A Previously Unreported Surgical Technique Utilizing Five Different Grafting Materials to Successfully Achieve Simultaneous Alveolar Regeneration and Closure of a Large Oronasal Defect

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This case report describes the successful surgical and restorative management of an unusual cyst-granuloma combination that had expanded to perforate the labial and nasal parts of the maxillary bone. Enucleation and curettage of the lesions resulted in a large oronasal communication that presented a reconstructive challenge. Five different graft and/or barrier materials were used to close the oral and nasal openings and to regenerate the alveolus for implant placement and for aesthetic prosthetic restoration.

KEY WORDS

Guided bone regeneration
Membranes, barrier
Membranes, absorbable
Type I bovine collagen
Demineralized freeze-dried bone
Laminar bone allograft
Acellular dermal matrix
Polyglactin 910

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Introduction

Various types of cysts commonly occur in the maxilla, including odontogenic cysts, fissural remnant cysts, pseudocysts, and cysts of unknown origin.[1] Globulomaxillary fissural cysts occur in the maxillary cuspid–lateral incisor area; historically, these cysts were thought to result from the proliferation of epithelial remnants that were trapped during the embryonic fusion of the globular and maxillary processes.[1,2] In recent years, various investigators have been unable to find evidence supporting previous descriptions of the genesis of globulomaxillary cysts. Their studies suggest that globulomaxillary cysts should be classified as odontogenic radicular cysts that arise from reduced enamel epithelium, from dental lamina, or from epithelial rests of Malassez present in the periodontal ligament.[3]

Radicular cysts are the most common of all odontogenic cysts; they are also called residual, remnant, or lateral periodontal cysts. They are usually

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asymptomatic and can occur in the presence of teeth or can generate from epithelial remnants following tooth extraction. They can become infected to present as a combined cystic-granulomatous or cystic-abscessed lesion.[2]

A granuloma is considered the body's attempt at lesion repair, with formation of granulation tissue and varying degrees of resorption of osseous tissue. The granuloma can begin as a periapical abscess, or, once formed, granuloma can break down to become a periapical abscess with accompanying symptoms such as pain, suppuration, or swelling.[1,2] A periapical granuloma is this sort of inflammatory lesion, usually associated with pulpal necrosis and/or with failed root canal therapy. Various studies report that periapical granulomas account for 45% to 94% of all maxillary radiolucencies and usually present mild to no symptoms.[2]

It is not possible to differentiate cystic and granulomatous bone erosion from radiographic appearance alone, but cysts often appear as clearly demarcated, circumscribed radiolucencies. Radiolucent areas with either clear or ill-defined borders abutting various areas of root surface suggest granulomatous bone loss associated with periapical and/or periodontal infection.[4,5]

Case Report

In this case, routine periapical X rays showed a fairly well defined radiolucency in the edentulous maxillary right lateral incisor area. The radiolucency was thought to represent a cyst and/or a failure of bone regeneration following a previous extraction many years previously. This area was contiguous with a periapical radiolucency at the maxillary right central incisor, suggesting a residual granuloma associated with failed root canal therapy. Since the lesions appeared to be well demonstrated by periapical films, no further X ray studies were done, and treatment was undertaken.

A 55-year-old woman was referred for periodontal evaluation with a complaint of very slight pain and pronounced swelling of 1 month's duration in the area of the maxillary right lateral incisor. The swelling had appeared suddenly and had increased only slightly since onset. This was the first occurrence of these symptoms; the patient had delayed seeking help because the area did not really bother her and she assumed that the problem would resolve itself.

When the lesion persisted, the patient consulted her dentist who recognized the possibility of a periapical granuloma at tooth 8 combined with distal bone loss caused by periodontal disease. Tooth 7 had been endodontically treated and had subsequently fractured at least 15 years earlier. Tooth 7 had then been extracted and replaced with a fixed bridge. The patient's significant medical history included diabetes, cholesteremia, hypertension, and edematous swelling; these conditions were all well controlled by daily oral medication. Clinical examination revealed a large buccal swelling centered over the edentulous tooth 7 area, extending from the right cuspid to the right central incisor and apically well into the mucobuccal fold. There was also slight lingual swelling. Pressure on the area provoked a white purulent discharge at the distal sulcus of tooth 8. Pain was rated as mild to moderate. In periodontal examination, we could probe no deeper than 4 mm at either tooth 6 or tooth 8. Both of these teeth were firm, although tooth 8 was slightly sensitive to incisal pressure.

Periapical radiography (Fig 1) seemed to adequately depict osseous destruction that was suggestive of a granuloma, a cyst, advanced periodontitis, or some combination of these. The clinical examination ruled out periodontitis because of the lack of any probing depths. We made a tentative diagnosis of periapical granuloma at tooth 8 with cystic or granulomatous osseous destruction in the adjacent tooth 7 area.

Because of uncertainty as to the nature of the lesion at tooth 8 and a poor prognosis for its retention, a decision had been made to extract it. With the patient under local anesthesia, a buccal flap was reflected, revealing circumferentially intact alveolar crestal bone. This confirmed that the bony lesion was not periodontal in nature, and the tooth was extracted. All soft tissue in the defect was removed by careful curettage, which revealed the extension of the lesion into the nasal cavity, producing a large oronasal communication (Fig 2). It was impossible to identify any structure resembling intact tissues, such as might be found when enucleating a cyst.

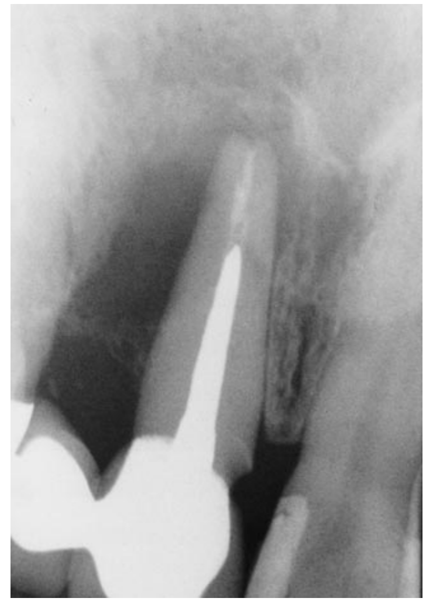

Figure 1. Preoperative radiograph showing tooth 7 area to have a very large radiolucent area contiguous with a periapical lesion and root resorption in tooth 8. Although there is a suggestion of ill-defined radiolucency in the bone superior to the obvious lesions, there is no indication that the lesion extends into the nasal cavity. Because of its poor prognosis, a decision was made to extract tooth 8. There was subsequent bone grafting to restore ridge form for aesthetics and for later implantation.

Once the lesions were curetted as thoroughly as possible, it was necessary to formulate a reconstruction plan to close the large defect between the oral and nasal cavities by regenerating the maxillary bone and the oral and nasal soft tissues.

Bone regeneration is the restoration of lost osseous tissue. Bioabsorbable

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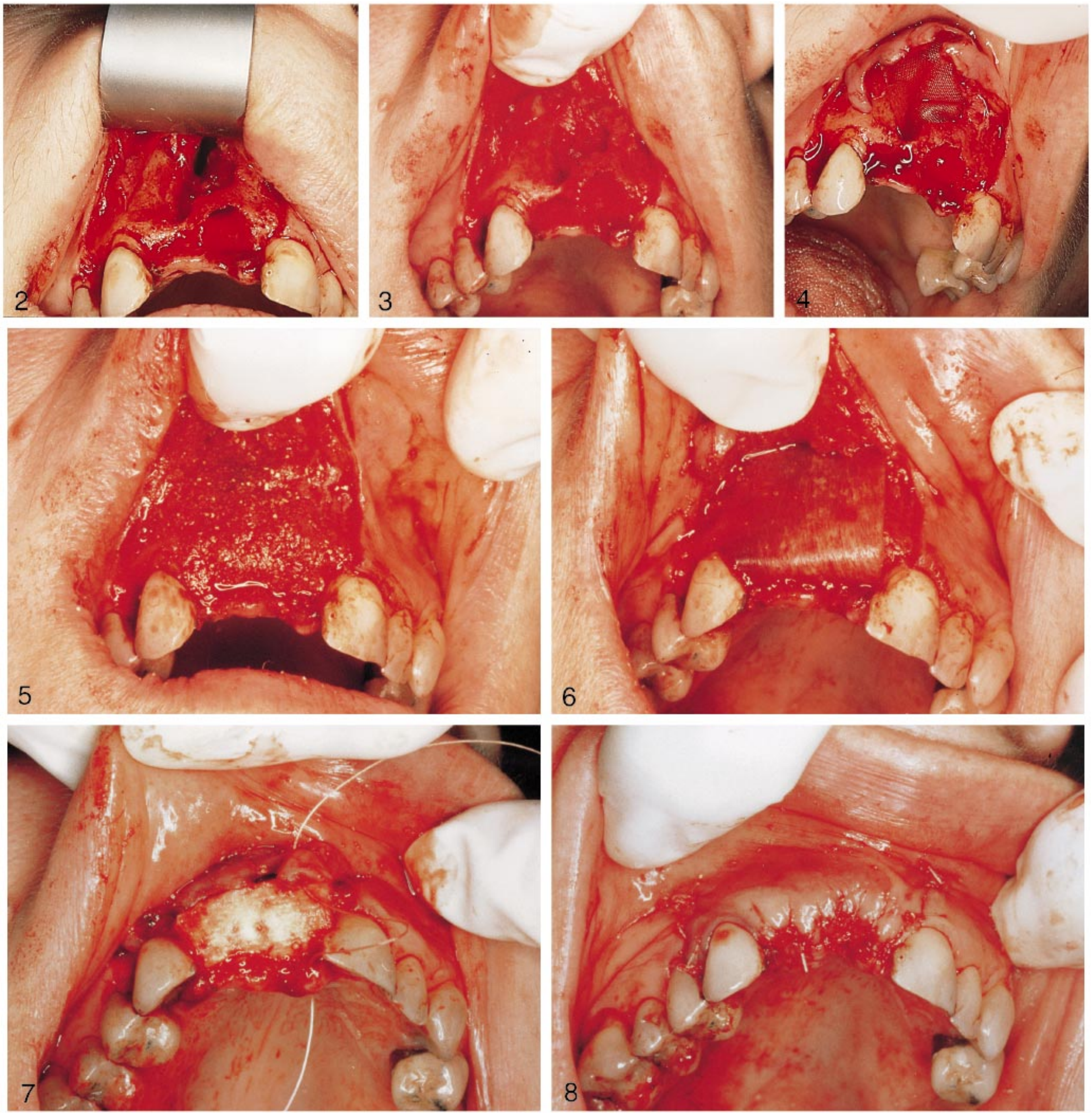

FIGURES 2–8. FIGURE 2. Extraction of tooth 7 and curettage of all pathologic soft tissue revealed labyrinthine bone destruction with occlusal openings at teeth 7 and 8, a buccal fenestration at tooth 7, and a large nasal fenestration. Intact alveolar bone crest at tooth 8 confirmed that periodontitis was not a causative factor. FIGURE 3. A collagen obturator was hydrated and gently placed to seal but not penetrate the nasal opening. This type of obturator was used to facilitate GBR while promoting regeneration of nasal mucosa because of the long history of predictable success using a type I bovine collagen barrier in both bone and torn Schneiderian membrane regeneration during sinus lift procedures. FIGURE 4. Since particulate DFDBA was to be the GBR vehicle, polyglactin 190 woven mesh was placed to completely cover the collagen in order to prevent the bone particles from dislodging, imbedding into, or penetrating the soft edges of the barrier. FIGURE 5. Particulate DFDBA was hydrated and placed to overfill the defect. It has been shown to enhance regeneration when attempting repair or augmentation. It is biocompatible, bioabsorbable, osseoinductive and/or osseoconductive, and possibly activates BMP. FIGURE 6. Laminar bone is a fairly rigid strip form of DFDBA that possesses the same characteristics as the particulate form. After hydration, it softens sufficiently to be manipulated into the desired ridge size and shape before placement as a matrix to maintain the molded shape of the pliable DFDBA particles. FIGURE 7. The bulk of graft materials did not permit primary closure. An acellular dermal matrix was hydrated and placed to promote gingival regeneration and to provide a GBR barrier for isolation and protection of the exposed laminar bone. FIGURE 8. The soft tissue margins were closed as completely as possible using polyglactin 910 sutures that were crisscrossed to provide stability to the exposed dermal matrix.

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particulate demineralized freeze-dried bone allografts (DFDBA) have been shown to enhance the formation of new bone by osseoinduction and/or by osseoconduction. It is postulated that the demineralization process activates bone morphogenic protein (BMP), which enhances the formation of new bone.[6–9]

Guided bone regeneration (GBR) is the name for surgical techniques that enhance bone regeneration by using barrier membranes for tissue compartment separation to exclude ingrowth of unwanted cells while stabilizing and protecting graft materials during the healing process. Ideally, this method promotes growth of desired cellular elements under and over the membrane surfaces while protecting the clot necessary for healing and bone regeneration.[5–7,10–12]

Various barriers have been used successfully with GBR. Using membrane barriers that are bioresorbable eliminates the need for second-stage surgical removal, with its accompanying morbidity, expense, and added treatment time.[12] Before attempting GBR using DFDBA, it was necessary to select a barrier that would seal the nasal opening while promoting regeneration of nasal soft tissues.

Numerous collagen-containing barriers have been used successfully for GBR. Among these is processed type I bovine collagen (Collatape, Calcitek, Carlsbad, Calif), which is absorbable and has been shown to be biocompatible and effective. It is well tolerated, does not produce an inflammatory response, and is at least equal to other absorbable barriers and to nonresorbable expanded polytetrafluoroethylene barriers in enhancing the formation of new bone.[12–14] This collagen promotes and protects clot formation and also promotes migration and attachment of stromal and epithelial cells.[15] The collagen has also proven to be successful in promoting regeneration of schneiderian membrane defects during sinus lift procedures.[16–18] Successful use of bovine collagen by the author in Schneiderian membrane repairs furnished an additional rationale for its use to obturate the nasal opening and to promote regenerative soft tissue closure of the nasal defect.

After trimming, hydration, and placement of the soft pliable collagen barrier (Fig 3), we deemed it advisable to place a secondary barrier to prevent DFDBA particles from displacing or penetrating the collagen borders. Polyglactin 910 mesh (Vicryl, Ethicon Inc, Sommerville, NJ) is another of the many resorbable barriers shown to be effective in GBR.[13,19–21] This mesh is fairly rigid but still pliable enough to be shaped as desired. A piece was trimmed and placed to cover and slightly overlap the collagen borders (Fig 4).

Particulate DFDBA (Lifenet, Norfolk, Va) was mixed with tetracycline powder and then hydrated in accord with tissue bank protocol. The particulate DFDBA was placed to slightly overfill the defect, and the curetted bony walls provided ample bleeding for clot formation. The bone particles were molded to the desired shape, but the resultant graft was too pliable not to distort under pressure, and the bulk of the particulate bone graft did not permit primary closure (Fig 5). For these reasons, it was decided to cover the particulate DFDBA with a more rigid barrier, which would isolate the area.

Laminar demineralized freeze-dried bone (Lambone, Pacific Coast Tissue Bank, Los Angeles, Calif) is bioabsorbable DFDBA, available in 1 × 3–cm pieces of varying thickness. It exhibits the same healing characteristics as particulate DFDBA does and therefore functions as an osseoinductive graft material while providing a rigid GBR barrier to isolate and preserve the desired shape of the underlying particulate material.[22–24] A strip was trimmed to allow for slight overcoverage of the particulate DFDBA borders, and hydration allowed the strip to be molded to approximate the desired ridge shape and dimensions. The placement of the laminar bone provided a rigid

FIGURE 9. Postoperative X ray showing radio-opaque material filling the defect and creating the desired ridge height.

form while preventing displacement of the underlying bone particles (Fig 6). Since the laminar bone was expected to become a part of the regenerated ridge, and since primary closure was not possible, a decision was made to protect the exposed surface with another bioabsorbable membrane.

AlloDerm (LifeCell Corp, The Woodlands, Tex) is a processed and freeze-dried human skin allograft from which the epithelium and all connective tissue cellular elements have been removed, leaving acellular dermis composed mainly of a basement membrane that covers collagen and elastin matrices. The resultant tissue acts as a biocompatible barrier that functions to compartmentalize, isolate, and protect underlying graft materials. When exposed to the oral environment, the dermal matrix furnishes a surface capable of promoting epithelial and dermal regeneration to cover and close the defect while preventing oral fluids from contacting deeper graft materials. If the dermis does not incorporate to become part of the regenerated tissues, then it sloughs off to reveal the healed soft tissues that have developed under it.[25–27] A piece of AlloDerm was trimmed to

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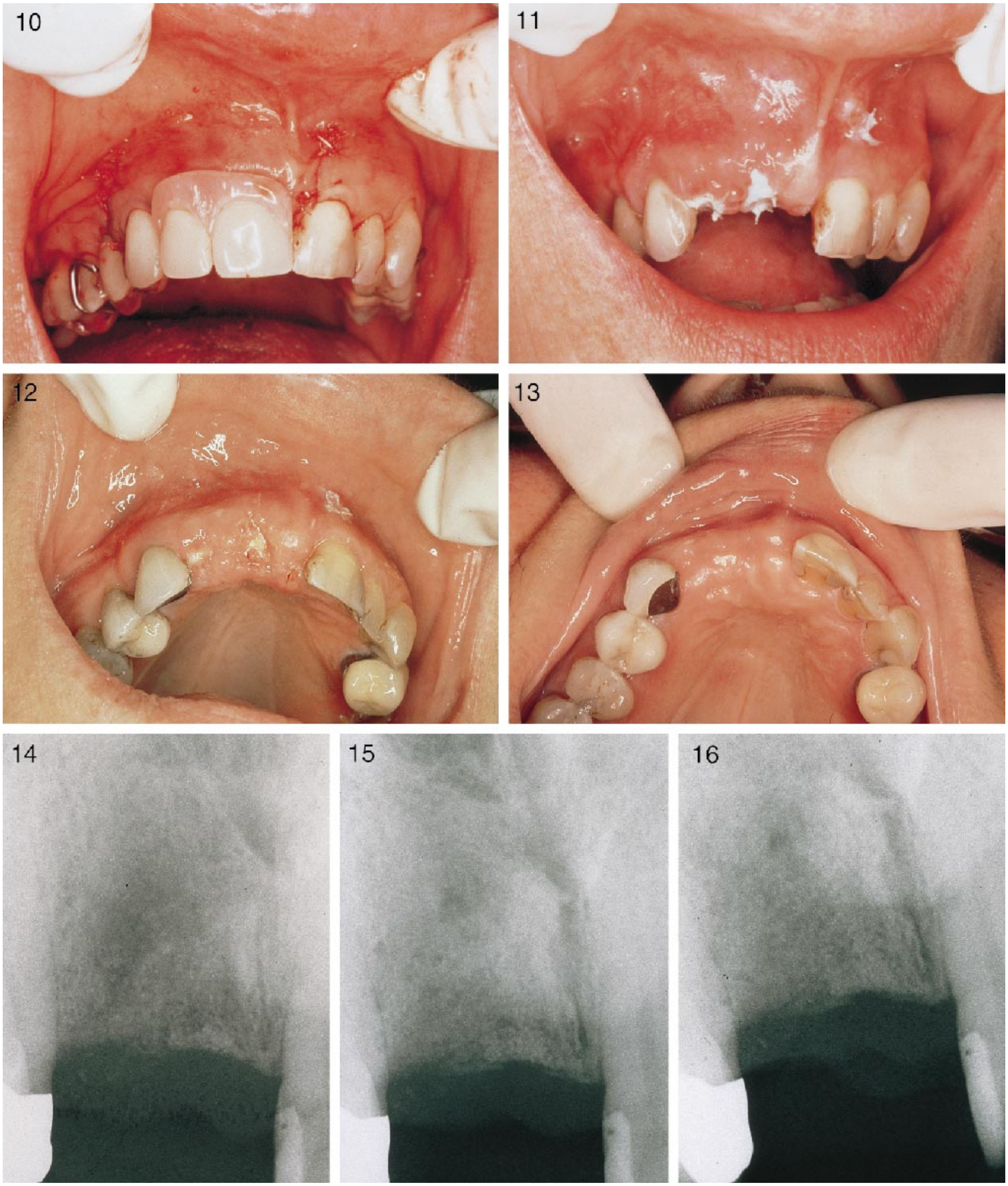

FIGURES 10–16. FIGURE 10. An immediate temporary partial denture was placed and relieved to prevent pressure on the ridge area. FIGURE 11. At 3 weeks, the soft tissue healing is proceeding nicely, and the exposed dermal matrix is beginning to slough. FIGURE 12. At 5 weeks, the created ridge form is intact. The soft tissue openings have almost totally closed, and only small dermal matrix remnants are present. FIGURE 13. At 3 months, the ridge form is intact, and there is complete epithelial closure. FIGURE 14. X ray at 4 months reveals maintenance of ridge height with increased radio opacity. FIGURE 15. X ray at 9 months shows progressive calcification, especially dense in the area of the tooth 8 socket. FIGURE 16. X ray at 11 months showing progressive calcification with continuing reduction in radiolucent areas.

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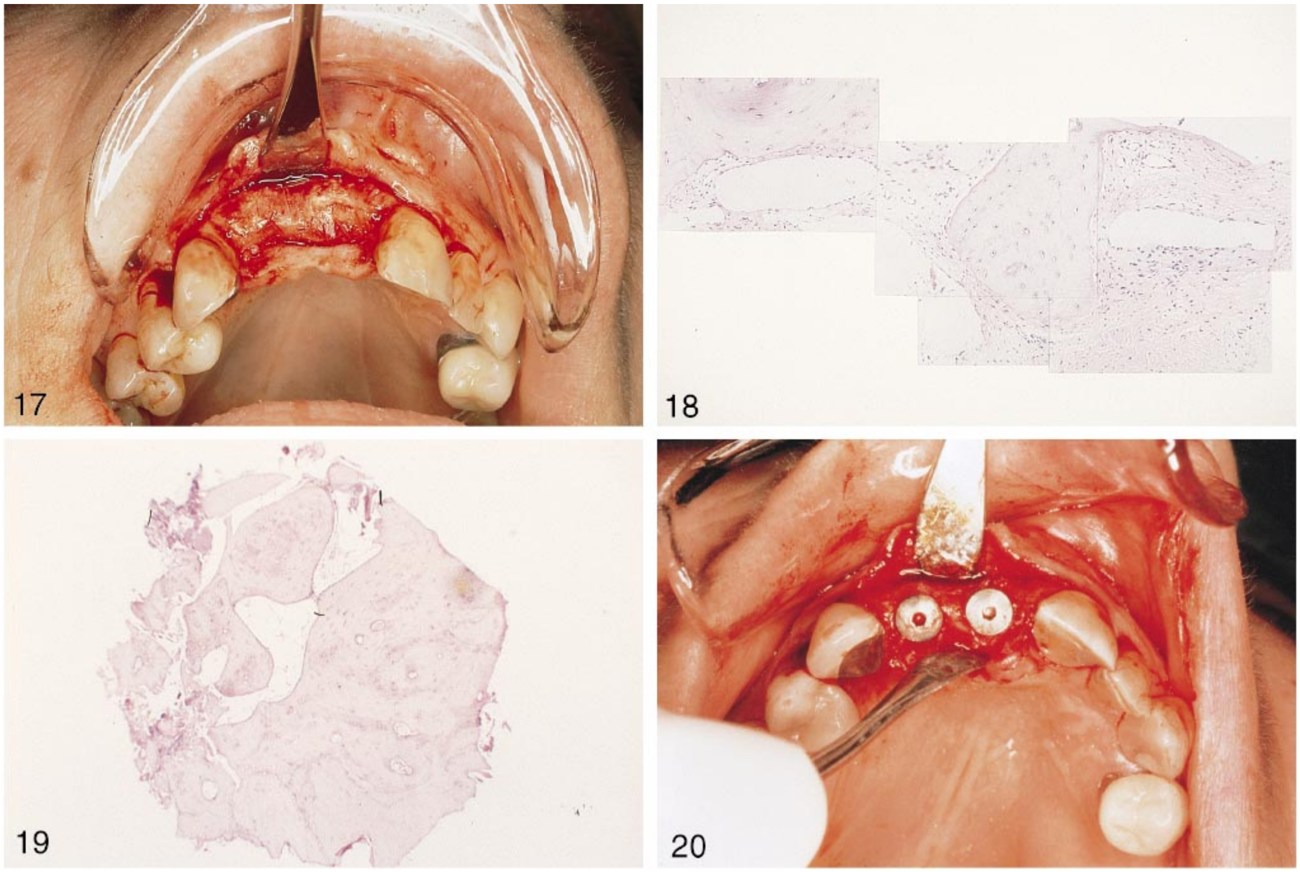

FIGURES 17–20. FIGURE 17. Opening the area at 11 months for implant placement revealed complete alveolar regeneration with no fenestrations. FIGURE 18. For biopsy purposes, samples of bone were trephined during preparation of the implant sites. Histologic examination of these samples revealed trabecular bone with the presence of a classic haversian system. FIGURE 19. Biopsy also revealed presence of some residual DFDBA particles. Trabeculae were thick and contained structural evidence of repair and regeneration. FIGURE 20. Implants were placed. Greater than expected resistance to the drill during site preparation suggested a high degree of calcification. Placement of the screw type implants without prethreading did not, however, seem to be met with more resistance than normal.

cover the exposed laminar bone and to extend 3 mm under the edges of the flap. This piece was hydrated and placed to effectively separate the laminar bone from the oral cavity (Fig 7).

The flap was secured with resorbable polyglactin sutures (Vicryl, Ethicon) (Fig 8). Postoperative X ray showed radio-opaque material filling the defect and creating the desired ridge height (Fig 9). The patient was placed on antibiotics for 15 days, starting the day before surgery. Chlorhexidine rinses were ordered to maintain cleanliness, and a temporary partial denture was placed (Fig 10).

Pathologic examination revealed that the curetted soft tissue contained granulomatous tissue and a cyst of unknown origin. The patient was notified that there was no way to be sure that all cystic epithelium was removed, and she was made aware of the possibility of recurrence.

At 1 week, the patient reported having an occasional yellowish discharge from the right nostril, but there was no postoperative discomfort and only a slight transient puffiness in the right upper lip. After 1 week, the discharge ceased, and no unusual occurrences were reported. At 3 weeks, the area was healing well, with an exposed area of dermal allograft beginning to slough off (Fig 11). The nonexposed dermal allograft was not mobile, demonstrating that it had incorporated into the healing connective tissue beneath the flaps. The remaining sutures were removed at 5 weeks (Fig 12), and full epithelial regeneration occurred by 3 months (Fig 13). The alveolar contours created at surgery appear to have been totally maintained, and the nasal mucosa was of normal appearance.

Periodic X rays during the healing period demonstrated progressive mineralization (Figs 14–16). The area was opened at 11 months, revealing complete alveolar ridge form regeneration (Fig 17), which allowed for the ideal positioning of implants (Figs 20, 21). There was considerable resistance to the drill when preparing the bone for implants, suggesting a high degree of calcification of the grafted bone materials.

A biopsy of the alveolus revealed connective tissue focally overlying the trabecular bone, with a classic haver-

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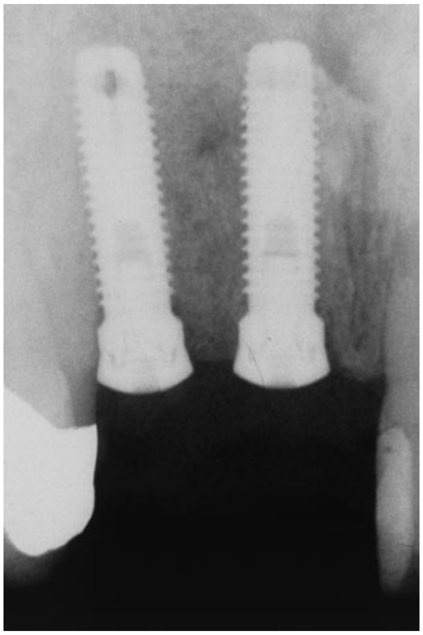

FIGURE 21. Postplacement X ray. The apparent proximity of the distal implant to the cuspid is an angulation artifact.

sian system present (Fig 18). The trabeculae were thick and contained structural evidence of repair and regeneration. Remnants of the DFDBA were present (Fig 19). Prosthetic restoration and implant maintenance instruction were completed 9 months later (Figs 22, 23). The patient has functioned comfortably for 6 months with no clinical or radiographic signs of breakdown. The area will be X-rayed periodically to monitor implant health and to assess possible cystic changes that could occur due to residual epithelial remnants.

DISCUSSION

Infection and cysts are the most common causes of alveolar bone loss, and periapical X rays are the imaging tools most commonly involved in diagnosis.[1,4,5] Although varying types of cysts or granulomatous lesions must be considered, the location and appearance of this lesion suggested a radicular or globulomaxillary cyst. However, it is also necessary to remember that other lesions and various tumors can present similar pictures and that a histologic examination of all such lesions is a necessity.[2]

In this case, periapical X rays did not reveal the entire extent of a combined cystic and granulomatous lesion, and a large oronasal communication was discovered only when the area was opened. In retrospect, it is questionable whether any other standard dental office imaging would have revealed the lesion's true extent. In this case, the use of more sophisticated imaging techniques did not seem to be indicated.

The use of guided bone regeneration principles and five different regenerative/barrier materials resulted in successful repair of an unusual combined lesion. The restoration of implants placed in the regenerated bone produced a functional and aesthetic result.

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FIGURES 22, 23. FIGURE 22. Completed restoration. Great care was taken to attain optimal gingival contour even though the patient did not show maxillary gingiva when smiling or during any other facial movement. FIGURE 23. Completed restoration. Normal lip posture results in a pleasant and harmonious smile line.

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