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Indications and procedures for segmental dentoalveolar osteotomy: A review of 13 patients

The authors evaluated the surgical area, indications, and procedures for segmental dentoalveolar osteotomy carried out on 16 jaws in 13 patients treated at the Department of Oral and Maxillofacial Surgery, Kobe University Graduate School of Medicine, between 1990 and 2001. Osteotomy was indicated mainly in cases where tooth repositioning by orthodontic treatment was limited, where social conditions (eg, age, time, finances) precluded orthodontic treatment, or where revision of orthodontic or surgical treatment was required. In cases of maxillary anterior segmental dentoalveolar osteotomy, the modified Wunderer method was used, where after an incision was made in the palatal mucosa, a mucoperiosteal flap was abraded as much as possible until the area of the osteotomy on the palatal side could be visualized. In maxillary posterior segmental dentoalveolar osteotomy, the operation was carried out in 2 stages because of the risk of necrosis of the bone fragments. In the first stage, an osteotomy was carried out on the vestibular side, since the vestibular gingival pedicle was intact. In the second stage, 3 weeks later, another osteotomy was performed after the palatal mucoperiosteal flap was abraded to visualize the area of the osteotomy as well as that of the maxillary anterior segmental dentoalveolar osteotomy. (Int J Adult Orthod Orthognath Surg 2002;17:254–263)

Bimaxillary protrusion may be defined as one of the more common forms of the Asian face. However, this feature can be regarded as a deformity necessitating corrective treatment. Since the position of anterior nasal spine cannot be corrected orthodontically, surgical orthopedic profiloplasty needs to be applied to the maxilla and the mandible. The most common procedure is a segmental dentoalveolar osteotomy, which in Japan has frequently been conducted by esthetic surgeons as profiloplasty for bimaxillary protrusion.[1,2] At the Department of Oral and Maxillofacial Surgery, Kobe University, however, this procedure has been indicated mainly in cases of malocclusion limited to the dentoalveolar region; therefore, the frequency of this operation is markedly lower than that at the Department of Aesthetic Surgery. This surgical technique has advantages, however, in terms of the effects of treatment, surgical invasiveness, and the social circumstances of the patient (age, treatment period, economic considerations).[3]

This study reviewed cases of segmental dentoalveolar osteotomies carried out in the Department of Oral and Maxillofacial Surgery, Kobe University, to clarify the indications, procedures, effects, and benefits of this type of osteotomy.

Patients and methods

Thirteen patients (16 jaws) underwent segmental dentoalveolar osteotomy between 1990 and 2001 (Table 1). Patients included 4 men and 9 women, ranging in age from 16 to 40 years (mean, 24.4 years). No complications such as bone necrosis were observed in any of the patients. The site, purpose, and procedure of the operation were evaluated.

Table 1 Patient data

Case	Sex	Age	Diagnosis	Operative procedure	Combination with jaw surgery
1	F	16	Reversed occlusion of the anterior teeth	ASDO-maxilla (2 teeth)	No
2	F	18	Bimaxillary dentoalveolar protrusion	ASDO-maxilla + ASDO-mandible	No
3	F	40	Reversed occlusion of the anterior teeth	ASDO-maxilla (4 teeth)	No
4	M	22	Bimaxillary dentoalveolar protrusion	ASDO-maxilla + ASDO-mandible	No
5	F	20	Anterior open bite	ASDO-maxilla	No
6	F	25	Bimaxillary dentoalveolar protrusion	ASDO-maxilla	L-1 + SSRO
7	F	35	Anterior open bite	PSDO-maxilla	No
8	M	21	Skeletal mandibular protrusion	ASDO-mandible	L-1 + SSRO
9	F	16	Skeletal mandibular protrusion	ASDO-maxilla + ASDO-mandible	SSRO
10	F	36	Mandibular asymmetry	APSDO-maxilla	SSRO
11	M	25	Skeletal mandibular protrusion	PSDO-maxilla	SSRO
12	F	18	Reversed occlusion of the anterior teeth	ASDO-maxilla (3 teeth)	No
13	M	18	Anterior open bite	ASDO-mandible	No

ASDO = anterior segmental dentoalveolar osteotomy; PSDO = posterior segmental dentoalveolar osteotomy; APSDO = anteroposterior segmental dentoalveolar osteotomy; L-1 = Le Fort I osteotomy; SSRO = sagittal split ramus osteotomy.

Results

Site of operation

Segmental dentoalveolar osteotomy in combination with Le Fort I osteotomy or sagittal split ramus osteotomy (SSRO) was carried out in 5 of the 13 patients, and segmental dentoalveolar osteotomy alone was used to improve dentoalveolar deformity in the remaining 8 patients. Maxillary anterior segmental dentoalveolar osteotomy (ASDO) was carried out in 8 of the 16 jaws, maxillary posterior segmental dentoalveolar osteotomy (PSDO) in 2, maxillary anteroposterior segmental dentoalveolar osteotomy (APSDO) in 1, and mandibular ASDO in 5. Neither corticotomy of Kole procedure nor single-tooth demo-osseous osteotomy was carried out. However, improvement of occlusion by repositioning of 4 or fewer teeth was carried out in 3 jaws treated by maxillary ASDO for malunited fractures.

Purpose of operation

Maxillary ASDO was carried out to improve teeth inclination in 1 jaw, anterior segmental dentoalveolar protrusion in 3, anterior reversed occlusion in 3, and anterior open bite in 1. Maxillary PSDO was carried out to expand the width of the maxillary alveolar arch in 1 jaw and to improve anterior open bite caused by posterior alveolar vertical overgrowth in 1 jaw.

Maxillary APSDO was applied to expand the width of the maxillary alveolar arch in 1 jaw. Mandibular ASDO was carried out to improve anterior teeth inclination in 3 jaws, anterior alveolar protrusion in 1, and anterior open bite in 1 (Table 2). Of the 13 patients, only 2 underwent this procedure for esthetic improvement: maxillary ASDO alone was carried out in case 3, and bimaxillary ASDO combined with SSRO in case 9.

Table 2 Indications for segmental dentoalveolar osteotomies

Operation/indication	No. of jaws
Maxillary anterior segmental dentoalveolar osteotomy	8
Inclination of anterior teeth	1
Anterior alveolar protrusion	3
Anterior reversed occlusion	3
Anterior open bite	1
Maxillary posterior segmental dentoalveolar osteotomy	2
Expansion of the maxillary alveolar arch width	1
Anterior open bite	1
Maxillary anteroposterior segmental dentoalveolar osteotomy	1
Expansion of the maxillary alveolar arch width	1
Mandibular anterior segmental dentoalveolar osteotomy	5
Inclination of anterior teeth	3
Anterior alveolar protrusion	1
Anterior open bite	1
Total	16

Operative procedure

The incision line and the areas of detachment in the maxillary segmental dentoalveolar osteotomies are shown in Figs 1a and 1b. The procedure for mucoperiosteal detachment was modified. Previously, the Wassmund method, consisting of a longitudinal incision in the medial palatal area, tunneling detachment, and osteotomy, had been used. In recent years, however, we have applied the modified Wunderer method. In this, the palatal mucosa is detached as far as possible toward the greater palatal foramen to clearly visualize the osteotomy site, whereas the reflected palatal mucoperiosteal area of the original Wunderer method is limited to the anterior portion of the hard palate. Particularly in the maxillary PSDO, the operation is carried out in 2 stages because of the risk of necrosis of the bone fragments. In the first stage, an osteotomy is carried out on the vestibular side. Two incisions are made in the vestibule perpendicular to the gingival margin. The anterior incision is made 1 width of a tooth medial to the planned osteotomy line. The posterior incision is made 1 width of a molar posterior to the zygomaticoalveolar crest. The mucoperiosteum around the anterior incision is elevated, not only over the roots but also in the canine fossa. The periosteum with the muscular insertions is elevated widely in the direction of the infraorbital foramen and the root of the zygomatic process with preservation of the gingiva, until a spacious tunnel has been formed beneath the soft tissue of the cheek. A similar procedure is carried out from the posterior incision to expose the infratemporal region and the rounded external surface of the tuberosity subperiosteally. In the second stage, 3 weeks thereafter, the second osteotomy is carried out after the palatal mucoperiosteal flap is abraded to visualize the area of the osteotomy as well as that of the maxillary ASDO. The palatal mucosa is elevated beginning at the gingiva and ending at the maxillary tuberosity; the palatal vessels are preserved.

Case reports

Case 3

A 40-year-old woman with anterior reversed occlusion attributed to a malunited fracture underwent ASDO in the area of the maxillary incisors. Longitudinal

Figs 1a and 1b Change of procedure of mucoperiosteum detachment in maxillary alveolar osteotomy. Bold lines = incision line; dotted areas = areas of detachment.

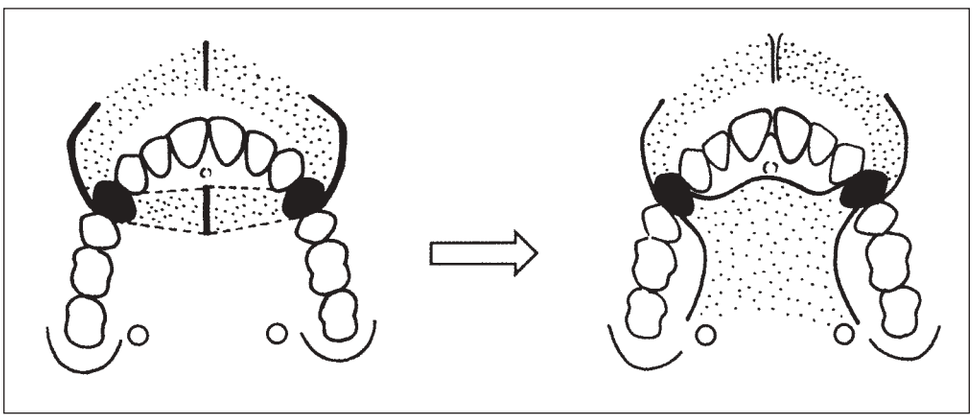


Fig 1a Maxillary anterior alveolar osteotomy.

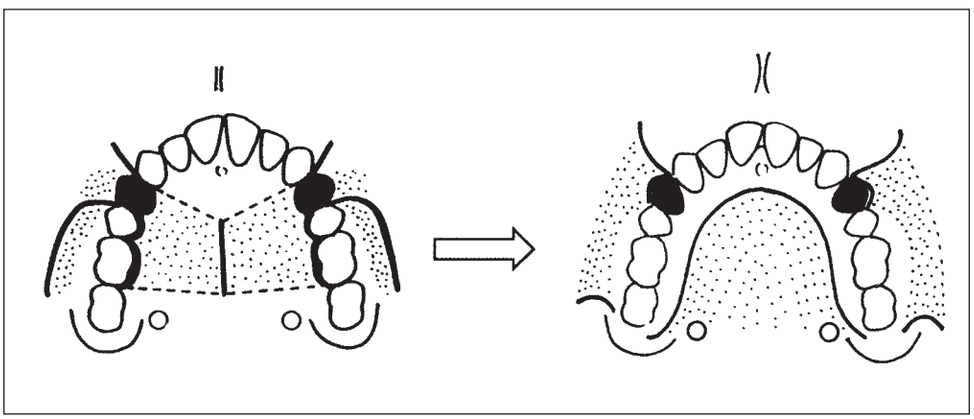


Fig 1b Maxillary posterior alveolar osteotomy.

mucogingival vestibular incisions were made at the right lateral incisor and the left canine. After a vestibular tunneling detachment, the osteotomy for improving the occlusion by repositioning only 4 teeth was carried out. The palatal side was not detached. The final occlusion was established with a dental implant. The chief complaint of the patient was not masticatory dysfunction but maxillary anterior dentoalveolar retrusion, an esthetic problem (Figs 2a to 2c).

Case 7

A 35-year-old woman with anterior open bite attributed to vertical overgrowth of the maxillary posterior alveolar process underwent maxillary PSDO. To minimize detachment of the palatal mucosa, the Wassmund method was used. A median longitudinal incision was made in the posterior hard palate, and after a tunneling detachment, the osteotomy was carried out. During the osteotomy, the right greater palatine artery was injured, but postoperative bone necrosis did not develop. The overbite improved to 5 mm (Figs 3a to 3d).

Case 8

Mandibular ASDO combined with preoperative orthodontic treatment was carried out on a 21-year-old man with skeletal mandibular protrusion, where orthodontic treatment was considered to have limitations in improving the inclination of the mandibular anterior teeth. The occlusion was restored by bimaxillary surgery (Le Fort I osteotomy and SSRO) (Figs 4a and 4b).

Case 9

A 16-year-old woman with skeletal mandibular protrusion combined with marked bimaxillary protrusion attributed to preoperative orthodontic treatment without tooth extraction by a general dentist,

Figs 2a and 2b Case 3, preoperative and final views (after prosthodontic treatment).

Fig 2c Case 3, procedure of osteotomy.

Fig 3a *(left)* Case 7, preoperative radiograph.

Fig 3b *(right)* Case 7, postoperative radiograph.

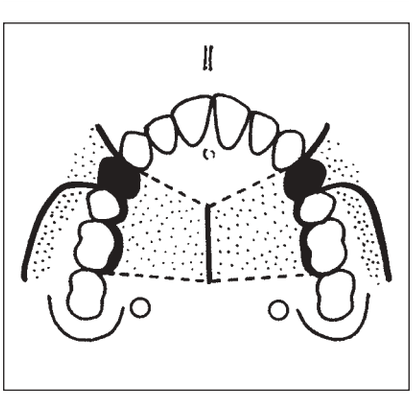


Fig 3c Case 7, area of detachment.

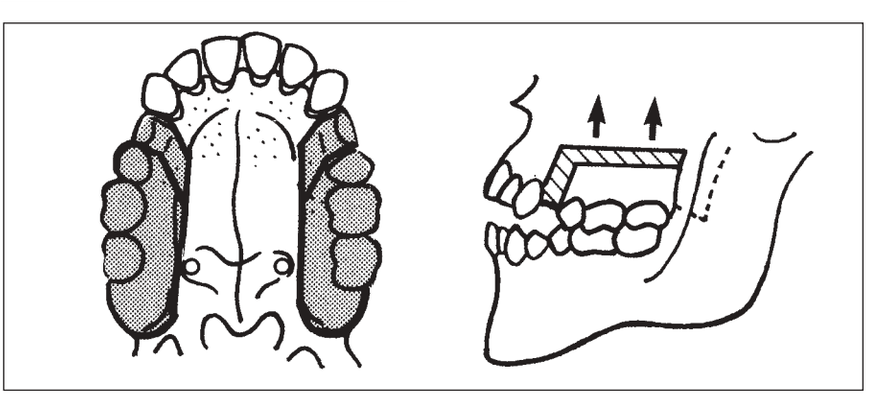


Fig 3d Case 7, osteotomy.

Fig 4a *(left)* Case 8, preoperative radiograph.

Fig 4b *(right)* Case 8, postoperative radiograph.

Fig 5a *(left)* Case 9, preoperative lateral facial view.

Fig 5b *(right)* Case 9, postoperative lateral facial view.

Fig 5c *(left)* Case 9, preoperative occlusion.

Fig 5d *(right)* Case 9, postoperative occlusion.

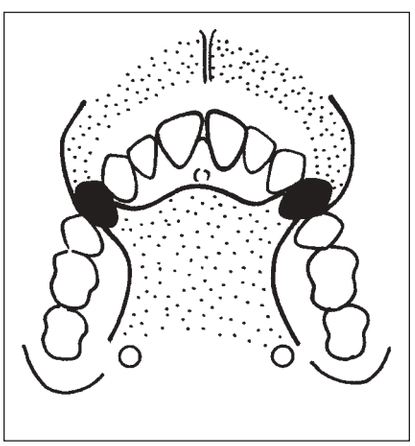


Fig 5e Case 9, area of detachment.

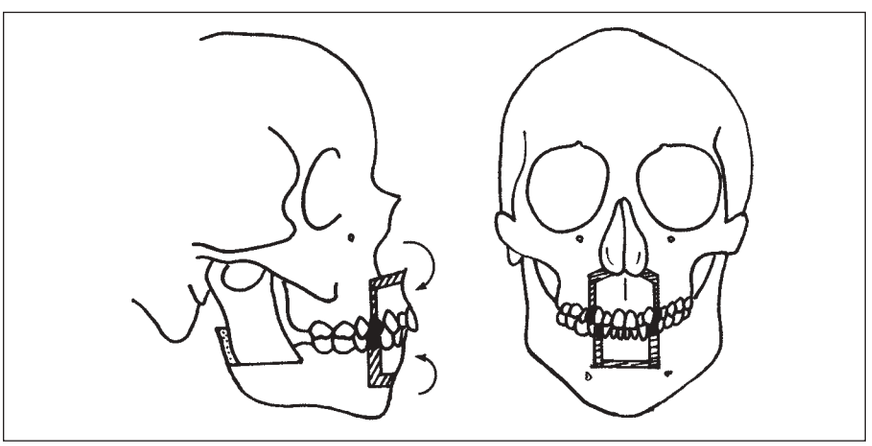


Fig 5f Case 9, osteotomy.

not an orthodontist, was treated by the modified Wunderer method for esthetic improvement. Simultaneously, mandibular SSRO was carried out to improve the occlusion. Postoperatively, the patient was satisfied with both her profile and occlusion (Figs 5a to 5f).

Case 10

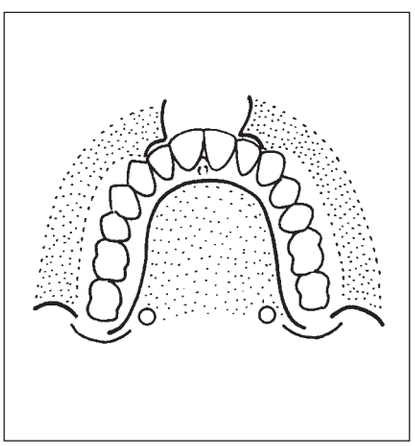
A 36-year-old woman requiring expansion of the maxillary alveolar arch preferred surgery to orthodontic treatment because of age and social circumstances. Maxillary APSDO was carried out in 2 stages to expand the maxillary alveolar arch. In the first stage, an osteotomy was

Fig 6a *(left)* Case 10, preoperative facial view.

Fig 6b *(right)* Case 10, postoperative facial view.

Fig 6c *(left)* Case 10, preoperative occlusion.

Fig 6d *(right)* Case 10, postoperative occlusion.



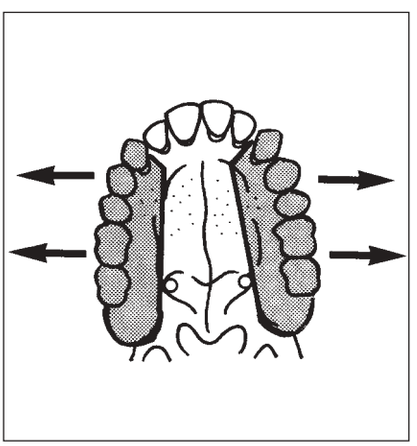


Fig 6e *(left)* Case 10, area of detachment.

Fig 6f *(right)* Case 10, osteotomy.

carried out on the vestibular side. In the second stage, performed 3 weeks later, the palatal mucosa was detached to the extent that osteotomy was possible under clear vision, and the palatal side was divided. The asymmetry of the mandible was improved by SSRO. The patient was satisfied with the short period of the treatment (Figs 6a to 6f).

Case 13

An 18-year-old man underwent open reduction of a mandibular fracture. Reduction was undertaken without adequate consideration of occlusion, resulting in an anterior open bite. Osteotomy by the Kole method was carried out to improve the occlusion. Considering the profile, especially

Fig 7a Case 13, preoperative view.

Fig 7b Case 13, postoperative view.

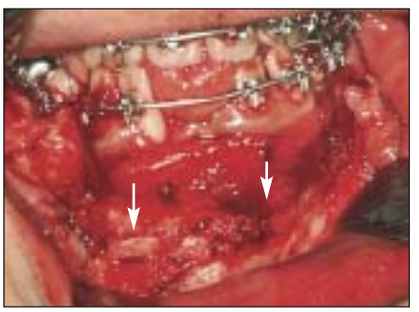
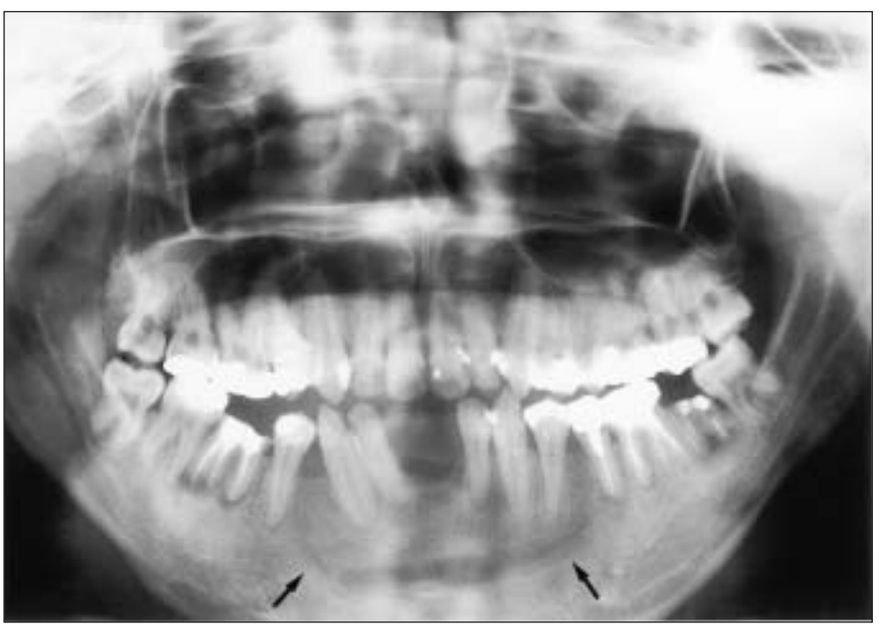


Fig 7c Case 13, grafting of iliac bone block and particulate cancellous bone and marrow *(arrows).*

Fig 7d Case 13, 6 months postoperatively. Arrows = good bone formation.



the facial height, iliac bone blocks and particulate cancellous bone and marrow (PCBM), rather than the bone segments from the chin, were transplanted into the gap. Six months after the operation, radiographs showed good bone formation. Orthodontic treatment is presently ongoing to detail the occlusion (Figs 7a to 7d).

Discussion

Bimaxillary protrusion may be defined as one of the most common forms of the Asian face. Japanese people tend to regard the Caucasian face as beautiful and the bimaxillary protrusion specific to the Japanese as unattractive.[1,2] Since patients with bimaxillary protrusion often visit the Department of Aesthetic Surgery wanting to improve the facial profile, segmental dentoalveolar surgery is carried out on a large number of such patients. However, most of those who consult the Department of Oral and Maxillofacial Surgery complain mainly of malocclusion. Segmental dentoalveolar surgery is rarely carried out on such patients at present because of the advances in orthodontic techniques.[3] It has been carried out on only 13 patients over the past 12 years (4% of 320 cases of orthognathic surgery) in our department, where dentoalveolar deformities are, whenever possible, preoperatively improved by orthodontic treatment. Osteotomy was indicated

mainly in cases where tooth repositioning by orthodontic treatment was limited; where social conditions (age, time, economic circumstances) precluded orthodontic treatment; or where revision of orthodontic or surgical treatment was required. Our treatment principle of jaw deformity has been to minimize surgical invasion by maximal orthodontic treatment, which results in long treatment periods for some patients. To shorten the period, the systemic incorporation of segmental dentoalveolar osteotomy in preoperative orthodontic treatment, as carried out in cases 6 and 8, may be important.[4]

During the 12-year period, the procedure for mucoperiosteal detachment in maxillary dentoalveolar osteotomy has changed. Whether vestibular or palatal mucogingival pedicles are superior in blood supply to osteotomy segments has been and still is the subject of controversy. Yeow et al[4] have described the importance of palatal blood supply, but Dennis et al[5] have described patients with pure palatal mucoperiosteal blood supply alone who developed severe bone necrosis; they also considered the vestibular and palatal blood supply similarly important. McCarthy[3] and Henderson[6] have suggested that blood supply from a vestibular mucogingival or palatal pedicle on at least one side of the alveolar bone segment is desirable but that the presence of both pedicles is optimal. They have proposed that the palatal pedicle should be selected when a choice between the two is presented, because vestibular pedicles are less firmly attached, more vulnerable to damage, and inferior in blood supply. Dennis et al[5] have recommended the preservation of the descending palatine artery whenever possible. However, Henderson[6] has discussed the subject as follows: "The collateral circulation within the maxilla and its soft tissue investment forms a complex network of supply to both bone and teeth comprising labial, buccal, and palatal afferents; apical, intraalveolar and pulpal vessels; and palatal, periodontal, and gingival plexuses—all intercommunicating and not irreversibly committed to the in vivo centrifugal pattern of flow after disturbance of the intramedullary haemodynamic balance which occurs as a result of osteotomy. Perhaps the most important pedicle supply is that delivered from the palate, but even this is not dependent upon preservation of the greater palatine arteries."[6p150] Bell et al[7] have also suggested that the preservation of the greater palatine artery is not always necessary to maintain blood flow to maxillary bone segments in Le Fort I osteotomy. In our case 7, bone necrosis did not develop despite injury to the unilateral greater palatine artery; this supports the opinions of Henderson[6] and Bell et al.[7] Based on previous reports[5–7] and our clinical experience, we have recently begun using the modified Wunderer method[8] for mucoperiosteal detachment on the palatal side. The vascularized periosteum shows an excellent osteogenic capacity. Even after palatal mucoperiosteal detachment, when periosteal continuity is preserved and adequate blood supply to the periosteum is obtained, good new bone formation is achieved, and bone necrosis can be avoided by reapplication of the mucoperiosteal flap to the bone segment. A high percentage of osteocytes die, but some survive in subcutaneously implanted ribs with the periosteum preserved, and marked osteogenic activity is observed primarily in the enlarged Haversian canals.[9,10] In addition, many investigators[11–13] have shown in animal experiments that vascularized periosteal grafting, even without bone, results in new bone formation from the periosteum itself. These results support the basis for palatal mucoperiosteal detachment by the modified Wunderer method.[8]

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