the donor site to completely fill the infrabony defect as well as leaving enough space at the dorsal alveolar ridge for the placement of an absorbable barrier membrane. A doxycycline impregnated absorbable barrier membrane[y] was placed over the autogenous bone graft. Care was taken to preserve the natural sulcal depth after membrane placement as well as maintain approximately 2-mm between the base of the sulcus and the newly engineered alveolar crest in efforts to preserve biologic width. The gingival margin and sulcus were debrided prior to closure and the mucoperiosteal flap was then replaced without tension and sutured using 4-0 glycolide, dioxanone, and trimethylene carbonate synthetic absorbable monofilament suture in a simple interrupted pattern. Postoperative intraoral radiographs were taken of the recipient site and the patient recovered uneventfully from general anesthesia (Fig 4).

The patient was prescribed oral carprofen[z] (2.2 mg/kg BID) and tramadol[aa] (4.0 mg/kg TID) for 5-days postoperatively. The owner was instructed to feed a softened diet for 30-days postoperatively. Considering the client's extensive travel circumstances, a conscious oral post-operative examination to evaluate healing was recommended to occur with the referring veterinarian in 10-14-days. The client was instructed not to begin tooth brushing the area of the periodontal treatment until after the 10-14 day postoperative examination.

The patient was returned to the Dentistry and Oral Surgery Service 7-months following treatment for a medical progress examination, professional scaling and polishing, and intraoral radiographs under general anesthesia as described previously. The complete oral examination with whole-mouth periodontal probing and charting was unremarkable and the previous extraction site of 408 and 409 demonstrated complete wound healing. The periodontal surgery site of 309 revealed 2-mm of gingival recession, 2-mm of remaining attached gingiva and normal probing depth for a total attachment loss of 2-mm.

Figure 5

Dental radiograph of the left mandibular first molar tooth (309) 7-months following application of autogenous cortical graft and resorbable barrier membrane placement. Note the radiodense tissue around the mesial root of 309 indicative of osteointegration with bone repair and remodeling. A narrow periodontal ligament space can be clearly traced along the entire length of the mesial root surface.



Intraoral radiographs of the recipient site of tooth 309 revealed proper alveolar crestal bone height and radiodense tissue indicative of osteointegration of the autogenous graft (Fig 5). The periodontal ligament could be continually observed around the mesial and distal roots of 309. Follow-up intraoral radiographs also showed no bony abnormalities associated with the donor site. The patient recovered uneventfully from general anesthesia. Daily tooth brushing and semi-annual professional cleanings and intraoral radiographs were recommended to monitor and maintain periodontal health.

Discussion

Regeneration is defined as the restoration of a lost or injured component of the body so that the form and function of the lost component is restored to its pre-injurious state.[7,10] The main goal of guided periodontal tissue regeneration is selective cell repopulation of specific tissues of the periodontium which have been lost to disease.[11] By creating cellular guidance for regeneration of the periodontal ligament while delaying apical migration of gingival epithelium, new attachment may form on a previously diseased root surface.[8] True periodontal regeneration can only be confirmed histologically. Thus, any post-procedural clinical and radiographic gain in attachment can only simply be referred to as new attachment.[7] Therefore, a distinction should be made between regeneration and new attachment.[7,12]

Human studies have shown that combining GTR with an autogenous bone graft resulted in greater attachment gain and bone-fill when compared to either procedure alone.[13,14] However, other human studies have shown conflicting results indicating that no difference in clinical results were achieved among individual techniques.[15,16] It is worth noting that in those studies researchers used a collagen-based absorbable membrane. A previously published veterinary case report described the clinical success of a combination technique using a doxycycline impregnated bioabsorbable barrier membrane placed over a bone graft.[17] Another previously published report on the treatment of a similar defect in a dog using a bone graft revealed successful results without the use of a barrier membrane.[18]

In this particular case, doxycycline impregnated in an absorbable polymeric carrier was the barrier membrane of choice based on accessibility of the product at our hospital as well as recent studies evaluating the effect of polylactic acid bioabsorbable membranes for treating infrabony defects in people.[19,20] Doxcycline has also been shown to have an anti-inflammatory effect through the inhibition of matrix metalloproteinases 8 and 12, which are collagen and elastin cleaving enzymes. Collagen and elastin are two of the main structural components of gingival connective tissue and alveolar mucosa, respectively.[21,22] If a defect is large enough, thorough open flap debridement must be performed. A root conditioner was not used in this particular case. The theory supporting the use of root conditioners such as citric acid, doxycycline, and EDTA is that demineralization of dentin exposes collagen fibrils which creates a surface conducive to cemental repopulation.[7] However, several studies have failed to demonstrate any significant new attachment or regeneration with the use of root conditioners.[23-25] Thus, their use is not equivocally supported by the literature.

One possible advantage in using a bone graft before placement of a resorbable membrane in this particular patient was that the graft may have aided in preventing soft tissue ingrowth as well as providing space maintenance due to the non-supportive slumping nature of the polymers currently utilized as barrier membranes in GTR.[11,26]

There are various classification systems used to describe types of bony defects based on the number of remaining walls of attachment.[27] The type of infrabony defect is important in that it will dictate the type of grafting material used to repair it.[26] A single-walled defect is one in which total vertical bone loss has left only one remaining wall of bone attached to root. This is the most challenging type of defect to repair. Two- and three-walled infrabony defects are much more amenable to reconstruction with bone grafting techniques.[26] In the case reported here, the 309 had a 2-walled defect and was considered an appropriate candidate for bone grafting.

Bone grafting materials can be classified on the basis of their source. The source of the graft can be further subclassified by location. The gold-standard in bone grafting involves the use of an autogenous bone graft.[12,26] Autografts are grafts harvested and transplanted within the same host.[12] Autografts are the only graft source that are osteogenic, meaning that they are the only type of graft capable of incorporating osteoprogenitor cells to induce new bone formation.[12] Autografts are completely non-allergenic and posses the functional grafting properties of osteogenesis, osteoinduction, and osteoconduction.[28] Osteoinduction refers

to the effect of a material which can stimulate pluripotent mesenchymal cells to differentiate and begin bone formation.[28] Osteoconduction refers to the functional property of a material which does not have a biologic influence in attracting osteogenic progenitor cells but can provide a scaffolding for the growth of new bone.[28,29] Allografts are materials harvested from one individual to be donated to another individual within the same species.[12] Allografts possess the functional properties of osteoinduction and osteoconduction.[12] However, without appropriate graft preparation, allografts can serve as a source of antigenicity. Xenografts are grafts taken from one individual and donated interspecies to a completely genetically dissimilar recipient.[12] Xenografts possess the highest antigenic potential. Alloplasts are synthetic particulate grafts, which do not possess any cellular or other biologic qualities but simply act as a scaffolding for the formation of new bone.[26] Osteoconduction is the only functional property of these types of materials. As mentioned previously, the source of a graft can be further classified according to the location from which the graft was harvested. A cortical bone graft is one taken from the outer, much more dense bone. Cancellous bone grafts are harvested from the softer trabecular, or spongy bone from the center of long and flat bones. Cancellous grafts have long been regarded as excellent graft sources due to their ability to effectively induce new bone formation.[12] Due to the significantly higher content of pluripotent osteoprogenitor cells, cancellous bone is considered to be superior to cortical bone as a grafting source, leading to rapid integration of the graft; unlike cortical bone which provides volume and structure through creeping substitution.[30] However, harvesting of cancellous bone can be significantly more technically demanding and time consuming than harvesting cortical bone and contribute to significant donor site morbidity.[8] The use of an autogenous cortical graft harvested with a reusable cortical bone grafter in this patient was justified and convenient because the patient was already undergoing an intraoral surgical procedure at a distant site from the site of graft placement. Thus, an increase in surgical and anesthetic time typically encountered with other grafting techniques was negated and additional morbidity associated with the chosen grafting technique was minimal. Possible sequela associated with autogenous bone grafts have been reported to include root resorption and ankylosis.[31,32] However, more recent studies have suggested that autogenous bone harvested intraorally does not result in ankylosis.[33]

The reusable cortical bone grafter is an instrument designed to harvest autogenous cortical bone intended for grafting. The instrument is composed of a stainless steel handle and blade. The blade is designed to shave bone in small coiled strips, which while being cut, combines osseous material with blood and is deposited into a reservoir in the handle's head. The resultant osseous coagulum can then be delivered directly from the reservoir or from an intermediary storage container such as a dappen dish.[34] Benefits associated with using a reusable autogenous cortical bone grafter in this patient included ease of use and minimal time associated with graft harvesting, minimal morbidity at the donor site, virtually unlimited volume of graft to be harvested, and a significant cost savings when compared to commercially available osteoinductive and osteoconductive particulate allografts. However, these benefits can be nullified if the donor site is diseased, therefore the donor site should be evaluated for suitability before harvest. Increases in surgical and anesthetic time are negligible when compared to the use of commercially available allografts since the time required to harvest 1-cc of buccal cortical bone with the current technique is typically about 1-minute. Other advantages to the use of this grafter include the significant increase in volume of the graft in relation to the amount of bone removed from the donor site.[35] This occurs as a result of the finely coiled ribbon-shaped shavings that are created when cortical bone is planed from the donor site (Fig 3). The unique design of the particulate can reduce the amount of graft necessary to fill similar defects when compared to more traditional grafting techniques. Thus, care was taken to not tamp or compact the graft after filling the defect. This may explain the narrow radiolucent space between the bone graft and the much more compact surrounding cortical bone seen on the dental radiograph immediately after graft placement (Fig 4).

Guided periodontal tissue regeneration, among other periodontal therapies in veterinary dentistry, has become widespread. The addition of a bone graft in combination with guided periodontal tissue regeneration has been demonstrated in some studies to improve overall clinical attachment, although other studies have shown conflicting results.[13,14,16] Justification for incorporating an autogenous cortical bone graft with guided periodontal tissue regeneration in this patient included preventing soft tissue ingrowth into the infrabony defect as well as the space maintenance the graft may provide due to the slumping properties of most polymeric absorbable barrier membranes.

Clinical success in periodontal surgery is predicated not only on the skill of the surgeon or the materials available but in selecting the proper patient and tooth selection for a given procedure. In this particular patient, surgical extraction of tooth 308 was justifiable in order to salvage 309, a strategically more important chewing tooth. The imbrication between teeth 308 and 309 in the dental arcade possibly interfered with the self-cleansing mechanisms of those teeth thus predisposing them to develop focal periodontitis. Tooth 409 appeared significantly more affected than 309 with virtually no bony attachment to the distal root and a class 3 furcation defect. Surgical extraction of 409 was justified given the circumferential defect affecting the distal root and the poor results obtained in treating class 3 furcation defects with guided tissue regeneration.[36,37] One possible alternative to surgical extraction could have been to hemisect the tooth and extract the distal root of tooth 409 and perform standard root canal therapy on the mesial root. This would have preserved the principal cusp of tooth 409, maintaining a viable chewing tooth. However, due to the prolonged general anesthetic requirement and additional cost, the owner declined such treatment. Despite the large defect surrounding the distal root of tooth 409, a very thin layer of alveolar bone remained along the mesial root of tooth 410. No treatment was deemed necessary due to the absence of periodontal pocketing and mobility.

Using a reusable autogenous cortical bone grafter is a safe, quick, and cost-effective way to deliver a completely non-reactive, osteogenic, osteoinductive, and osteconductive graft to an infrabony periodontal defect. Autogenous graft harvesting within the oral cavity reduces disadvantages of increased surgical time and patient morbidity typically encountered with other distant grafting techniques.

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[a] Acepromazine. Pheonix Pharmaceuticals. Burlingame, CA

[b] Hydromorphone. Baxter Healthcare Corporation. Deerfield, IL

[c] Monoject Veterinary IV Catheter. Tyco Healthcare Group. Mansfield, MA

[d] Normosol-R. Hospira, Inc. Lake Forest, IL

[e] Propoflo, Abbott Laboratories, North Chicago, IL

[f] Dre Veterinary, Louisville, KY

[g] Forane. Airco, Inc. Montvale, NJ

[h] VetOx 4404. Heska. Loveland, CO

[i] Datex-Ohmeda Cardiocap 5. Madison, WI

[j] Datex-Ohmeda Cardiocap 5. Madison, WI

[k] Datex-Ohmeda Cardiocap 5. Madison, WI

[l] Bair-Hugger. Arizant Inc. Eden Prairie, MN.

[m] Marquis Periodontal Probe. Hu-Friedy. Chicago, IL

[n] Kodak 6100. Eastman Kodak Co., Rochester, NY

[o] Bupivacaine. Hospira, Inc. Lake Forest, IL

[p] Molt #9 Periosteal Elevator. Miltex. Plainsboro, NJ

[q] 331 FG carbide bur. Henry Schein. Port Washington, NY

[r] 701 FG carbide bur. Henry Schein. Port Washington, NY

[s] EX-W4 Winged Elevator. Cislak Manufacturing. Niles, IL

[t] Straight Handle Forceps. Nordent Manufacturing Inc. Elk Grove Village, IL

[u] Miller Surgical Curette. Hu-Friedy. Chicago, IL

[v] Ebner 502 Autogenous Bone Grafter. Maxilon Laboratories, Inc. Hollis, NH

[w] Biosyn. Covidien. Mansfield, MA

[x] Mini Five Gracey Curette. Hu-Friedy. Chicago, IL

[y] Doxirobe. Pfizer Animal Health. New York, NY

[z] Rimadyl. Pfizer Animal Health. New York, NY

[aa] Tramadol. Amneal Pharmaceuticals. Glasgow, KY

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