Bony Press-Fit Closure of Oro-Antral Fistulas: A Technique for Pre-Sinus Lift Repair and Secondary Closure

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Purpose: To evaluate the use of intra-oral bone grafts for closing chronic oro-antral fistulas (OAFs), for providing a sound basis for subsequent conventional sinus lifting and for preserving the teeth adjacent to OAFs.

Patients and Methods: Twenty-one patients with oro-antral fistulas of variable origin were treated with monocortical bone blocks harvested from the retromolar or interforaminal regions of the mandible. The preoperative treatment, the surgical procedure for both hard and soft tissue closure, and the postoperative management are reviewed in detail.

Results: Press-fit closure for repair of the bony sinus floor was sufficient in 17 patients. Four of them needed additional internal fixation. In all 21 patients adequate closure of the fistulas was obtained, although 3 patients (14.3%) developed wound dehiscences at the grafted sites, which healed by secondary intention. Meanwhile, 3 patients underwent successful sinus lifting.

Conclusion: The use of monocortical bone grafts harvested at intra-oral donor sites is a safe and easy technique for repairing defects of the maxilla, especially OAFs in need of secondary closure. It provides a sound basis for subsequent conventional sinus lifting and preserves the teeth adjacent to OAFs.

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Oro-antral communications (OACs) commonly occur after extraction of the first and second molars.[1] If the communication fails to close spontaneously, it remains patent and is epithelialized so that an oro-antral fistula (OAF) develops.[2] OACs left untreated may rapidly cause acute sinus disease. Wassmund[3] found sinusitis in 60% of cases on the fourth day after sinus exposure,[3] and Eneroth and Martensson[4] reported a sinusitis rate of approximately 50% on the third day after OACs manifested themselves. Therefore, a reliable diagnosis of OACs is needed early to permit successful closure.[5] Numerous surgical techniques were described in the literature, most of them based on mobilizing the tissue and advancing the resultant flap into the defect.[6,7] The Rehrmann flap, which is fashioned by mobilizing the vestibular mucosa,[8] is commonly used for this purpose. Most of the surgical procedures share equal success and failure rates.[9,10] Secondary closure of OAFs produces comparably low success rates and poses a challenge for the oral surgeon.[11,12] Numerous modifications of existing techniques were recommended for soft tissue closure of the fistulas.[13] For repairing the bony maxilla, bone autografts harvested from the iliac crest or from the mandible have been used.[14,15]

Because of the continued need for implant rehabilitation and the necessity of pre-implant surgery in terms of sinus floor elevation, routine soft tissue closure of OAFs has become a major problem. It causes matting of the mucosa and the Schneiderian membrane and makes elevation of the sinus membrane

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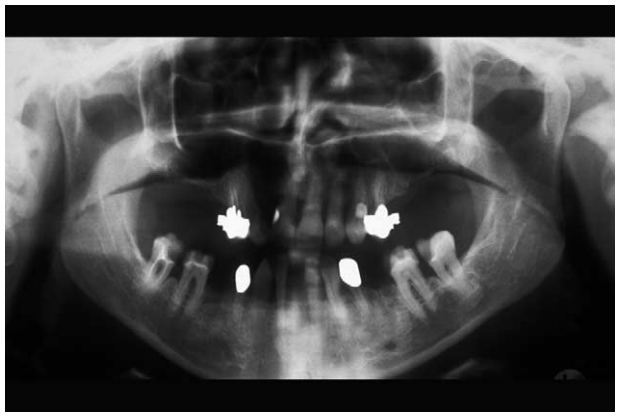

FIGURE 1. OPG showing OAF in the molar region on the left side.

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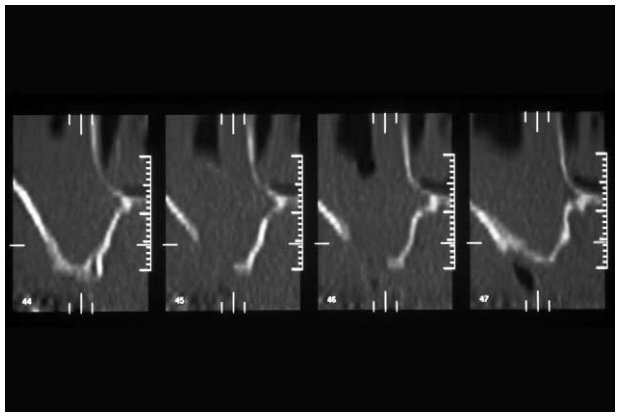

FIGURE 2. Same patient as in Figure 1. Orthoradial reconstruction based on transverse CT scans. Note the clearly defined OAF in the molar region on the left side.

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impossible without disrupting it. Another problem may be the location of OAFs along the roots of neighboring teeth, which are bound to be lost in the process.[16]

This study was designed to show the effectiveness of intra-oral bone grafts for closing OAFs, for providing a sound basis for subsequent conventional sinus lifting, and for preserving the teeth adjacent to OAFs.

Materials and Methods

Patients enrolled in this study had to fulfill 1 of the following criteria:

- OAF and planned sinus floor elevation;
- OAF along a neighboring root surface extending into the maxillary sinus and undesirable tooth extraction;
- Chronic OAF with multiple unsuccessful attempts at closure.

Surgery was planned on the basis of an OPG (Fig 1) and on axial dental computed tomography (CT) (Fig 2). Preoperatively, the affected sinus was irrigated through the fistula with physiologic saline solution followed by an iodine-containing solution diluted with physiologic saline (1:1; betadine; Purdue, Norwalk, CT) to control infection. This regimen was administered 3 times a week until the lavage fluid no longer contained inflammatory exudates.

Peri-operatively, all patients received amoxicillin and clavulanic acid (Augmentin; GlaxoSmithKline, Uxbridge, England), 1 g twice daily, or clindamycin (Dalacin C; Pharmacia & Upjohn, Vienna), 300 mg 3 times daily for at least 5 days, and a nasal decongestant (Otrivin 0.05%; Novartis Consumer Health-Gebro, Fieberbrunn).

SURGICAL PROCEDURE

Surgery was performed in local anesthesia (Ultracain Dental Forte 1:50,000 epinephrine; Avantis Pharma, Vienna). Bone blocks were harvested from the interforaminal or retromolar regions of the mandible using the techniques described in the literature.[17,18]

The basic principle of the surgical procedure lies in press-fitting monocortical block grafts into the bone defect to ensure primary stability.[19] For this purpose, ovoid defects (Fig 3) were trimmed to a standard shape with a trephine to obtain the smallest possible circular hole (Fig 4). Using a trephine (Fig 5) with an inner diameter matching that of the circular sinus floor defect, a monocortical block graft was harvested from the interforaminal or retromolar donor sites (Fig 6) and press-fitted into the defect (Fig 7). If the press-fit was unstable, miniplates or bone screws (Leibinger, Freiburg, Germany) were used for internal

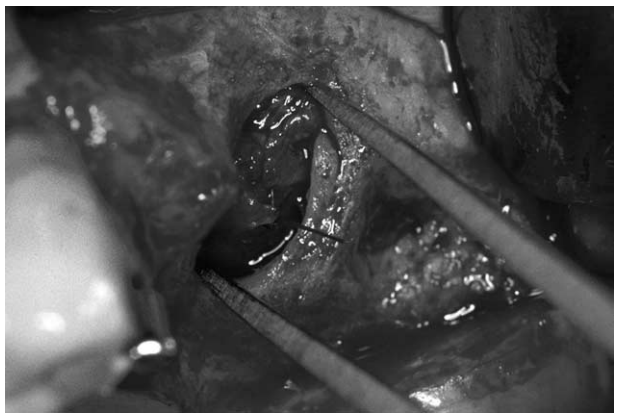

FIGURE 3. Intraoperative view of the bone defect in the molar region on the left side.

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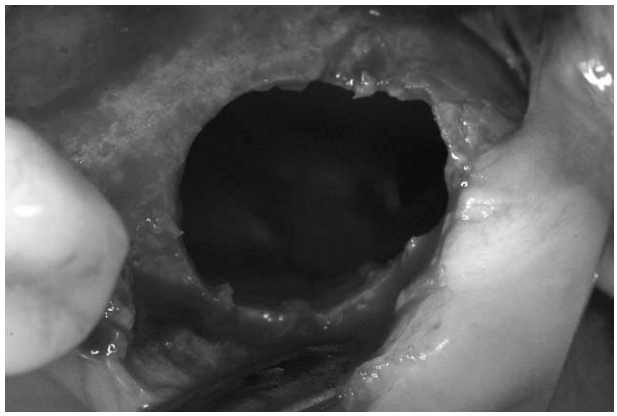

FIGURE 4. Bone defect in the molar region on the left side trimmed to standard size with a trephine (intraoperative view).

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fixation. Care was taken not to force the grafts into the sinus during graft placement. This never happened in any of the 21 patients reported here. A simple trick facilitating the surgical procedure and making it safer was applied in 1 case: two small holes were made in the center of the block graft and a thread was pulled through these to make sure that the graft did not fall into the sinus. After successful graft placement, the thread was removed without any problems. Soft tissue closure was obtained with a Rehrman flap.[8]

Patients were instructed to avoid strenuous physical activities that might raise the pressure within the paranasal sinuses until the sutures were drawn 1 week post surgery. The miniplates were removed at the time of the scheduled sinus lift (ie, 3 months after the bony closure of the oro-antral fistula).

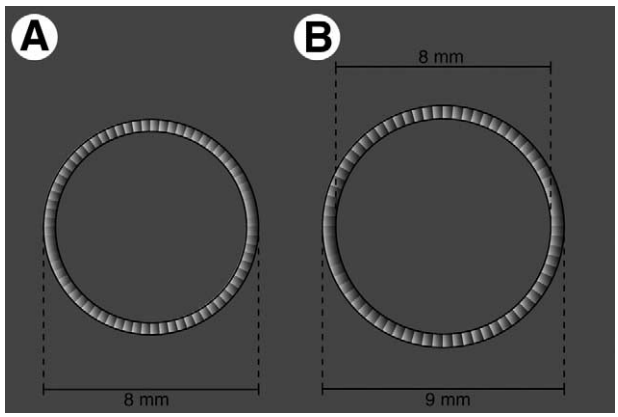

FIGURE 5. *A*, Graph illustrating trephine with outer diameter of 8 mm = diameter of bone defect trimmed to standard size. *B*, Graph illustrating trephine with outer diameter of 9 mm = inner diameter of 8 mm = diameter of bone graft (matching size of standard bone defect shown in *A*).

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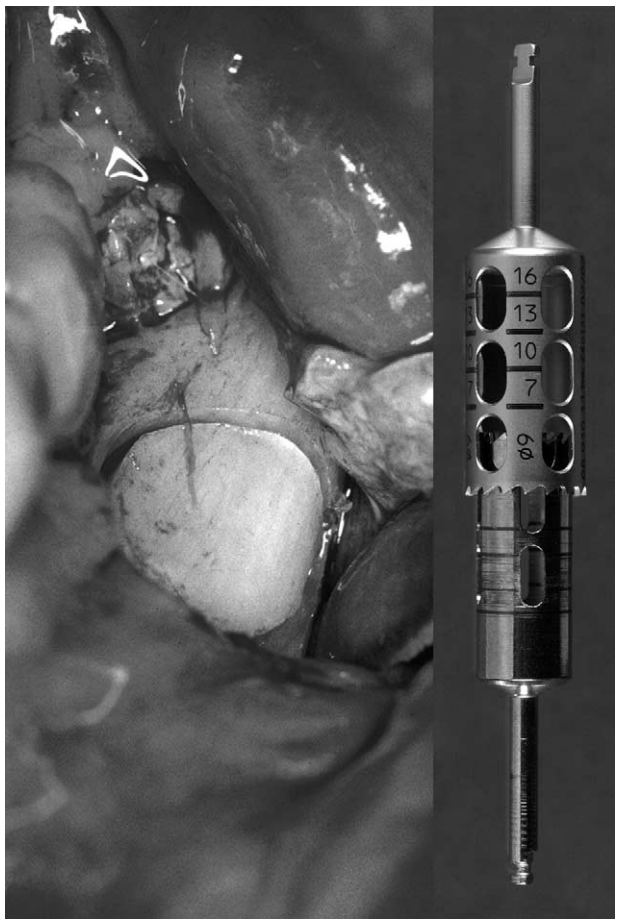

FIGURE 6. (*Left*) Intraoperative view of left retromolar donor site. (*Right*) Trephines of matching sizes.

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Six to 12 months after sinus closure, the sites were evaluated by CT to ascertain whether surgery had been successful (Fig 8).

Results

Twenty-one patients were treated with monocortical block grafts harvested at intra-oral donor sites. Mean age was 49.8 years (range, 32 to 73 years). The causes of OAFs, the defect sizes, and other characteristics are listed in Table 1. Tooth or implant removal in the region of the first or second molars was the most common underlying cause. Each patient with extraction-related fistulas had undergone 2 unsuccessful attempts at sinus closure with a buccal sliding flap. Five patients were candidates for 2-stage subantral sinus augmentation and implant placement after sinus closure. In 17 of the 21 patients, the bone grafts were harvested from the chin. In 4 patients the donor site was retromolar. The size of the defect varied in diameter between 4 and 12 mm (mean, 7.35 mm). In the

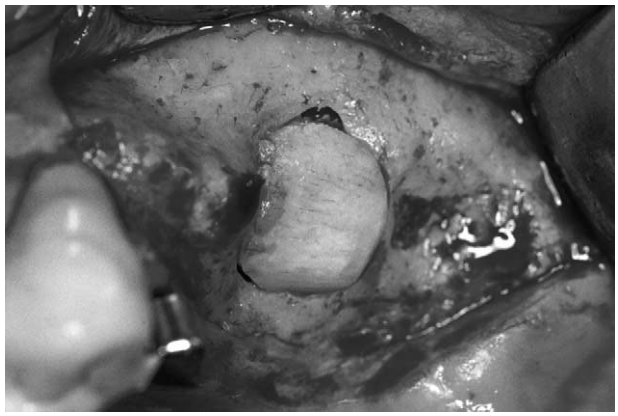

FIGURE 7. Intraoperative view showing press-fit of monocortical bone graft in the molar region on the left side.

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majority of cases (17 out of 21) a stable press-fit of the grafts in the bony maxillary defect was achieved. The remaining 4 patients needed additional internal fixation with miniplates (2 patients) or bone screws (2 patients).

In 3 patients, mucosal dehiscence developed 2 to 4 weeks post surgery. This necessitated superficial decortication of the bone graft with a round diamond bur to the point of bleeding. In addition, 3% hydrogen peroxide and Peruvian balm (resin extracted from the Myroxylon balsamum tree) were applied daily to combat bacteria (bactericidal action) and to promote wound healing. In all other patients, the postoperative course was uneventful.

Radiologically, bony union was verified 8 months after surgery, on average, by CT. In 3 patients scheduled for implant rehabilitation, sinus lifting was performed through a lateral window 3 months after bony sinus closure. At the time of sinus lifting, the sinus membrane overlying the original bone defect was intact. Neither membrane elevation nor augmentation caused any problems (Fig 9). Healing after successful sinus lifting was uneventful.

Discussion

If the sinus is uninfected at the time OACs develop post extraction and a normal blood clot forms within the socket, spontaneous closure is likely.[2] But according to Schuchardt,[20] spontaneous closure is jeopardized by soft tissue damage at the gingival margin, by perforations >4 mm in diameter and a socket depth <5 mm. This agrees well with the findings of the present study, which showed diameters varying between 4 mm (smallest size) and 12 mm. If the communication fails to close spontaneously, it remains patent and is epithelialized so that an OAF develops.[2] To avoid problems secondary to OACs (eg, infection of the sinus), surgical closure is advisable within the first 48 hours.[11,12] For closing small or moderately sized defects the buccal flap technique has been used most commonly. Because of the absence of a bony base, its variable success rate is no better than 84%.[21] The success rate of secondary closure was reported to be no more than 67%.[11,12] Along with modifications of existing techniques for soft tissue closure,[13] bone autografts were recommended in the literature for closing OAFs.[14,15] Although using part of the bone from the extraction socket, interseptal alveoplasty reported by Minoru et al[22] is of limited usefulness for communications between teeth because of the lack of space. Moreover, it requires a residual alveolar process of adequate height and an intact buccal cortical layer. Sinus closure with bone grafts harvested from the iliac crest as reported by Proctor[14] is an attractive option. It should, however, be reserved for large defects because of the known morbidity inherent in it.[23] The demands it makes on the patients can be substantially reduced by harvesting grafts at intra-oral donor sites.[17,18] Therefore, Haas et al[15] proposed press-fitting monocortical block grafts harvested intra-orally for closing OAFs. In their preliminary report, 5 patients were successfully treated with this technique. In the present study of 21 patients, secondary closure was achieved with congruently fitting block grafts. If press fitting was not possible, the bone blocks were fixed with miniplates or bone screws (4 patients). Phillips and Rahn[24] found grafted membranous bone to be more extensively revascularized if fixed. Maximal rigid fixation may be 1 reason for the high success rate of the technique in the present study. "Threading" the block grafts on a suture for greater safety as described did not have any negative effects on graft

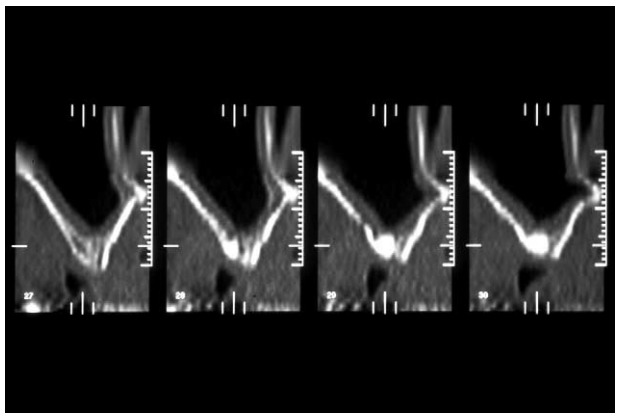

FIGURE 8. Orthoradial reconstruction based on transverse CT scans of the left molar region showing graft healing 8 months postoperatively.

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Table 1. OVERVIEW OF CLINICAL DATA OF PATIENTS INCLUDED IN THIS STUDY

Patient No.	Age (yrs)	Duration of OAF (mos)	Cause of OAF	Site of OAF	Indication	Donor Site	Defect Size (in mm)	Graft Fixation
1	48	1	Extraction	Left side-1M	Chron. OAF	Chin	5 mm	Press-fit
2	46	1	Extraction	Left side-1M	Chron. OAF	Ramus	4 mm	Press-fit
3	60	2	Extraction	Right side-1PM	Chron. OAF	Chin	4 mm	Press-fit
4	44	4	Explantation	Right side-1 PM, 2PM, 1M	Chron. OAF Sinus lift	Chin	10 mm	Miniplate
5	32	3	Extraction	Right side-2M, 3M	Chron. OAF along root 16	Chin	9 mm	Press-fit
6	43	2	Explantation	Left side-1M	Chron. OAF Sinus lift	Chin	7 mm	Bone screw
7	48	3	Extraction	Right side-1PM Left side-1PM, 1M	Chron. OAF	Chin	8 mm (1PM) 5 mm (1PM) 5 mm (1M)	Miniplate
8	47	4	Extraction	Left side-1M	Chron. OAF Sinus lift	Ramus	8 mm	Press-fit
9	46	3	Extraction	Left side-2M	Chron. OAF	Ramus	6 mm	Press-fit
10	35	12	Extraction	Left side-2M	Chron. OAF	Chin	9 mm	Press-fit
11	45	0	Explantation	Right side-2PM, 2M Left side-1PM	Bone defect during expl.	Chin	8 mm (2PM) 6 mm (2M) 6 mm (1PM)	Miniplate
12	49	120	Extraction	Left side-canine, 2M	Chron. OAF	Chin	8 mm (canine) 12 mm (2M)	Press-fit
13	61	26	Extraction	Left side-1M	Chron. OAF	Chin	10 mm	Press-fit
14	56	132	Extraction	Left side-2M	Chron. OAF	Chin	9 mm	Press-fit
15	47	120	Extraction	Right side-1M	Chron. OAF	Chin	8 mm	Press-fit
16	58	18	Extraction	Left side-1M	Chron. OAF	Chin	10 mm	Press-fit
17	70	2	Extraction	Left side-2PM	Chron. OAF	Ramus	4 mm	Press-fit
18	73	4	Extraction	Right side-2M	Chron. OAF	Chin	7 mm	Press-fit
19	41	2	Extraction	Left side-1M	Chron. OAF	Chin	9 mm	Press-fit
20	42	9	Extraction	Right side-1M	Chron. OAF	Chin	6 mm	Press-fit
21	54	6	Explantation	Right side-1M	Chron. OAF	Chin	8 mm	Bone screw

Abbreviations: OAF, oro-antral fistula; PM, premolar; M, molar; Extraction, tooth removal; Explantation, implant removal.

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healing. Although 3 patients (14.3%) developed wound dehiscences at the recipient site, which is in keeping with the complication rates reported for other procedures,[25] these did not result in re-opening of the sinus. Minoru et al[22] claimed that their technique offered the added advantage of facilitating spontaneous postoperative healing of the soft tissue, which is supported by the bony base. In the present study, wound dehiscences caused marginal problems. Healing by secondary intention and a success rate close to 100% for OAF closure were, nevertheless, attained. Recontouring of the maxillary sinus is an added benefit. For internal grafting of the maxilla, the sinus membrane should be intact without any signs of inflammation. Chronic OAFs usually cause severe chronic inflammatory thickening of the sinus membrane and thus rule out sinus lifting. Solitary soft tissue closure of OAFs before implant surgery carries a high risk of mucosal injury during augmentation because of the adhesion of the oral mucosa to the Schneiderian membrane. In the present study, sinus closure with bone grafts harvested from intra-oral donor sites paved the way for subsequent conventional sinus lifting, which was successfully completed in 3 patients. In addition, harvesting the grafts at intra-oral donor sites rather than from the iliac crest reduced the demands made on the patients.

The location of OAFs along the roots of neighboring teeth may be a problem after solitary soft tissue closure. While mucoperiosteal flaps may reattach to exposed cervices, relapses are quite common.[16] Salvage of the teeth adjacent to the communication by restoring the bony sheath around the exposed root surfaces is yet another advantage of the press-fit technique. Thanks to this advantage, the first right molar of patient no. 5 was saved. Because there was only 1 patient with this kind of OAF in the present study, further research is needed to shed light on this special aspect.

One limiting factor of the technique may be the amount of bone available intra-orally. Therefore, it is important to identify the largest diameter of the bone defect on preoperative CT scans and to decide (clin-

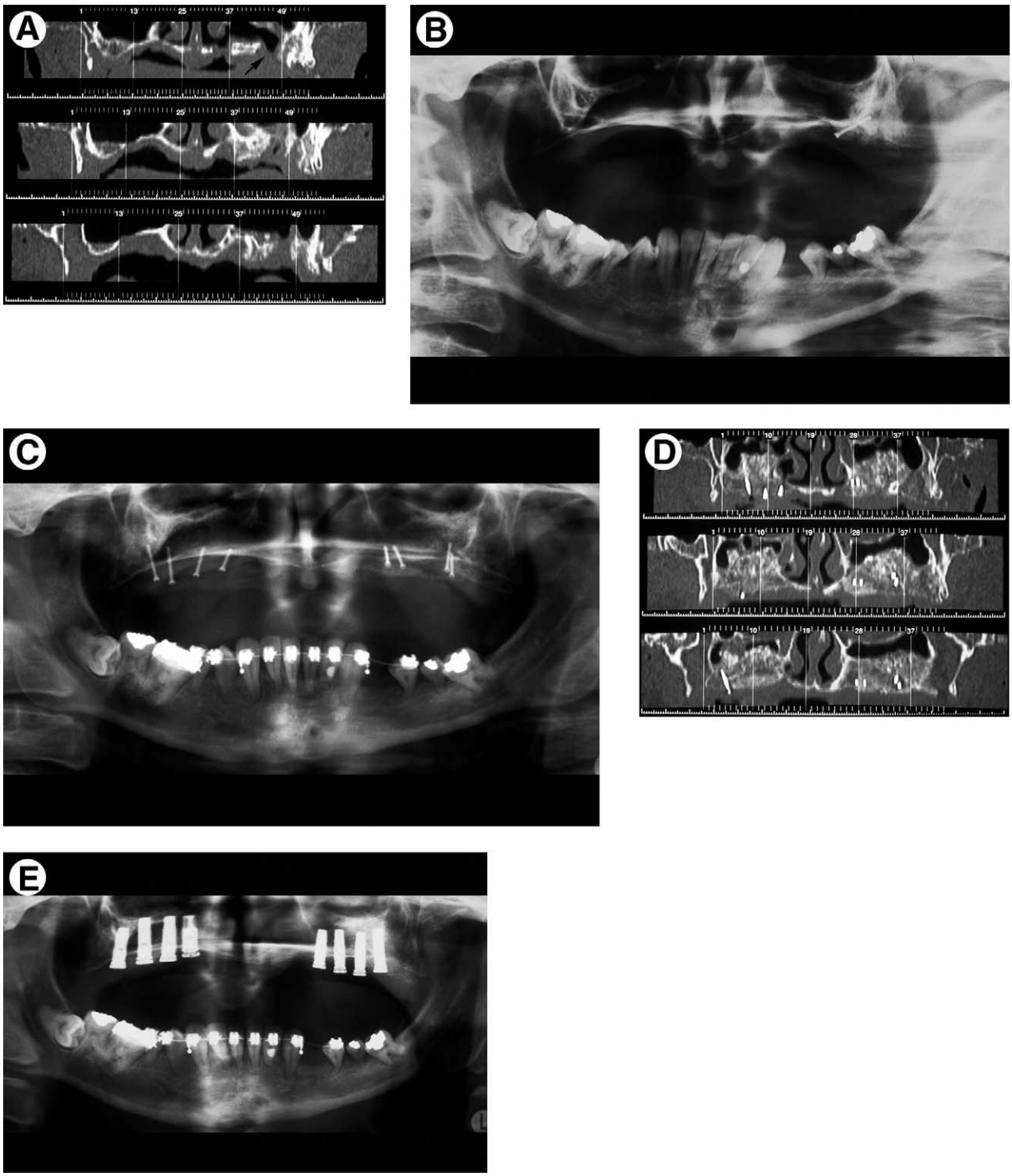

FIGURE 9. *A*, CT scans showing clearly defined OAF (*arrow*). *B*, OPG after surgical closure of OAF with monocortical bone graft. Note bone screw for internal graft fixation. *C*, OPG after sinus lifting and lateral grafting with bone autograft from iliac crest. *D*, CT scans after sinus lifting and lateral grafting with bone autograft from iliac crest. Note clear sterile sinus. *E*, OPG after placement of 8 implants in the posterior maxilla bilaterally.

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ically and/or radiologically) whether the chin or the retromolar regions are adequate donor sites. Sometimes it is impossible to get a block graft of suitable size because of the proximity to sensitive anatomic structures (root apices, mental nerve, mandibular margin) or because of an insufficient retromolar shelf.[26,27] In these cases it is inevitable to consider extra-oral donor sites (eg, the iliac crest) for graft

harvesting. Although the grafts were exposed to the external (sinus cavity) environment, the question is why no problems were encountered. In orthognathic surgery bone grafts are frequently placed in regions without mucosal coverage on the sinus side. These are usually not lost and do not cause major problems.[28] Large perforations of the sinus mucosa during sinus lifting may require the placement of block grafts, which are not covered by Schneiderian membrane. However, this does not mean that the grafts are lost.[28]

In conclusion, the regeneration of the bony support of soft tissue flaps is an alternative treatment option for OAFs, especially if secondary closure is required. It provides a sound basis for subsequent conventional sinus lifting and preserves the teeth adjacent to OAFs.

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