Localized Management of Sinus Floor With Simultaneous Implant Placement: A Clinical Report

Giovanni B. Bruschi, MD, DDS*/Agostino Scipioni, MD, DDS*/
Gaetano Calesini, MD, DDS*/Ernesto Bruschi, DDS*

Localized management of sinus floor (LMSF) achieves implant placement and sinus lifting simultaneously. LMSF is a further application of the principles of the edentulous ridge expansion (ERE) technique. It comprises the dissection of a partial-thickness flap, the buccal expansion of the residual alveolar bone, and the fracture and elevation of the sinus floor with simultaneous implant placement. Three hundred three patients were treated with 499 implants placed using the LMSF between April 1988 and December 1993. The selected patients, who showed no signs of sinus pathology, exhibited insufficient vertical alveolar bone dimensions for the placement of dental implants with the traditional technique. The minimal residual alveolar bone height was between 5 and 7 mm. Based on the criteria established by Albrektsson and his coworkers in 1986, the success rate of the 499 implants placed with the LMSF was 97.5%.
(INT J ORAL MAXILLOFAC IMPLANTS 1998;13:219–226)

Key words: edentulous ridge expansion, osseointegration, sinus elevation

Osseointegrated dental implant therapy initially was indicated only for completely edentulous patients,[1,2] but more recently it has also been used in partially edentulous patients.[3–6] Treatment of completely and partially edentulous patients with osseointegrated implants differs significantly: in completely edentulous patients, implants placed only in the anterior segments of the mandibular and maxillary arches can provide sufficient support for either a removable or a fixed prosthesis; however, in partially edentulous patients, clinicians frequently are confronted with anatomic variations of the premolar and molar areas, one of which is the maxillary sinus. Periodontal diseases frequently cause the loss of maxillary molars with local resorption of the alveolar bone; and in patients with a large maxillary sinus, bone dimensions often are inadequate for the placement of properly proportioned implants.

It is also important to consider the magnitude of occlusal forces in the posterior segments of the dental arch in relation to implant support. Molars are multirooted teeth with large occlusal surfaces and an anatomy that is specifically designed for masticatory function. In a well-designed treatment plan, if these teeth have to be replaced with osseointegrated implant-supported prostheses, the clinician must consider the possibility or necessity of replacing the teeth with relatively large implants.

The successful placement of implants in the posterior maxillary arch of partially edentulous patients is advantageous clinically because it is the ideal way to resolve the prosthetic problems related to this type of condition. This is especially true for dental arches with class I and II of the Applegate-Kennedy classification in patients who wear removable partial prostheses.

A variety of bone augmentation procedures have been used to create sufficient bone support for properly proportioned osseointegrated implants in the posterior segments of the maxillary arch. One of these is the "sinus lift" procedure, consisting of localized bone grafting on the alveolar ridge.[7–9] Kahnberg et al[8] reported bone graft exposure, and the resulting loss of a graft portion, during the healing phase in 30% of the patients treated with this technique. In addition, it has been reported that 8 to 14% of the implants are lost prior to loading and 26% are lost

*Private Practice, Rome, Italy.

Reprint requests: *Dr Giovanni B. Bruschi, Via di Porta Pinciana 4, 00187 Rome, Italy. E-mail: bsc@exhibit.it*

during the first 5 years.[8,9] Boyne and James[10] and Brånemark et al[11] reported the formation of bone around the apical portion of implants placed by carefully raising the Schneiderian membrane, provided the occlusal portion of the implant has integrated with crestal bone. Nonetheless, the failure rate remains around 70% during the first 5 to 10 years of prosthetic loading. Tatum[12] proposed a modification of the Caldwell-Luc procedure, which involved a long healing time. Misch[13] suggested combining implant placement and sinus lift in a single surgical procedure. Sindet-Pedersen and Enemark[14] proposed the use of intramembranous bone as graft material. Hirsch & Ericsson[15] reported the use of mandibular bone grafts.

Localized management of the sinus floor (LMSF) is a reliable solution to the problems described above. In a single surgery, the procedure combines elevation of the maxillary sinus floor, buccal expansion of the residual alveolar bone, and implant placement. As in the edentulous ridge expansion (ERE) technique,[16–18] bone regeneration and implant osseointegration occur simultaneously.

The basis for the LMSF approach is the careful fracture of the sinus floor cortex, which induces advantageous peri-implant osteogenesis. Moreover, as previously mentioned, the LMSF involves simultaneous horizontal bone regeneration according to the principles of the ERE technique. Both the LMSF and the ERE techniques can usually be performed in a single surgical stage. Compared to multiple-stage procedures, healing times are, of course, much reduced.

The LMSF allows osseointegration of implants that far exceed the preoperative bone dimensions in length and caliber. Moreover, as in the ERE technique, buccal bone regeneration in LMSF facilitates the achievement of an optimal implant position with respect to occlusal forces.

Materials and Methods

Using LMSF, 499 implants (317 IMZ and 182 Frialit 2; Friatec AG, Mannheim, Germany) were placed in 303 patients between April 1988 and December 1993. Based on periapical radiographs produced with the paralleling technique and/or computed tomography (CT) scans, the minimal residual alveolar bone height was judged to be between 5 and 7 mm. All 499 implants included in this work were placed using the LMSF protocol in edentulous areas of the posterior maxillary arch that were not suitable for traditional implant surgery without some form of bone augmentation procedure because of the proximity of the sinus floor. All patients included in this study were edentulous in one or both maxillary posterior segments (Applegate-Kennedy classes I, II, and III). Patients were informed of the possibility of a higher-than-normal risk of failure before submitting written consent to proceed. All patients received annual radiographic evaluations according to the protocols established by Albrektsson et al.[19]

Preoperative Evaluation. Various authors have suggested that deep periodontal pockets may act as a reservoir for bacteria that may infect implant sites.[20–22] Accordingly, any periodontal infections were resolved before the initiation of implant surgery. All signs and symptoms of sinus inflammation or infection also were resolved prior to implant surgery.

Surgical Protocol. Local Xylocaine anesthesia (Astra, Milan, Italy) was used on all patients. All were premedicated with a nonsteroidal anti-inflammatory drug (Naprosyn, 1.5 g; Recordati, Milan, Italy) and an antimicrobial agent (Ciproxin, 1 g; Bayer, Milan, Italy) 1 hour before surgery. Antibacterial and anti-inflammatory medication were continued for 3 to 4 days after surgery.

The surgical procedure of LMSF is an advanced application of the previously reported ERE technique.[16–18] The distance between the ridge crest and the floor of the sinus is measured on a periapical radiograph produced with the paralleling technique (Fig 1). The implant site is exposed via a modified superimposed[23] partial-thickness flap. The first incision starts on the palatal surface of the masticatory mucosa with a long bevel that extends buccally within the suprabony connective tissue and continues over the edentulous crest and towards the fornix. The second incision is complementary to the first; it begins on the buccal border of the bevel and continues within the connective tissue on the palatal aspect of the ridge (Fig 2).

A vertical fissure is opened within and through the residual alveolar bone with a No. 64 Beaver blade (Becton Dickinson Acute Care, Franklin Lakes, NJ) (Fig 3). The incision is drawn along the crest of the ridge (covered by preserved suprabony soft tissue, including the periosteum and its vasculature), through cortex and spongiosa, and towards the floor of the maxillary antrum.

The buccal wall of the intra-alveolar fissure (consisting of the preserved suprabony connective tissue and compact and cancellous bone—ie, a sort of "bone flap"—for a minimum overall thickness of 1.0 to 1.5 mm) is carefully displaced buccally, while simultaneously the intrabony fissure is deepened to within 0.5 to 1.0 mm of the sinus floor. The crestal distraction corresponds to a small rotation around the basal bone. The result is creation of a new space within the cancellous bone of the residual alveolar crest (Fig 4).

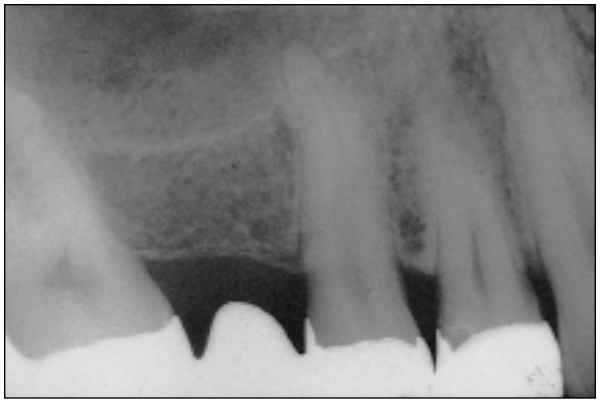

Fig 1 Case A. The distance between the ridge crest and the floor of the sinus is measured on a preoperative periapical radiograph produced with the paralleling technique. For this patient, the treatment plan prescribes the placement of an implant in the position of the first molar. Four months later, the third molar will be extracted and the second molar uprighted.

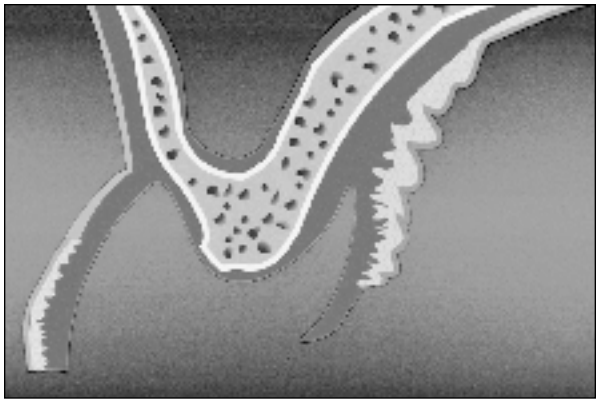

Fig 2 Illustration depicting the exposure of the implant site with a modified superimposed partial-thickness flap. The first incision starts on the palatal surface of the masticatory mucosa with a long bevel that extends buccally within the suprabony connective tissue and continues over the edentulous crest and towards the fornix. The second incision begins on the buccal border of the bevel and continues within the connective tissue on the palatal aspect of the ridge.

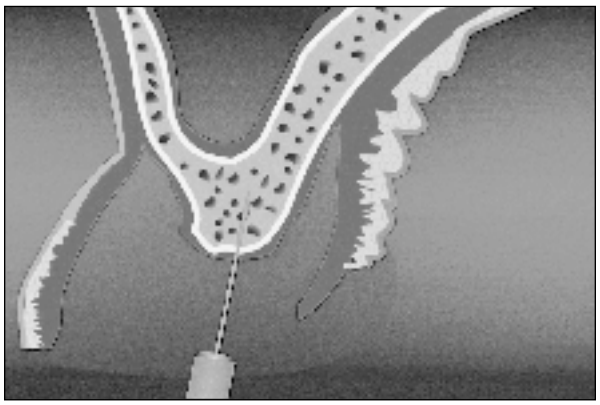

Fig 3 An intrabony fissure is carved within the bone crest with a No. 64 Beaver blade, and it is deepened almost to the level of the maxillary sinus floor.

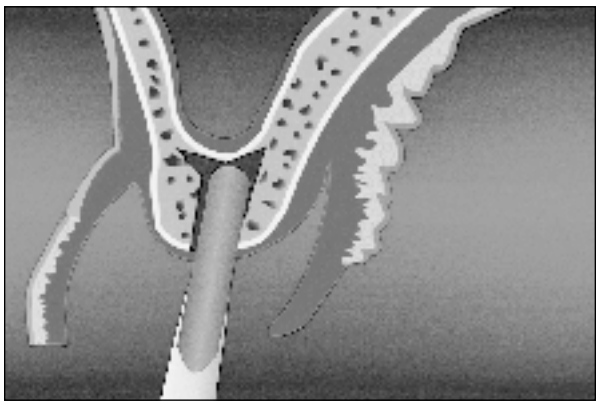

Fig 4 A Heidbrink root elevator (Hu-Friedy, Chicago, IL) is used to enlarge the intrabony fissure. The careful rotation of the elevator's tip within the bone groove obtains the initial horizontal expansion of the crest by displacing the buccal wall of the intrabony fissure, which is simultaneously deepened to within 0.5 to 1.0 mm of the sinus floor.

Up to this stage, the LMSF corresponds to the ERE technique, since a new horizontal intrabony space (buccal ridge expansion) is created but does not disturb the sinus floor. The implant bed is created with a series of round end probes, with diameters of 2.5, 3.3, and 4.0 mm. Surgical burs are avoided because they are too destructive for the delicate bone involved. The 2.5-mm probe is gently tapped with a surgical mallet to compress the remaining 1.0 to 0.5 mm of bone against the cortex of the maxillary antrum. This procedure continues with the 3.3- and 4.0-mm probes. The force applied must always be proportioned to the bone's resistance. The force used then increases progressively until an initial fracture of the sinus floor, with minimal or no displacement, is obtained (Fig 5). Very delicate, careful tapping is now used to displace the complex of Schneiderian membrane and cortical and pericortical osseous tissue into the sinus cavity. These structures are considered potential sources of osteogenetic cells, and consequently their integrity must be preserved while they are displaced.

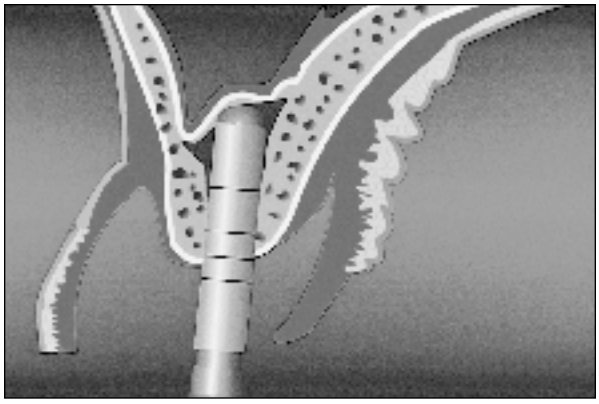

Fig 5 The implant bed is created with a series of round end probes, with diameters of 2.5, 3.3, and 4.0 mm. The 2.5-mm probe is gently tapped with a surgical mallet to compress the remaining 0.5 to 1.0 mm of bone against the cortex of the maxillary antrum. This procedure continues with the 3.3- and 4.0-mm probes, and the force used increases progressively until an initial fracture of the sinus floor, with minimal or no displacement, is obtained.

Fig 6 The planned implant is tapped into position in the space obtained with the probes. The red substance around the basal portion of the implant represents a collagen sheet.

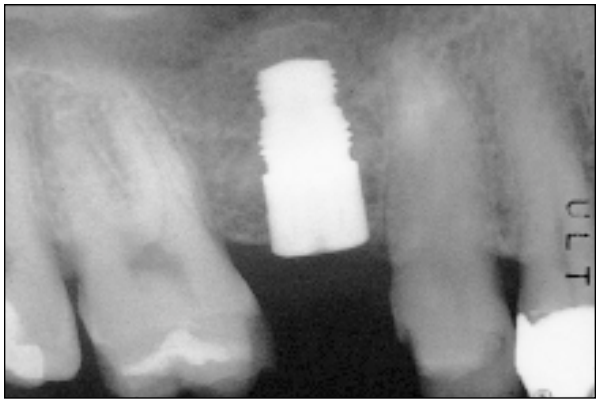

Fig 7 Case A. Postoperative periapical radiograph produced with the paralleling technique immediately after the placement of a 10 × 5.5 mm Frialit-2 implant with LMSF. The shadow of the fractured sinus floor can be seen above the implant.

Once the space obtained with the probes is sufficient for the planned implant(s), a 1 × 1 cm collagen sheet is placed in the implant bed and pushed against the vault. The implant is then tapped into position (Figs 6 and 7).

In addition to having limited crestal height, most patients also exhibited inadequate palatobuccal dimensions of the crestal bone (Figs 8 and 9) and thus required horizontal expansion to accommodate the proposed implants (Figs 10 and 11). Primary stability was not a problem. The bone plates and their covering soft tissues retained elasticity, and therefore closed back on the implant(s), locking them into position. Screw-shaped implants placed with this technique must be tapped into position.

The net result is the creation of new horizontal and vertical intraosseous spaces for the implants, with complete preservation of the original bone. The horizontal expansion corresponds, as indicated above, to the buccal displacement of the vestibular cortical plate, which has already been proved successful in the ERE technique.[17,18] The combination of the horizontal and vertical augmentation of the implant bed, the distinctive characteristic of LMSF, is thus owed to the sinus cavity, within which the complex of cancellous and cortical bone, periosteum, and respiratory mucosa lining is displaced.

Postoperative Treatment. Ciproxin (1 g/day) and Naprosyn (1.5 g/day) were continued postoperatively for 3 to 4 days. Sutures were removed after 1 week. Removable prostheses were always adapted postoperatively to the enlarged ridge morphology by removing the vestibular portion of the acrylic resin, but patients were also discouraged from using them for the first 1 to 2 weeks. After this initial period, the tissue-bearing surfaces were rebased with a soft lining material, avoiding any pressure in the emerging implant zone(s). Stage-two surgery was invariably performed 4 months after implant placement. A heat-cured acrylic resin temporary prosthesis was then fabricated and worn for at least 3 to 5 months. All patients were followed with annual radiographic evaluations (Figs 12 and 13).

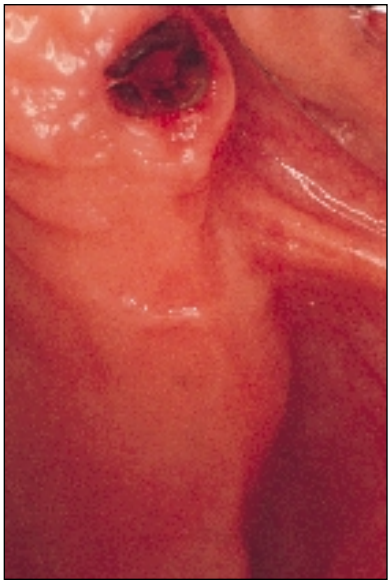

Fig 8 Case B. Clinical photograph showing the appearance of the edentulous ridge of the right maxilla before surgery.

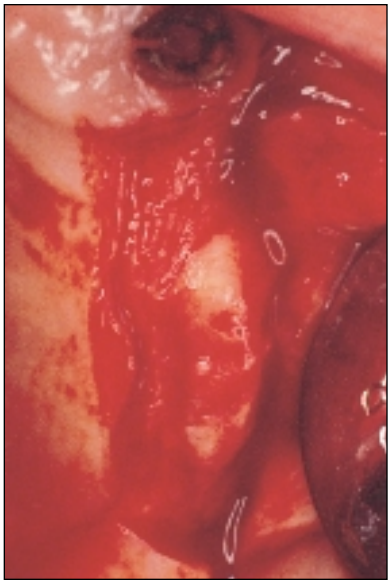

Fig 9 Case B. Exposure of the crest with the modified superimposed partial-thickness flap. Note generalized buccolingual resorption of the crest and marked concave defect distal to the canine.

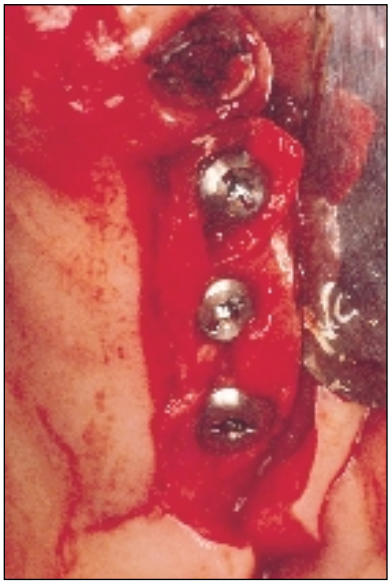

Fig 10 Case B. The implants as they appear immediately after placement with LMSF. The displacement of the "bone flap," which is kept open by the implants, results in immediate horizontal expansion of the crest and simultaneous correction of the concave defect distal to the canine.

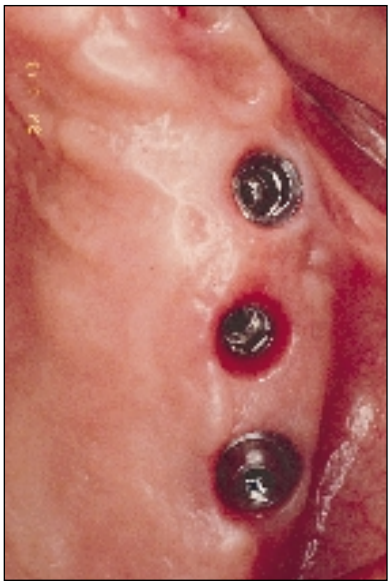

Fig 11 Case B. Clinical photograph of the crest 10 months after placement of the implants with LMSF. Compared to Fig 8, the magnitude of horizontal ridge expansion obtained is visible.

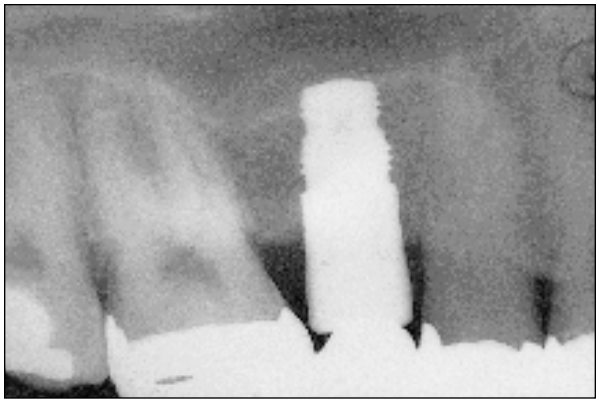

Fig 12 Case A. Periapical radiograph produced with the paralleling technique at the time of stage-two surgery, performed as usual 4 months later. The modified profile or the cortical bone lining the floor of the maxillary sinus can be identified above the implant. The transformation is evident when this radiograph is compared with Fig 1, using the apex of the second bicuspid as a reference point.

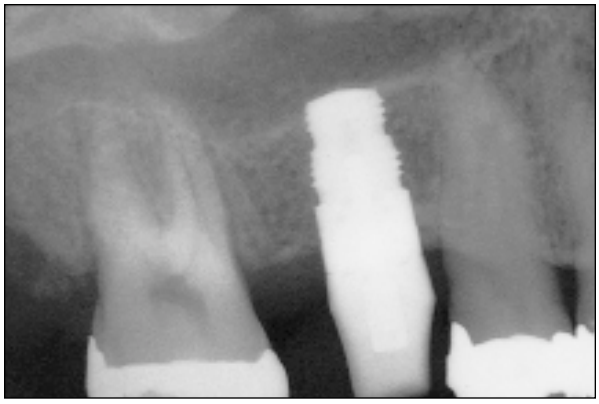

Fig 13 Case A. Two-year follow-up radiograph. The uprighting of the second molar was accomplished over a period of 50 days by increasing weekly the intensity of the distal contact point on an acrylic resin temporary crown supported by the implant.

Table 1a Annual Numbers of Patients Treated and Failures Recorded for the IMZ Implants Placed With LMSF Between 1988 and 1993

Year	No. of implants	No. of patients	No. of failed implants
1988	18	14	0
1989	32	22	0
1990	62	42	0
1991	91	56	1
1992	75	45	3
1993	39	20	2
Total	317	199	6

Table 1b Sex and Age Distribution of Patients Treated With IMZ Implants Placed With LMSF Between 1988 and 1993

Sex	Percent	Mean age (y)
Female	69.3	52
Male	30.7	48

Table 2a Annual Numbers of Patients Treated and Failures Recorded for the Frialit-2 Implants Placed With LMSF Between 1992 and 1993

Year	No. of implants	No. of patients	No. of failed implants
1992	52	32	4
1993	130	72	2
Total	182	104	6

Table 2b Sex and Age Distribution of Patients Treated With Frialit-2 Implants Placed With LMSF Between 1992 and 1993

Sex	Percent	Mean age (y)
Female	65.3	49
Male	34.7	52

Results

The results are summarized in Tables 1a and 1b for IMZ implants and in Tables 2a and 2b for Frialit-2 implants. The standard of success for implant function established by Albrektsson et al[19] was applied. Overall, in the period considered, 303 patients received 499 implants. The success rate was 97.5%. The most recent implants included in this report were functionally loaded for more than 24 months. The earliest implants were loaded for at least 5 years.

Discussion

The failure in 1991 occurred in a patient who received a total of three implants and lost all of them. One was placed using the LMSF technique and is therefore included in the data of this report; the other two were placed using a traditional procedure. The adequately supported implants failed along with the one placed using LMSF, suggesting the possible presence of an underlying organic condition that interfered with the healing process.

It is interesting to note that the three failures recorded in 1992 also occurred in a single patient. This patient wore a maxillary removable prosthesis that was anchored with clasps to the surviving teeth. Thus, it was difficult to control the pressure on the underlying implants. Although they were considered failures in this study, these implants were replaced (after modifying the prosthesis) with two new implants, which are now functioning well.

Many other techniques have been proposed to resolve the lack of adequate bone support for implants in the maxillary posterior area. However, all of these are invasive, disrupt the normal anatomic relationships of the structures of this area, rely on the placement of foreign substances into the sinus cavity, and sometimes involve membrane-guided healing (which may promote complications during the healing phase).

The LMSF procedure, when properly performed, uses only natural healing potential, is simple, and, in practice, well tolerated. Four patients experienced minor nasal bleeding, which disappeared within the first 24 to 48 hours. This was the only postoperative complication experienced.

Primary stability is achieved when implants are tapped into place, because the maxillary cortical and cancellous bone, covered by the preserved periosseous connective tissues, is elastic and closes back on the implants to become tightly adapted to their surfaces.

Radiographic analysis of the successful implants showed that an increase of 3 to 7 mm of available bone is possible with this procedure.

Conclusions

With the LMSF, it is possible to expand the dimensions of resorbed posterior maxillary alveolar bone both vertically and horizontally. In addition, the LMSF offers reliable (97.5% success) implant osseointegration within the expanded bone plates. Moreover, the implant can be large enough to replace the lost maxillary molars and is therefore capable of sustaining the heavy occlusal forces characteristic of this area.

The 7-year observation period of 497 implants in 302 patients confirms the reliability of the LMSF. Furthermore, when implant failure occurred, as in one patient with peri-implantitis, the regenerated apical bone was preserved even after years of occlusal function. With the LMSF, it is possible to adopt the use of implant therapy for a wider range of edentulous patients. The LMSF permits the placement of relatively large implants in sites that are normally considered inappropriate for implant therapy. It allows the replacement of maxillary multirooted teeth with appropriately large implants seated in an anatomically proper position. In fact, buccal expansion of the alveolar crest also shifts the position of the implant(s) towards a more ideal prosthetic site and improved occlusal relation. The LMSF combines bone regeneration and osseointegration in a single procedure.

Acknowledgments

The authors wish to acknowledge the editorial assistance of Dr David R. Leidner at various stages in the preparation of this manuscript.

References

1. Adell R, Lekholm U, Rockler B, Brånemark P-I. A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. J Oral Surg 1981;10:387–416.
2. Adell R, Eriksson B, Lekholm U, Brånemark P-I, Jemt T. A long-term follow-up study of osseointegrated implants in the treatment of the totally edentulous jaw. Int J Oral Maxillofac Implants 1990;5:347–359.
3. Ericsson I, Lekholm U, Brånemark P-I, Lindhe J, Glantz P-O, Nyman S. A clinical evaluation of fixed bridge restorations supported by the combination of teeth and osseointegrated titanium implants. J Clin Periodontol 1986;13:307–312.
4. Ericsson I, Glantz P-O, Brånemark P-I. Use of implants in restorative therapy in patients with reduced periodontal tissue support. Quintessence Int 1988;19:801–807.
5. Jemt T, Lekholm U, Adell R. Osseointegrated implants in the treatment of partially edentulous patients: A preliminary study on 876 consecutively placed fixtures. Int J Oral Maxillofac Implants 1989;4:211–217.
6. van Steenberghe D, Lekholm U, Bolender C, Folmer T, Henry P, Hermann I, et al. The applicability of osseointegrated implants in the rehabilitation of partial edentulism: A prospective multicenter study of 558 fixtures. Int J Oral Maxillofac Implants 1992;5:272–281.
7. Breine U, Brånemark P-I. Reconstruction of alveolar jaw bone. An experimental and clinical study of immediate and preformed autologous bone grafts in combination with osseointegrated implants. Scand J Plast Reconstr Surg 1980;14:23–48.
8. Kahnberg KE, Nystrom E, Bardtholdsson L. Combined use of bone grafts and Brånemark fixtures in the treatment of severely resorbed maxillae. Int J Oral Maxillofac Implants 1989;4:297–304.
9. Adell R, Lekholm U, Gröndahl K, Brånemark P-I, Lindström J, Jacobsson M. Reconstruction of severely resorbed edentulous maxillae using fixtures in immediate autogenous bone grafts. Int J Oral Maxillofac Implants 1990;5:233–246.

10. Boyne JP, James RA. Grafting of the maxillary sinus floor with autogenous marrow and bone. J Oral Surg 1980;15:265–281.
11. Brånemark P-I, Adell R, Albrektsson T, Lekholm U, Lindström J, Rockler B. An experimental and clinical study of osseointegrated implants penetrating the nasal cavity and maxillary sinus. J Oral Maxillofac Surg 1984;42:497–505.
12. Tatum H. Maxillary and sinus implant reconstruction. Dent Clin North Am 1986;30:207–229.
13. Misch CE. Maxillary sinus augmentation for endosteal implants: Organized alternative treatment plans. Int J Oral Implantol 1987;4:49–58.
14. Sindet-Pedersen S, Enemark H. Reconstruction of alveolar clefts with mandibular or iliac bone grafts. J Oral Maxillofac Surg 1990;48:554–558.
15. Hirsch JM, Ericsson I. Maxillary sinus augmentation using mandibular bone grafts and simultaneous installation of implants. A surgical technique. Clin Oral Implants Res 1991;2:91–96.
16. Bruschi GB, Scipioni A. Alveolar augmentation: New applications for implants. In: Heimke G (ed). Osseointegrated Implants, vol 2. Boca Raton: CRC Press, 1990:35–61.
17. Scipioni A, Bruschi GB, Calesini G. The edentulous ridge expansion technique: A five-year study. Int J Periodont Rest Dent 1994;14:451–459.
18. Scipioni A, Bruschi GB, Giargia M, Berglundh T, Lindhe J. Healing at implants with and without primary bone contact. Clin Oral Implants Res 1997;8:39–47.
19. Albrektsson T, Zarb G, Worthington P, Eriksson AR. The long-term efficacy of currently used dental implants: A review and proposed criteria of success. Int J Oral Maxillofac Implants 1986;1:11–25.
20. Apse P, Ellen RP, Overall CM, Zarb CA. Microbiota and crevicular fluid collagenase activity in the osseointegrated dental implant sulcus: A comparison of sites in edentulous and partially edentulous patients. J Periodont Res 1989;24:96–105.
21. Haanaes HR. Implants and infections with special reference to oral bacteria. J Clin Periodont 1990;17:516–524.
22. Quirinen M, Listgarten MA. The distribution of bacterial morphotypes around implants ad modum Brånemark. Clin Oral Implants Res 1990;1:8–12.
23. Langer B, Langer L. The superimposed flap: Modification of the surgical technique for implant insertion. Int J Periodont Rest Dent 1990;10:208–215.