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A New Method of Inserting Endosseous Implants in Totally Atrophic Maxillae*

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Summary

A new method is described (*Sailer,* 1988) whereby endosseous implants are inserted in the totally atrophic maxilla, the intermaxillary relationship and vertical dimension corrected and a vestibuloplasty performed during one surgical procedure. The method can also be used to treat minor degrees of maxillary alveolar atrophy. The procedure enables 20 mm-long Titanium screws to be used in totally atrophic maxillae. The following surgical procedures are carried out during one operation: A Le Fort I osteotomy, removal of the mucous membrane of the sinus floor, obturation of the denuded maxillary sinus floor by autologous bone grafts from the iliac crest, simultaneous insertion of Titanium screws, fixation of the down-fractured maxilla by miniplates, and a modified submucous vestibuloplasty. Intermaxillary relationship and vertical dimension can be normalized, and the aesthetic results are excellent. To date 35 implants of which none has been lost, have been placed in 5 patients.

Key words

Endosseous implants (Brånemark fixtures) – Atrophy of maxilla – Le Fort I-osteotomy – Bone grafts – Miniplate fixation of maxilla

Introduction

Implanting endosseous dental implants in a completely atrophic maxilla is considered to be an unresolved surgical problem, and a standardized surgical procedure is required. The five surgical procedures available to date are summarized below:

1. placement of Titanium fixtures in the remaining bone of the atrophic maxilla and simultaneously grafting cancellous bone and marrow around the fixtures (*Breine* and *Brånemark,* 1980);
2. directly fixing tibial cortico-cancellous bone grafts (*Breine* and *Brånemark,* 1980) or iliac bone grafts (*Keller* et al., 1987) to the residual bone of the maxilla;
3. transplanting preformed autologous, composite bone grafts from the tibia containing integrated fixtures, which had been implanted in the donor site several months previously (*Breine* and *Brånemark,* 1980);
4. horizontal osteotomy of the residual maxillary alveolar process beneath the floor of the sinus without perforating it and interpositional bone grafting. Titanium implants are then placed 16 to 18 months later (*Keller* et al., 1987);
5. in an initial operation, bone marrow is implanted below the carefully elevated mucous membrane of the maxillary sinus floor via a fenestration of the lateral wall of the sinus (*Boyne* and *James,* 1980). In a second operation several months later, endosseous implants are placed (*Jensen* and *Simonsen,* 1988), and they are then uncovered several months later during a third operation. A similar method was described by *Misch* (1987) who used a mixture of Tricalcium Phosphate, demineralized freeze-dried cancellous bone, Lincomycin and the patient's blood instead of autologous bone; in this procedure the lateral wall of the sinus also forms part of the graft.

The above methods are not reliable because of bone resorption or not suitable for the highly atrophic maxilla where the sinus floor also forms the alveolar margin. Further, some of the methods are not suitable for skeletal class-III patients which is the common finding in most cases of total maxillary alveolar atrophy. Finally, other surgical procedures may be too hazardous.

In contrast, our new method (*Sailer,* 1988) which is a straight-forward procedure where bone grafting and placement of endosseous implants are performed simultaneously in all cases with minor to extreme resorption of the alveolus, skeletal class-III conditions can be simultaneously corrected; a modified submucous maxillary vestibuloplasty is also performed as a routine.

Step-by-Step Description of the New Method

1. A Le Fort I-osteotomy is performed through the walls of the maxillary sinus. The more atrophic the maxilla, the higher the horizontal bone cut of the Le Fort I-osteotomy. The nasal mucosa is preserved, but when damaged it can be sutured after the down-fracturing has been completed (Fig. 1).
2. The next step is the most important of the procedure. It involves the careful removal of the maxillary sinus mucous membrane from the down-fractured part of the maxilla, i. e. from the floor of the maxillary sinus (Fig. 2). Care is taken to preserve the mucous membrane of the cranial part of the maxillary sinus. After removing the mucous membrane with elevators or Freer-instruments, the former floor of the sinus is meticulously abraided with a rose head bur to ensure total removal of all cellular mucosal remnants (Fig. 3).
3. Autologous iliac bone blocks, either mono- or bicortical, are then shaped to fit into the anterior part of the down-fractured nasal floor and the denuded parts of the maxillary sinuses (Fig. 4).
4. Each of the bone blocks placed on the nasal floor and on both denuded maxillary sinus floors are fixed in position with two bone clamps (Fig. 5). The height of the bone

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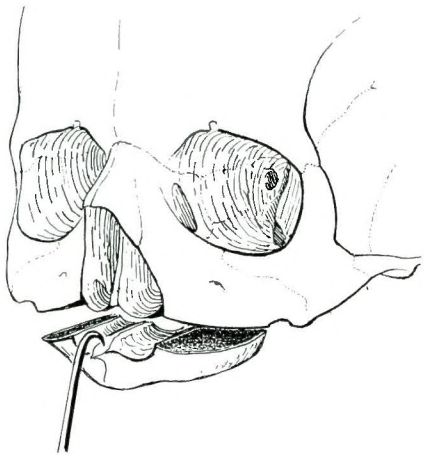


Fig. 1 a

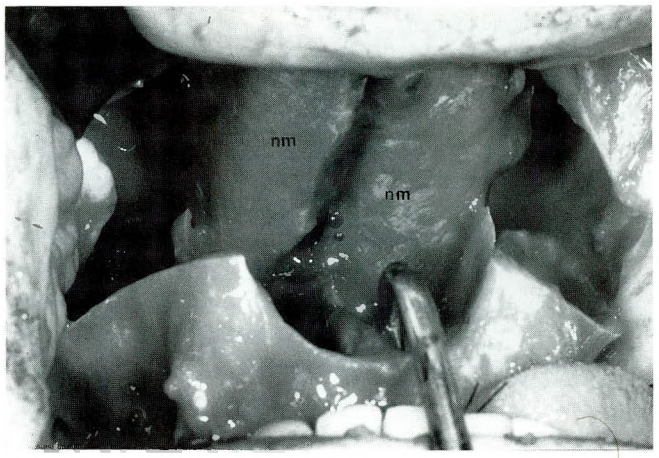


Fig. 1 b

Fig. 1 a, b Le Fort I-osteotomy: Routine Le Fort I-osteotomy (a) is performed preserving the nasal mucosa.

The intraoperative view (b) shows the situation after down-fracturing the maxilla; the nasal mucosa (nm) is preserved.

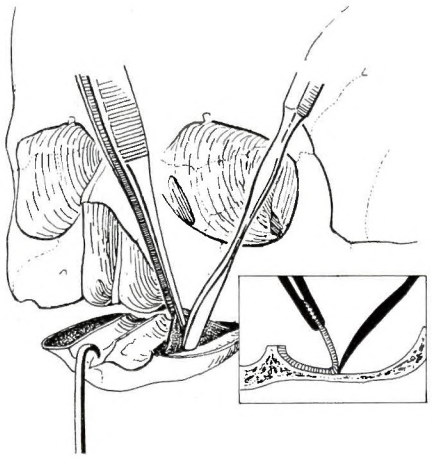


Fig. 2 a

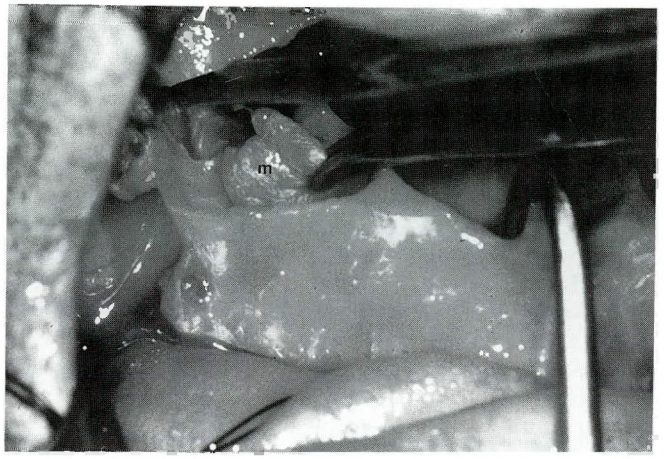


Fig. 2 b

Fig. 2 a, b Removal of the antral mucous membrane: The mucosa of the floor of the maxillary sinus is carefully removed (a).

The intraoperative view (b) shows the partially removed mucosa (m) held by a clamp.

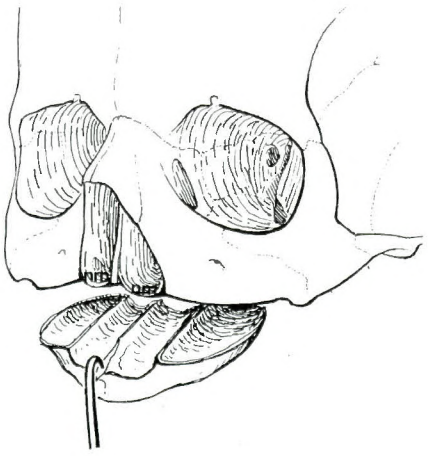


Fig. 3 a



Fig. 3 b

Fig. 3 a, b Denudation of the cranial aspect of the mobilized part of the maxilla: After removing the mucous membrane from the floor of the maxillary sinuses and elevating and preserving the nasal mucosa, the mobilized maxilla is completely denuded on one surface (a).

The intraoperative view (b) shows this stage and the bleeding surfaces of the denuded maxilla.

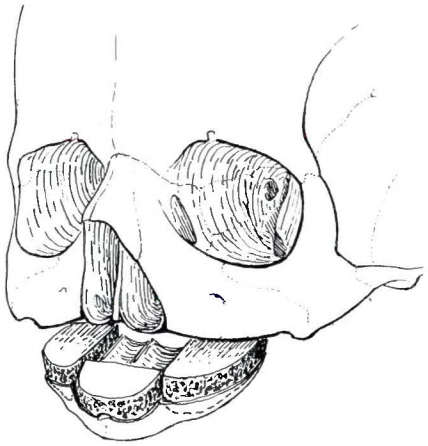


Fig. 4 a

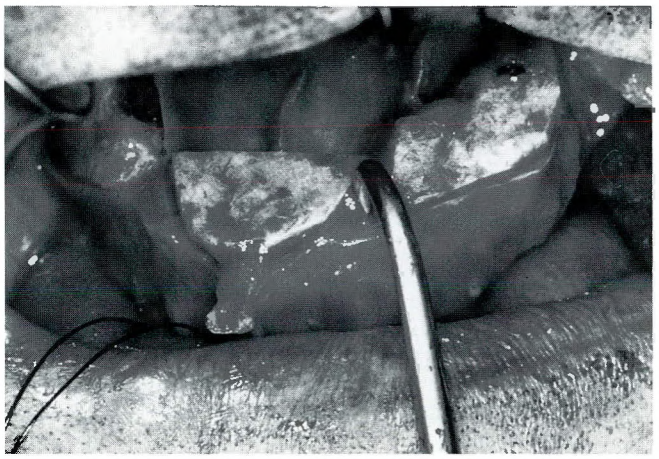


Fig. 4 b

Fig. 4 a, b Carving and adaptation of bone blocks: Autologous bone blocks from the iliac crest, containing at least the cortical layer on one surface, are fitted to the previous floor of the sinuses and nose (a).

The intraoperative view (b) shows the bone blocks in situ with the cortical layer on the cranial side.

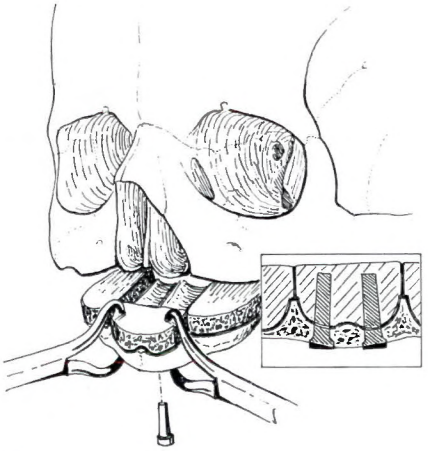


Fig. 5 a

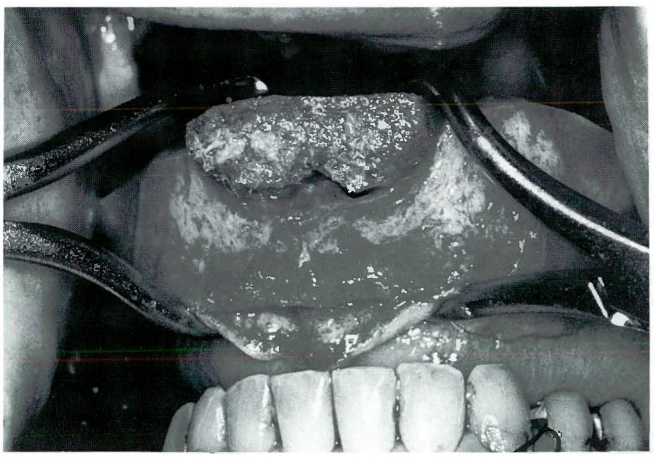


Fig. 5 b

Fig. 5 a, b Fixation of the bone blocks: Each bone transplant is fixed using two bone clamps (a).

The intraoperative view (b) shows the corresponding clinical situation; the bone blocks can consist of two layers of iliac bone if additional height is required.

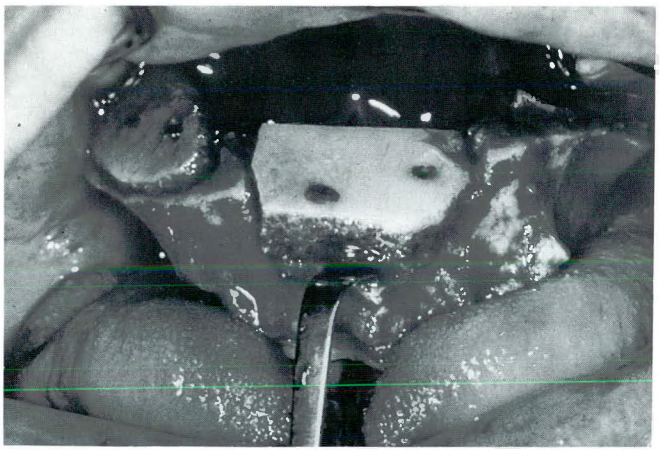


Fig. 6 a

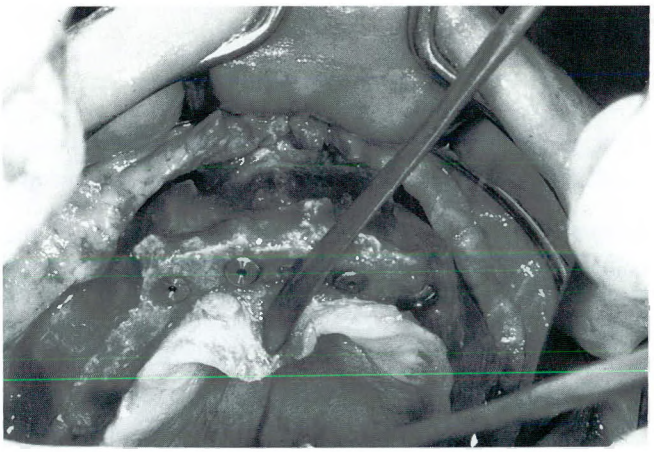


Fig. 6 b

Fig. 6 a, b Fixation of the bone grafts: The intraoperative cranial view showing Brånemark fixtures just penetrating the cortical layer of the bone grafts (a). Penetration of the cortex is not necessary but improves fixation of the bone blocks.

The caudal view (b) shows the same endosseous implants in the same patient. The implants are each 18 mm long.

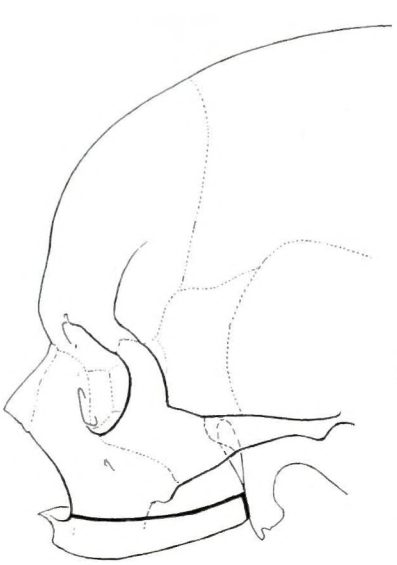


Fig. 7a

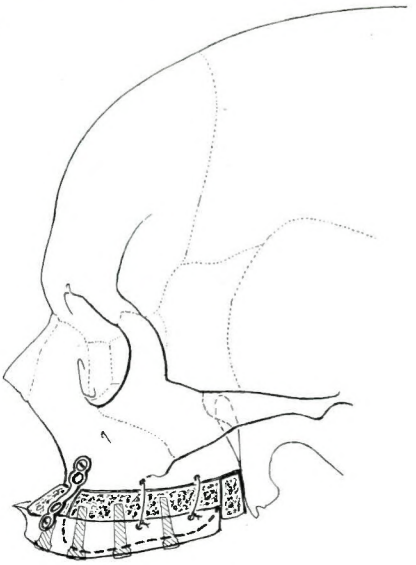


Fig. 7b

Fig. 7a, b Forward and downward positioning of the maxilla: The atrophic maxilla (a), often in a skeletal class III position, can be placed forward and downward (b) into a class I-relationship, placing the endosseous implants simultaneously (b).

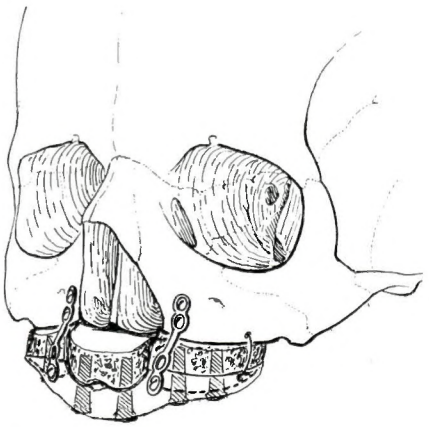


Fig. 8a



Fig. 8b

Fig. 8a, b Fixation of the maxilla: The mobilized maxilla is usually advanced and positioned more inferiorly and fixed by two miniplates and/or several wires (a).

The intraoperative view (b) shows this stage with the miniplates in position. In addition, lyophilized bank bone blocks (bb) were used to bridge defects produced by the inferior positioning of the maxilla.

blocks chosen determines the length of the Titanium implants. The Titanium implants are then placed in the usual way. The ends of the implants can be visible within the cranially placed cortex of the bone graft (Fig. 6 a). In fact, they fix the bone blocks to the residual maxilla (Fig. 6 b). Depending on the height of the bone block used, six to eight implants 18–20 mm in length can be placed.

5. In most cases the mobilized, down-fractured maxilla is then advanced or placed into a class I position. It is simultaneously rotated downwards by an amount equal to the estimated original height of the alveolar process (Fig. 7). With this procedure any airway obstruction is also avoided, and the original vertical dimension of the face is restored.

6. Finally, the maxilla is fixed using a miniplate on each side (wiring is also possible) (Fig. 8), a modified submucous vestibuloplasty is performed with special bone sutures through bur holes and the incision line closed by continuous suturing (Fig. 9).

7. Six months postoperatively or later, the endosseous implants are uncovered, and the prosthodontic procedures can be performed in the usual way.

Results

The procedure described above was first performed in 1987. To date five patients have been treated, with seven Titanium implants each. The postoperative course was uneventful in every case. In three patients the implants were uncovered after 6, 8 and 11 months respectively, and all

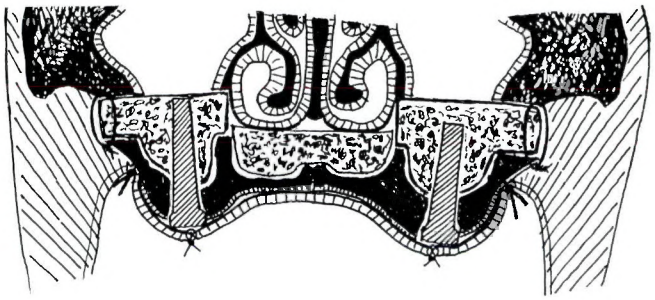


Fig. 9 A modified submucous vestibuloplasty using deep fixation sutures to the periosteum or through bur holes within the walls of the maxillary sinus is used routinely at the end of the procedure.

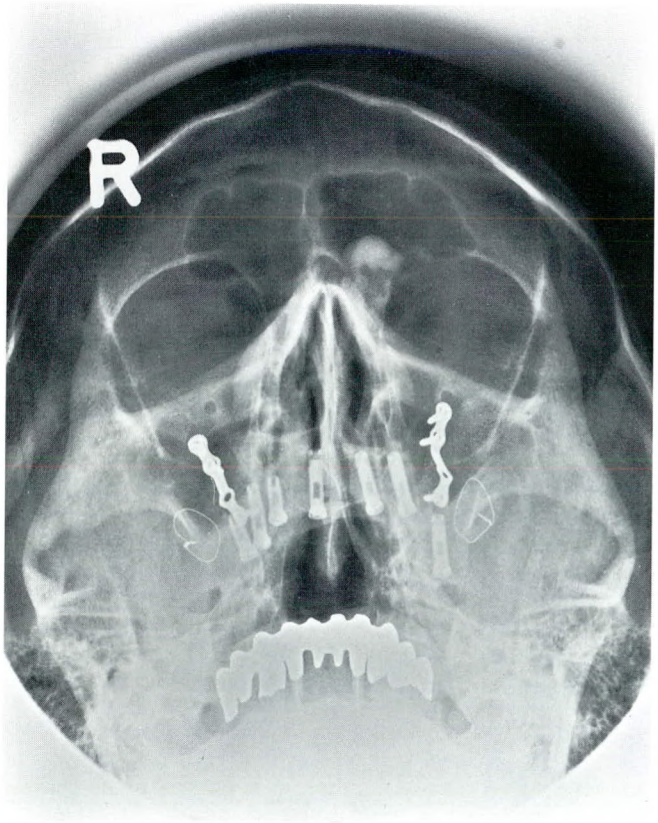


Fig. 10 Recovery of the maxillary sinus: Re-pneumatisation visible in the Water's view is usually complete within two to three months.

21 implants were perfectly healed. As after routine Le Fort I-osteotomy, re-pneumatisation of the maxillary sinus takes place within 2 to 3 months (Fig. 10). The implants of the other two patients have not yet been uncovered, but the postoperative course has been complication-free. Even after 13 months there was no resorption visible on the radiographs (Fig. 11).

Discussion and Conclusions

The new method described is particularly designed to treat patients who have totally atrophic maxillae with a skeletal class III position of their jaws. The procedure is a break-through procedure for such patients because they could not have been treated previously with endosseous implants. The operation is also indicated in cases having only minor degrees of resorption but who still have a class III jaw relationship. Further indications include all other conditions in which screws up to 20 mm long are considered to be favourable.

The advantages of the procedure are:

1. It enables treatment of the totally atrophic maxilla with no residual alveolus because the maxillary sinus floor coincides with the alveolar ridge.
2. Bone grafting and placement of endosseous implants is performed during the same procedure.
3. The implants can be uncovered and already loaded 6 months after placement.
4. The intermaxillary relationship is corrected simultaneously with bone grafting and placement of the implants.
5. The original vertical dimension of the face is restored and the best possible aesthetic facial appearance achieved.
6. The patient can wear a properly-fitting, conventional denture for the intermediate period before the fixed suprastructure is fitted because a modified submucous vestibuloplasty is performed simultaneously.
7. Even if all the implants were lost, a significantly improved prosthodontic condition compared to the preoperative situation results, because the intermaxillary relationship is corrected, the alveolar ridge is augmented and an acceptable vestibule created.

Disadvantages of the Method

The procedure must be performed under general anaesthesia using autologous bone. The use of other materials is presently only in the experimental stage.

The Present Procedure Compared to other Methods

No other surgical treatment of totally atrophic maxillae is presently available which achieves results similar to those listed under "Advantages". Only the sinus elevation method produces suitable conditions for endosseous implantation in cases with a normal intermaxillary relationship, but the implants can only be placed 10 to 12 months after sinus elevation combined with heteroplastic graft material (*Misch,* 1987). When the sinus elevation method is combined with grafting of autologous cancellous bone (*Jensen* and *Simonsen,* 1988), a second operation is necessary to insert the implants 4 months later and the length of the screws is limited. Both methods require a second operation to place the implants and their indications are limited only for use in class I skeletal conditions.

In contrast to the above-mentioned authors, *Tatum* (1986) described the sinus elevation technique combined with simultaneous implant placement using autologous bone or autologous bone plus Augmen material. All these techniques can potentially damage the antral mucosa, resulting in chronic sinusitis when any grafted material lies on the mucous membrane of the sinus.

In addition, patients with totally atrophic maxillae combined with skeletal class III intermaxillary relationship could only be treated previously with onlay techniques (*Breine* und *Brånemark,* 1980; *Keller* et al., 1987).

The high resorption rate of bone grafts onlayed onto the maxilla is well-known. Therefore, sandwich operations are increasingly employed (*Bell* et al., 1977; *Härle,* 1982; *Obwegeser* and *Farmand,* 1984; *Farmand,* 1986). Evidence

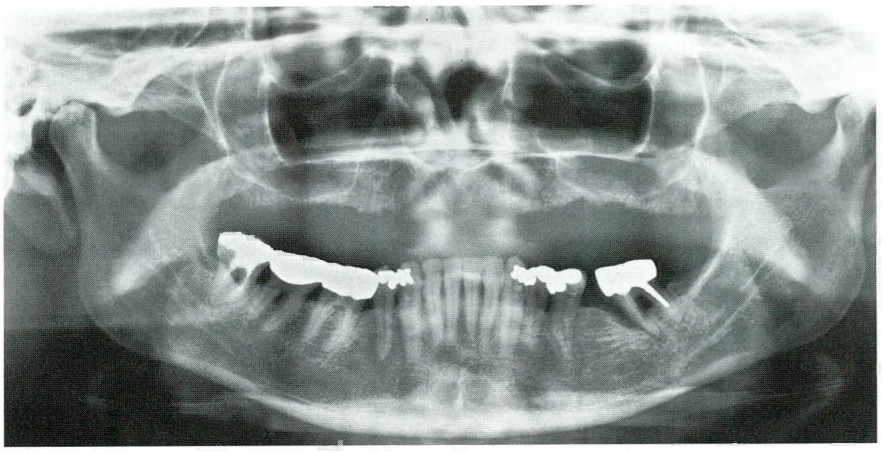


Fig. 11 a

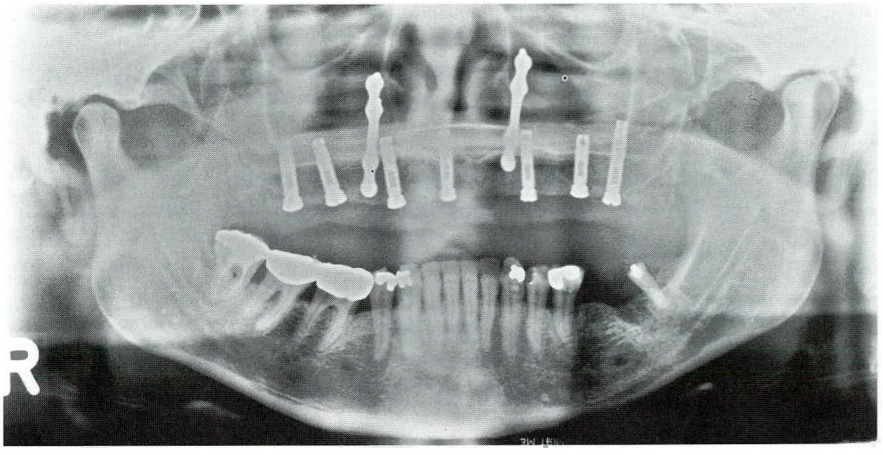


Fig. 11 b

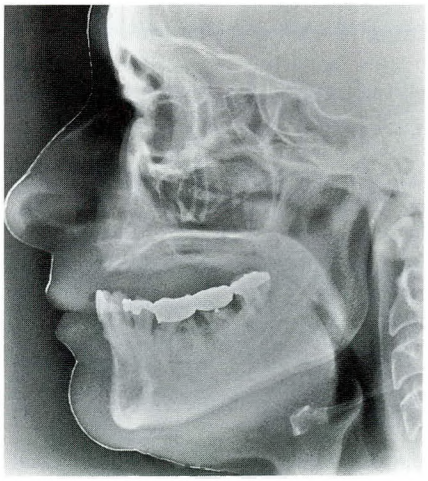


Fig. 11 c

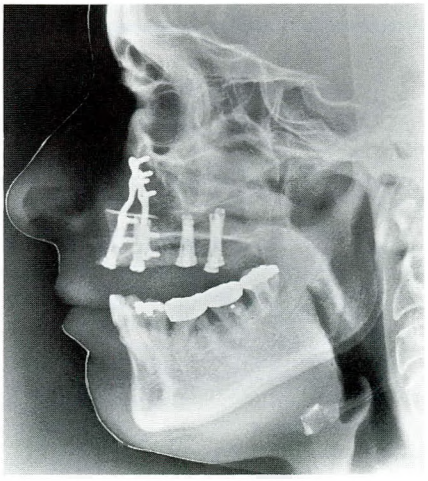


Fig. 11 d

Fig. 11 a–d Case of a 38-year-old female patient with an atrophic edentulous maxilla and skeletal class III position: The preoperative orthopantomogram (a) shows an extensively atrophic maxilla; the preoperative lateral cephalogram (c) shows a narrow anterior alveolar ridge and a skeletal class III-jaw position. The postoperative orthopantomogram (b) shows a typical condition after placement of 7 endosseous implants, 18 mm and 20 mm long, 10 months after surgery. The corresponding lateral cephalogram (d) confirms the maxillary advancement.

shows that substantial resorption also occurs when fixtures are utilized in combination with onlay bone grafts (*Friedman,* 1988). In fact *Keller* et al. (1987) reported that 4 out of 28 Titanium fixtures were lost as a result of this. The so-called Le Fort I-sandwich-technique without opening the maxillary sinus described by *Keller* et al. (1987) can only be performed in cases where a substantial amount of alveolar ridge is present. Its major disadvantage, however, is that the maxillary sinus should not be opened. In addition, the horse-shoe-like osteotomized alveolar process is difficult to handle and may be associated with blood supply problems. Further the disadvantage of secondary

implantation of the endosseous implants must also be considered. *Keller* et al. (1987) reported that 5 out of 21 Titanium fixtures had failed when this procedure was used.

Apart from the use of *Brånemark*-fixtures (*Brånemark* et al., 1985), the present method has nothing in common with the trials of implant penetration of the nasal cavity (*Brånemark* et al., 1984) which is a risky intervention. This holds particularly for the bone wall or nasal mucosa-penetrating implants which had a loss rate of 28% compared to a 5% loss in the non-penetrating cases, over an observation time of up to 5 years (*Brånemark* et al., 1984). The difference between perforating and non-perforating implantations in the sinus floor area was 12% (*Brånemark* et al., 1984). Because of this substantial difference we advocate non-perforating techniques or the use of the bone-augmentation procedure as presently described (*Sailer*, 1988).

To date no other surgical method exists for treating totally atrophied maxillae which improves the intermaxillary relationship, the soft tissue condition and simultaneously allows placement of endosseous Titanium implants in adequate bone.

Acknowledgement

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Stability after Osteotomy of the Edentulous Maxilla*

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Summary

The results after advancement and lowering of the edentulous maxilla after a mean follow-up of 21 months are presented. Eight cases were stabilized with wire osteosyntheses, eight others with miniplates. In contrast to earlier reports considerable variation of the results after a longer follow-up was found, although the means of the whole group do not differ very much from other series. It is concluded that the Le Fort-I operation is more reliable for the augmentation of the edentulous maxilla than onlay grafting. Better results are achieved after stabilization with miniplates than with wiring.

Key words

Edentulous maxilla – Le Fort-I osteotomy – Wire fixation – Plate fixation – Follow-up

Introduction

Osteotomy for correction of the atrophic maxilla (*Farrell* et al., 1976) has, in some centres, replaced the conventional onlay grafting of the alveolar ridge. There are obvious advantages in this procedure. There is still little information about the long term stability and relapse tendency. Also, the results deal only with vertical changes. However, simultaneous advancement of the maxilla is an even more important component in most cases.
The purpose of this study, therefore, was to evaluate the postoperative stability of the maxilla in the long term, in the horizontal as well as in the vertical direction.

Material and Methods

From 1981–1986 18 patients had been operated on for improvement of position and height of their edentulous maxillae. The majority of the patients showed the usual atrophy of the upper jaw, however, in both groups there were also cleft and posttraumatic cases (Table 1). Age varied from 26 to 66 years, with a mean of 44 years.
In 16, a Le Fort-I and in 2, a Le Fort-I and III osteotomy was performed. In only one case was a horse-shoe modification used. This case, however, could not be evaluated later, because the postoperative X-rays did not permit reliable definition of comparable points for measurement. One other case was lost to follow-up.
In cleft patients, the osteotomy had to be done in two segments and oro-nasal communications were closed simultaneously with reconstruction of the alveolar cleft. In 6 patients, a simultaneous submucous vestibuloplasty was also performed. Intermaxillary fixation was never used.
Initially, all maxillae were stabilized with autologous bone grafts and wire osteosyntheses. In all, except one case with rib grafts, autologous iliac crest was used, wedging the bone blocks into the defects in order to improve stability. Following a preliminary evaluation (*Freihofer,* 1984), stabilization with bone grafts and miniplates was aimed at, in the hope of reducing postoperative movement. In this group the iliac crest grafts were not truly wedged between the bone rims in all cases, because of interference with the plates. This resulted finally in two groups of 8 patients, each with one Le Fort-III, which were compared. Follow-up time was one to four years with a mean of 21 months. The results were measured on cephalometric X-rays.
The main point for attention was an equivalent to point A on the anterior aspect of the residual maxilla. Its movements were measured parallel to SN, perpendicularly to it but also as a combination of the horizontal and vertical vectors of movement.

Results

Interpretation of the X-rays was sometimes difficult and resulted in a measurement error of up to 1 mm. The movement parallel to SN (sagittally) varies at the extremes between 14.5 advancement and 5.5 mm retrusion. In both groups, one maxilla was slightly retruded. The mean advancement was a little more extensive in the group with wiring. Relapse was also variable, between 5.5 and 1 mm. In both groups two maxillae moved forward postoperatively. The postoperative movements were less variable in the group fixed with plates. The mean relapse rates were very comparable, being 15 % for the wiring and 14 % for the plating group, amounting to about 1 mm (Table 2).

Table 1 Aetiology of retro-/micromaxillism

	wiring	plating
cleft maxilla	3	1
post-traumatic	3	1
pure atrophy	2	8*

* 2 cases not considered in follow-up (see text)

Table 2 Movement of point A parallel to SN

	wiring mean extremes	plating mean extremes
intra-operative mm	7.8 (+14.5/−5.5)	5.7 (+12/−6)
relapse mm	− 1.2 (+ 3.5/−5.5)	− 0.8 (+ 4/−3)
%	15	14

*Paper read at the 9th Congress of the European Association for Cranio-Maxillo-Facial Surgery, Athens, September 1988

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A New Method of Inserting Endosseous Implants in Totally Atrophic Maxillae*

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Summary

A new method is described (*Sailer,* 1988) whereby endosseous implants are inserted in the totally atrophic maxilla, the intermaxillary relationship and vertical dimension corrected and a vestibuloplasty performed during one surgical procedure. The method can also be used to treat minor degrees of maxillary alveolar atrophy. The procedure enables 20 mm-long Titanium screws to be used in totally atrophic maxillae. The following surgical procedures are carried out during one operation: A Le Fort I osteotomy, removal of the mucous membrane of the sinus floor, obturation of the denuded maxillary sinus floor by autologous bone grafts from the iliac crest, simultaneous insertion of Titanium screws, fixation of the down-fractured maxilla by miniplates, and a modified submucous vestibuloplasty. Intermaxillary relationship and vertical dimension can be normalized, and the aesthetic results are excellent. To date 35 implants of which none has been lost, have been placed in 5 patients.

Key words

Endosseous implants (Brånemark fixtures) – Atrophy of maxilla – Le Fort I-osteotomy – Bone grafts – Miniplate fixation of maxilla

Introduction

Implanting endosseous dental implants in a completely atrophic maxilla is considered to be an unresolved surgical problem, and a standardized surgical procedure is required. The five surgical procedures available to date are summarized below:

1. placement of Titanium fixtures in the remaining bone of the atrophic maxilla and simultaneously grafting cancellous bone and marrow around the fixtures (*Breine* and *Brånemark,* 1980);
2. directly fixing tibial cortico-cancellous bone grafts (*Breine* and *Brånemark,* 1980) or iliac bone grafts (*Keller* et al., 1987) to the residual bone of the maxilla;
3. transplanting preformed autologous, composite bone grafts from the tibia containing integrated fixtures, which had been implanted in the donor site several months previously (*Breine* and *Brånemark,* 1980);
4. horizontal osteotomy of the residual maxillary alveolar process beneath the floor of the sinus without perforating it and interpositional bone grafting. Titanium implants are then placed 16 to 18 months later (*Keller* et al., 1987);
5. in an initial operation, bone marrow is implanted below the carefully elevated mucous membrane of the maxillary sinus floor via a fenestration of the lateral wall of the sinus (*Boyne* and *James,* 1980). In a second operation several months later, endosseous implants are placed (*Jensen* and *Simonsen,* 1988), and they are then uncovered several months later during a third operation. A similar method was described by *Misch* (1987) who used a mixture of Tricalcium Phosphate, demineralized freeze-dried cancellous bone, Lincomycin and the patient's blood instead of autologous bone; in this procedure the lateral wall of the sinus also forms part of the graft.

The above methods are not reliable because of bone resorption or not suitable for the highly atrophic maxilla where the sinus floor also forms the alveolar margin. Further, some of the methods are not suitable for skeletal class-III patients which is the common finding in most cases of total maxillary alveolar atrophy. Finally, other surgical procedures may be too hazardous.

In contrast, our new method (*Sailer,* 1988) which is a straight-forward procedure where bone grafting and placement of endosseous implants are performed simultaneously in all cases with minor to extreme resorption of the alveolus, skeletal class-III conditions can be simultaneously corrected; a modified submucous maxillary vestibuloplasty is also performed as a routine.

Step-by-Step Description of the New Method

1. A Le Fort I-osteotomy is performed through the walls of the maxillary sinus. The more atrophic the maxilla, the higher the horizontal bone cut of the Le Fort I-osteotomy. The nasal mucosa is preserved, but when damaged it can be sutured after the down-fracturing has been completed (Fig. 1).
2. The next step is the most important of the procedure. It involves the careful removal of the maxillary sinus mucous membrane from the down-fractured part of the maxilla, i. e. from the floor of the maxillary sinus (Fig. 2). Care is taken to preserve the mucous membrane of the cranial part of the maxillary sinus. After removing the mucous membrane with elevators or Freer-instruments, the former floor of the sinus is meticulously abraided with a rose head bur to ensure total removal of all cellular mucosal remnants (Fig. 3).
3. Autologous iliac bone blocks, either mono- or bicortical, are then shaped to fit into the anterior part of the down-fractured nasal floor and the denuded parts of the maxillary sinuses (Fig. 4).
4. Each of the bone blocks placed on the nasal floor and on both denuded maxillary sinus floors are fixed in position with two bone clamps (Fig. 5). The height of the bone

* Presented at the 9th Congress of the European Association for Cranio-Maxillo-Facial Surgery, in Athens, September 1988.

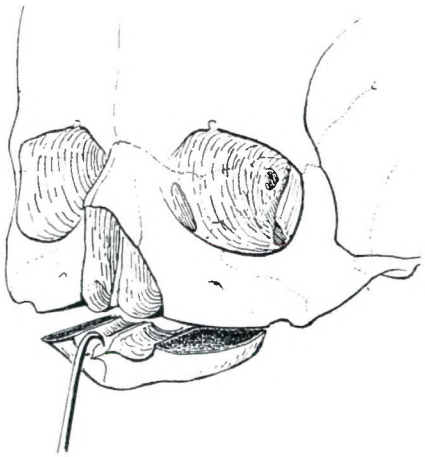


Fig. 1 a

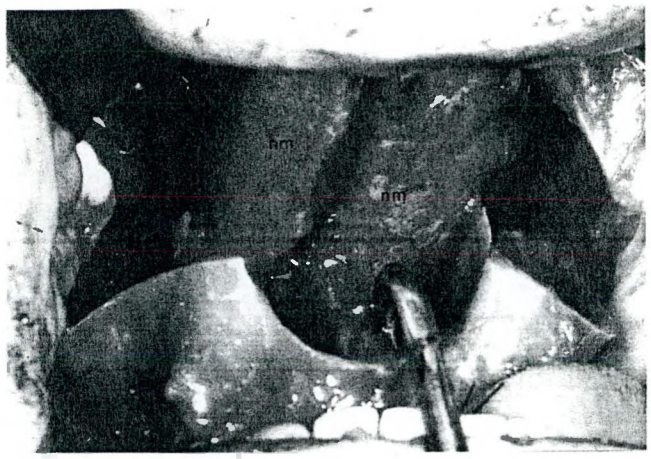


Fig. 1 b

Fig. 1 a, b Le Fort I-osteotomy: Routine Le Fort I-osteotomy (a) is performed preserving the nasal mucosa.

The intraoperative view (b) shows the situation after down-fracturing the maxilla; the nasal mucosa (nm) is preserved.

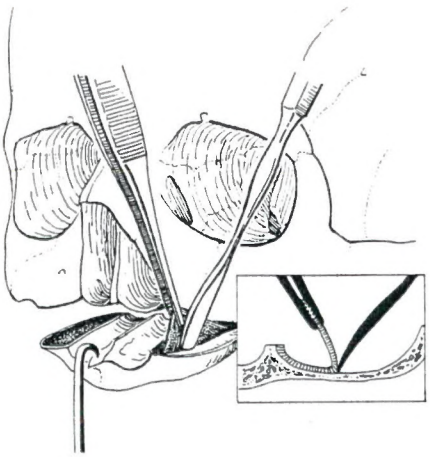


Fig. 2 a



Fig. 2 b

Fig. 2 a, b Removal of the antral mucous membrane: The mucosa of the floor of the maxillary sinus is carefully removed (a).

The intraoperative view (b) shows the partially removed mucosa (m) held by a clamp.

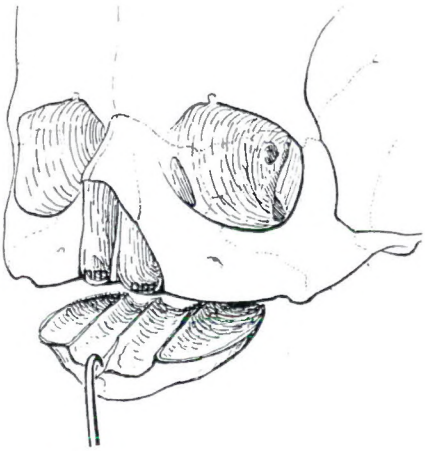


Fig. 3 a

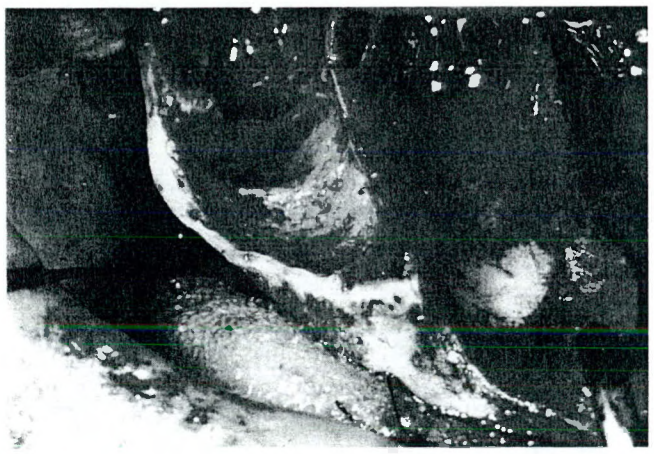


Fig. 3 b

Fig. 3 a, b Denudation of the cranial aspect of the mobilized part of the maxilla: After removing the mucous membrane from the floor of the maxillary sinuses and elevating and preserving the nasal mucosa, the mobilized maxilla is completely denuded on one surface (a).

The intraoperative view (b) shows this stage and the bleeding surfaces of the denuded maxilla.

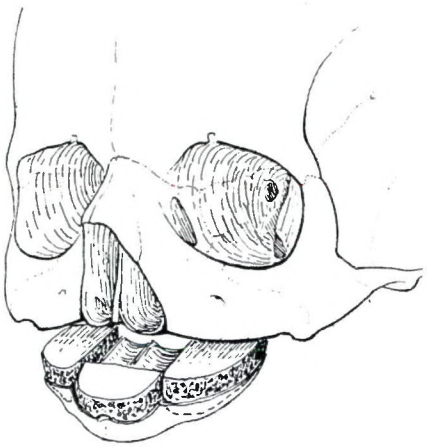


Fig. 4 a

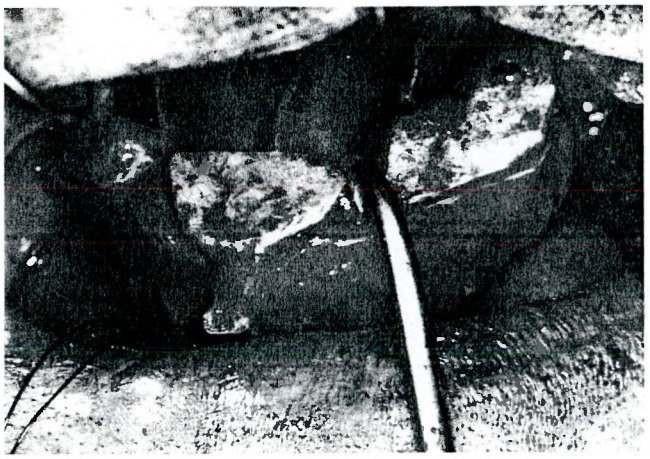


Fig. 4 b

Fig. 4 a, b Carving and adaptation of bone blocks: Autologous bone blocks from the iliac crest, containing at least the cortical layer on one surface, are fitted to the previous floor of the sinuses and nose (a).

The intraoperative view (b) shows the bone blocks in situ with the cortical layer on the cranial side.

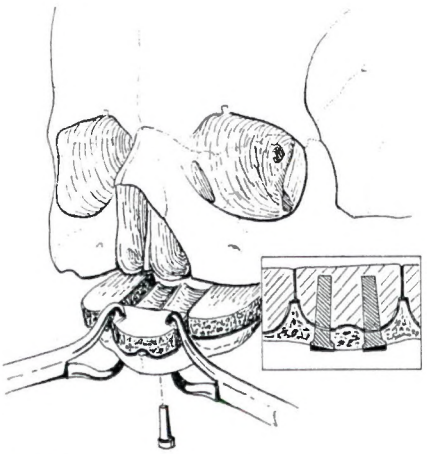


Fig. 5 a

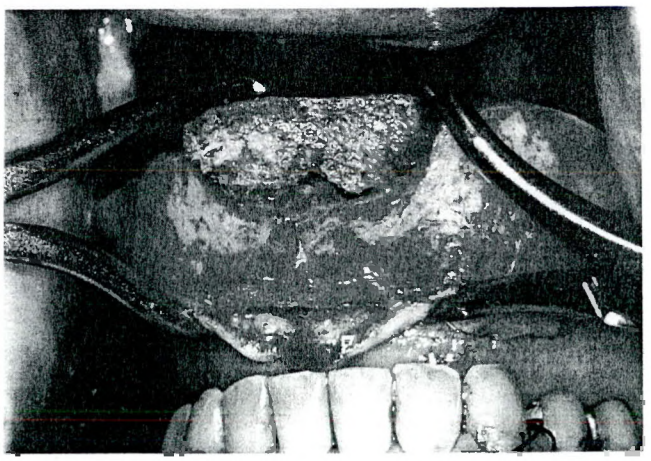


Fig. 5 b

Fig. 5 a, b Fixation of the bone blocks: Each bone transplant is fixed using two bone clamps (a).

The intraoperative view (b) shows the corresponding clinical situation; the bone blocks can consist of two layers of iliac bone if additional height is required.

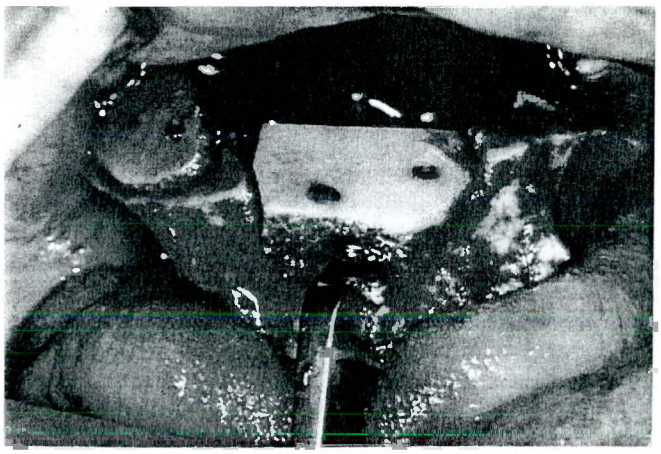


Fig. 6 a

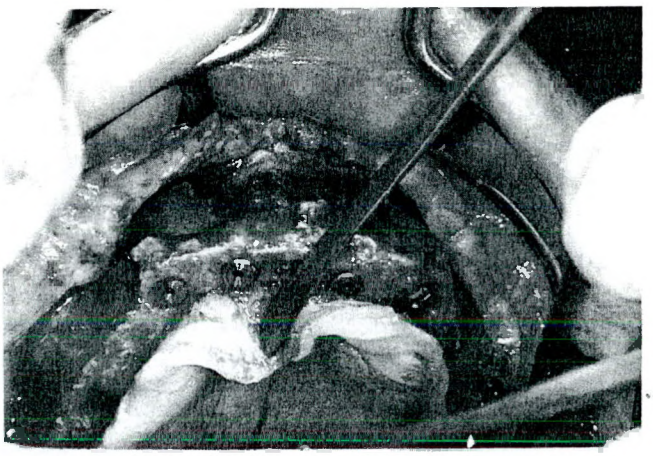


Fig. 6 b

Fig. 6 a, b Fixation of the bone grafts: The intraoperative cranial view showing Brånemark fixtures just penetrating the cortical layer of the bone grafts (a). Penetration of the cortex is not necessary but improves fixation of the bone blocks.

The caudal view (b) shows the same endosseous implants in the same patient. The implants are each 18 mm long.

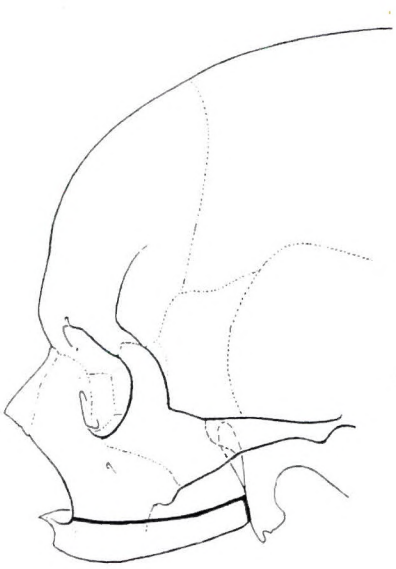


Fig. 7 a

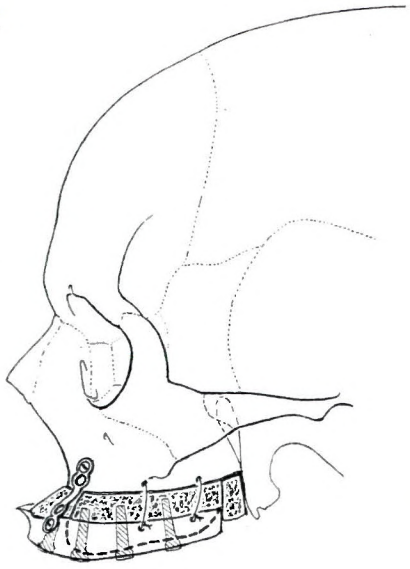


Fig. 7 b

Fig. 7 a, b Forward and downward positioning of the maxilla: The atrophic maxilla (a), often in a skeletal class III position, can be placed forward and downward (b) into a class I-relationship, placing the endosseous implants simultaneously (b).

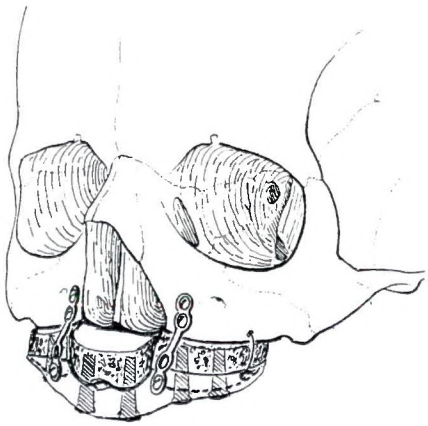


Fig. 8 a



Fig. 8 b

Fig. 8 a, b Fixation of the maxilla: The mobilized maxilla is usually advanced and positioned more inferiorly and fixed by two miniplates and/or several wires (a).

The intraoperative view (b) shows this stage with the miniplates in position. In addition, lyophilized bank bone blocks (bb) were used to bridge defects produced by the inferior positioning of the maxilla.

blocks chosen determines the length of the Titanium implants. The Titanium implants are then placed in the usual way. The ends of the implants can be visible within the cranially placed cortex of the bone graft (Fig. 6 a). In fact, they fix the bone blocks to the residual maxilla (Fig. 6 b). Depending on the height of the bone block used, six to eight implants 18–20 mm in length can be placed.

5. In most cases the mobilized, down-fractured maxilla is then advanced or placed into a class I position. It is simultaneously rotated downwards by an amount equal to the estimated original height of the alveolar process (Fig. 7). With this procedure any airway obstruction is also avoided, and the original vertical dimension of the face is restored.

6. Finally, the maxilla is fixed using a miniplate on each side (wiring is also possible) (Fig. 8), a modified submucous vestibuloplasty is performed with special bone sutures through bur holes and the incision line closed by continuous suturing (Fig. 9).

7. Six months postoperatively or later, the endosseous implants are uncovered, and the prosthodontic procedures can be performed in the usual way.

Results

The procedure described above was first performed in 1987. To date five patients have been treated, with seven Titanium implants each. The postoperative course was uneventful in every case. In three patients the implants were uncovered after 6, 8 and 11 months respectively, and all

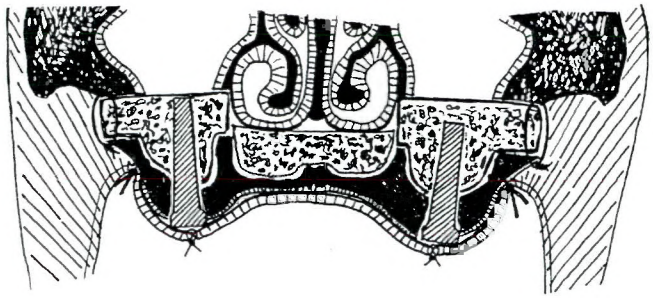


Fig. 9 A modified submucous vestibuloplasty using deep fixation sutures to the periosteum or through bur holes within the walls of the maxillary sinus is used routinely at the end of the procedure.

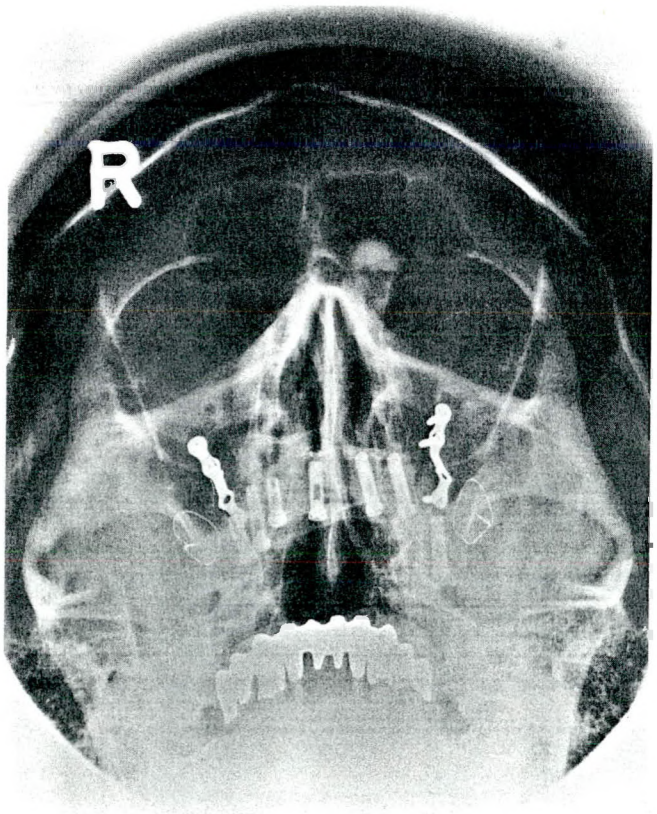


Fig. 10 Recovery of the maxillary sinus: Re-pneumatisation visible in the Water's view is usually complete within two to three months.

21 implants were perfectly healed. As after routine Le Fort I-osteotomy, re-pneumatisation of the maxillary sinus takes place within 2 to 3 months (Fig. 10). The implants of the other two patients have not yet been uncovered, but the postoperative course has been complication-free. Even after 13 months there was no resorption visible on the radiographs (Fig. 11).

Discussion and Conclusions

The new method described is particularly designed to treat patients who have totally atrophic maxillae with a skeletal class III position of their jaws. The procedure is a break-through procedure for such patients because they could not have been treated previously with endosseous implants. The operation is also indicated in cases having only minor degrees of resorption but who still have a class III jaw relationship. Further indications include all other conditions in which screws up to 20 mm long are considered to be favourable.

The advantages of the procedure are:

1. It enables treatment of the totally atrophic maxilla with no residual alveolus because the maxillary sinus floor coincides with the alveolar ridge.
2. Bone grafting and placement of endosseous implants is performed during the same procedure.
3. The implants can be uncovered and already loaded 6 months after placement.
4. The intermaxillary relationship is corrected simultaneously with bone grafting and placement of the implants.
5. The original vertical dimension of the face is restored and the best possible aesthetic facial appearance achieved.
6. The patient can wear a properly-fitting, conventional denture for the intermediate period before the fixed suprastructure is fitted because a modified submucous vestibuloplasty is performed simultaneously.
7. Even if all the implants were lost, a significantly improved prosthodontic condition compared to the preoperative situation results, because the intermaxillary relationship is corrected, the alveolar ridge is augmented and an acceptable vestibule created.

Disadvantages of the Method

The procedure must be performed under general anaesthesia using autologous bone. The use of other materials is presently only in the experimental stage.

The Present Procedure Compared to other Methods

No other surgical treatment of totally atrophic maxillae is presently available which achieves results similar to those listed under "Advantages". Only the sinus elevation method produces suitable conditions for endosseous implantation in cases with a normal intermaxillary relationship, but the implants can only be placed 10 to 12 months after sinus elevation combined with heteroplastic graft material (*Misch*, 1987). When the sinus elevation method is combined with grafting of autologous cancellous bone (*Jensen* and *Simonsen*, 1988), a second operation is necessary to insert the implants 4 months later and the length of the screws is limited. Both methods require a second operation to place the implants and their indications are limited only for use in class I skeletal conditions.

In contrast to the above-mentioned authors, *Tatum* (1986) described the sinus elevation technique combined with simultaneous implant placement using autologous bone or autologous bone plus Augmen material. All these techniques can potentially damage the antral mucosa, resulting in chronic sinusitis when any grafted material lies on the mucous membrane of the sinus.

In addition, patients with totally atrophic maxillae combined with skeletal class III intermaxillary relationship could only be treated previously with onlay techniques (*Breine* und *Brånemark*, 1980; *Keller* et al., 1987).

The high resorption rate of bone grafts onlayed onto the maxilla is well-known. Therefore, sandwich operations are increasingly employed (*Bell* et al., 1977; *Härle*, 1982; *Obwegeser* and *Farmand*, 1984; *Farmand*, 1986). Evidence

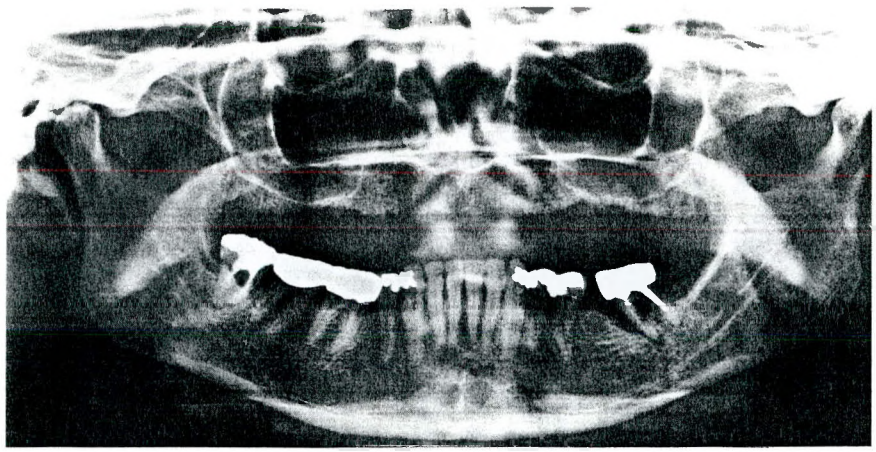


Fig. 11 a

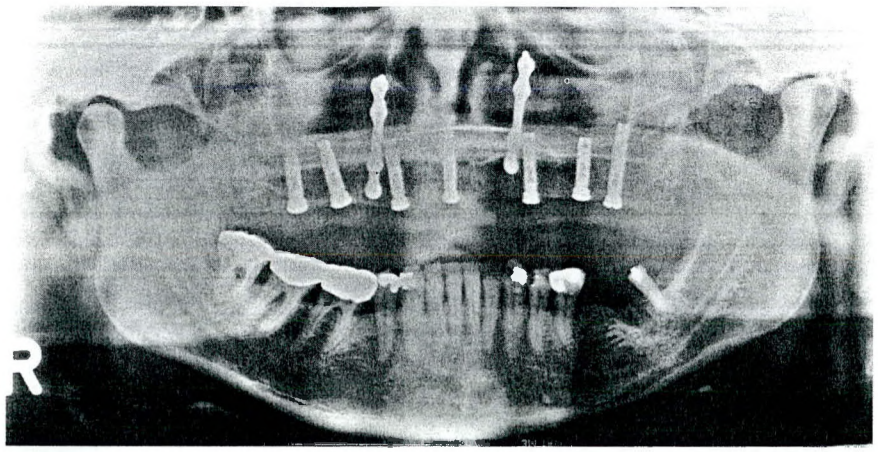


Fig. 11 b

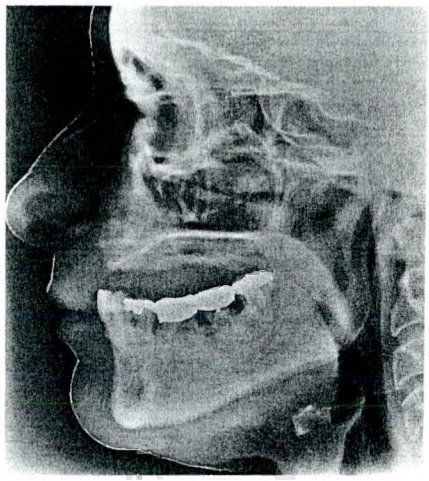


Fig. 11 c

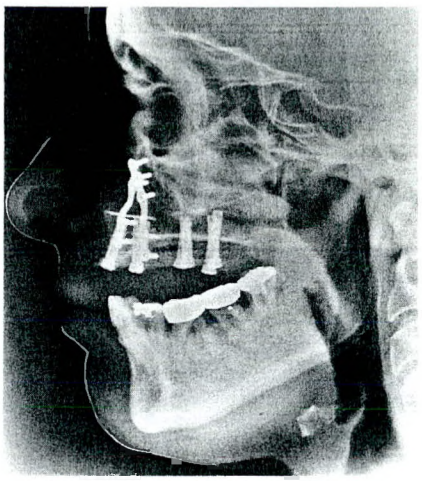


Fig. 11 d

Fig. 11 a–d Case of a 38-year-old female patient with an atrophic edentulous maxilla and skeletal class III position: The preoperative orthopantomogram (a) shows an extensively atrophic maxilla; the preoperative lateral cephalogram (c) shows a narrow anterior alveolar ridge and a skeletal class III-jaw position. The postoperative orthopantomogram (b) shows a typical condition after placement of 7 endosseous implants, 18 mm and 20 mm long, 10 months after surgery. The corresponding lateral cephalogram (d) confirms the maxillary advancement.

shows that substantial resorption also occurs when fixtures are utilized in combination with onlay bone grafts (*Friedman*, 1988). In fact *Keller* et al. (1987) reported that 4 out of 28 Titanium fixtures were lost as a result of this. The so-called Le Fort I-sandwich-technique without opening the maxillary sinus described by *Keller* et al. (1987) can only be performed in cases where a substantial amount of alveolar ridge is present. Its major disadvantage, however, is that the maxillary sinus should not be opened. In addition, the horse-shoe-like osteotomized alveolar process is difficult to handle and may be associated with blood supply problems. Further the disadvantage of secondary

implantation of the endosseous implants must also be considered. *Keller* et al. (1987) reported that 5 out of 21 Titanium fixtures had failed when this procedure was used.
Apart from the use of *Brånemark*-fixtures (*Brånemark* et al., 1985), the present method has nothing in common with the trials of implant penetration of the nasal cavity (*Brånemark* et al., 1984) which is a risky intervention. This holds particularly for the bone wall or nasal mucosa-penetrating implants which had a loss rate of 28% compared to a 5% loss in the non-penetrating cases, over an observation time of up to 5 years (*Brånemark* et al., 1984). The difference between perforating and non-perforating implantations in the sinus floor area was 12% (*Brånemark* et al., 1984). Because of this substantial difference we advocate non-perforating techniques or the use of the bone-augmentation procedure as presently described (*Sailer*, 1988).
To date no other surgical method exists for treating totally atrophied maxillae which improves the intermaxillary relationship, the soft tissue condition and simultaneously allows placement of endosseous Titanium implants in adequate bone.

Acknowledgement

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