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Orthognathic Surgery for Occlusal Reconstruction of Old Malunited Jaw Fracture

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Old malunited jaw fractures of nine patients who underwent orthognathic surgery for occlusal reconstruction were clinically evaluated. Early surgery on fractures of the jaw is the optimal treatment when due attention must be paid to occlusion. Since occlusal revision surgery subsequent to inaccurate diagnosis and inappropriate surgery is certainly very difficult and often unsuccessful, surgeons need to pay special attention to this situation.

Fractures in the oral and maxillofacial region, especially midfacial fractures, are often complicated by severe injuries such as cranial bone fractures and cerebrovascular damage (9). Since priority is given to the treatment of severe complications, fractures in the oral and maxillofacial region tend to become old because of deferred treatment, thus causing skeletal malocclusion. On the other hand, even in the absence of complications and when reduction is carried out relatively early, surgery without due consideration to occlusion can result in masticatory disturbances attributable to malocclusion (6).

The purpose of this study was to clinically evaluate patients with old malunited fractures of the jaw who underwent orthognathic surgery for occlusal reconstruction, and to clarify the problems associated with such surgery.

SUBJECTS AND METHODS

Nine patients with old malunited jaw fractures who underwent orthognathic surgery showed malocclusion and complained of masticatory disturbance. Six patients (Nos. 1, 3, 4, 5, 7 and 8) showed reversed occlusion because of maxillary fractures. The other three patients (Nos. 2, 6 and 9) suffered from malocclusion because of condylar fractures and showed anterior open bite. The jaw fractures of patients 1 to 5 had become old and malunited because priority had been given to the treatment of injuries other than the jaw fractures (*previously untreated group*). Reduction surgery had been performed early for patients 6 to 9, but without due consideration to occlusion (*previously treated group*). Le Fort I osteotomy alone was used for four patients, sagittal splitting ramus osteotomy (SSRO) (Fig.1) alone for

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three, and two-jaw surgery (Le Fort I osteotomy (Fig.2) + SSRO) and mandibular anterior alveolar osteotomy using Köle's method (Fig.3) for one each (Table 1).

The occlusal condition of the malunited fractures, the selection of surgical procedures, and the surgical results were all evaluated.

The surgical results for five patients (three in *the previously untreated group* and two in *previously treated group*), who underwent Le Fort I osteotomy for old malunited fractures of the maxilla, were compared with those for another 20 patients with common jaw deformities who underwent the same operation. The problems that such old fractures impose for orthognathic surgery were also examined. For cephalometric analysis, the SNA angle and Ptm'-ANS length were used (Fig.4), and the difference between the actual and the computer-predicted extent of preoperative repositioning was calculated.

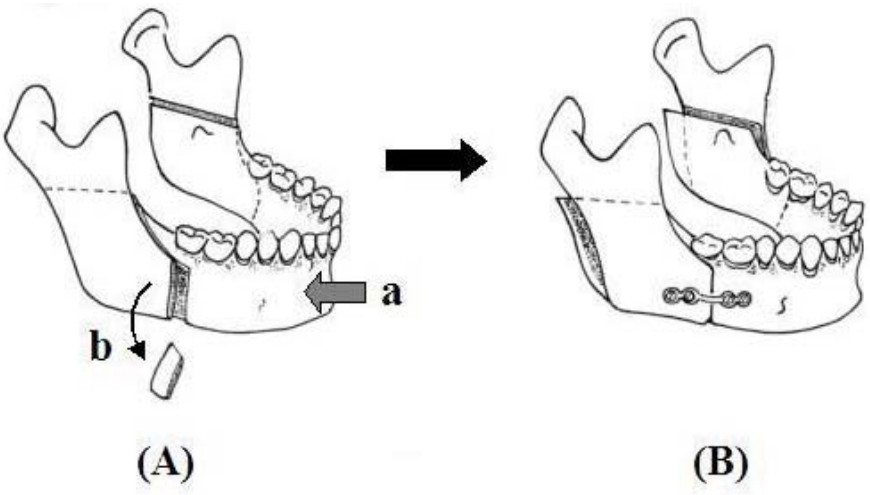

Fig. 1 Sagittal splitting ramus osteotomy (SSRO)
Sagittal splitting ramus osteotomy (SSRO) is the most versatile form of ramus osteotomy, as it can be used for both mandibular advancement and setback (a). The procedure uses an intraoral approach and the ramus, angle, and posterior body of the mandible are split in the sagittal dimension, resulting in a proximal condyle-bearing segment and a distal tooth-bearing segment. In the case of set-back, a section of the buccal plate (b) is removed to allow good approximation of the buccal cortex of the proximal segment against the lingual cortex of the distal segment on each side (A). The procedure requires special instrumentation to be performed with ease. Titanium or dissolvable miniplates are used to effect semi-rigid fixation (B).

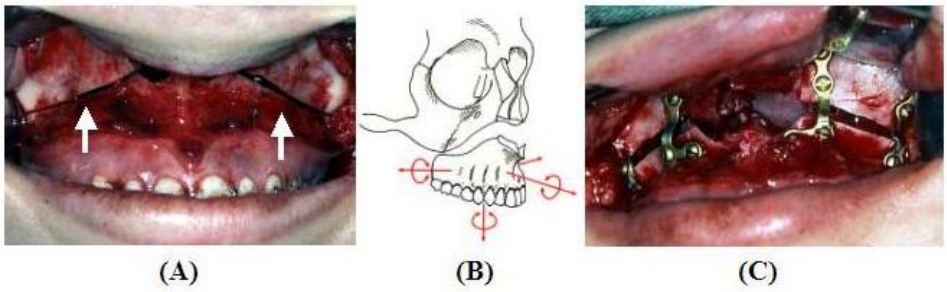

Fig.2 Le Fort I osteotomy
For Le Fort I osteotomy, the maxilla is sectioned transversely at the level between the roots of the teeth (note that the root of the cuspid may extend as high as the piriform rim) and the infraorbital foramen (A). After the lower portion of the maxilla is mobilized, movement in a number of directions is possible (B). Titanium or dissolvable miniplates are used to effect semi-rigid fixation (C).

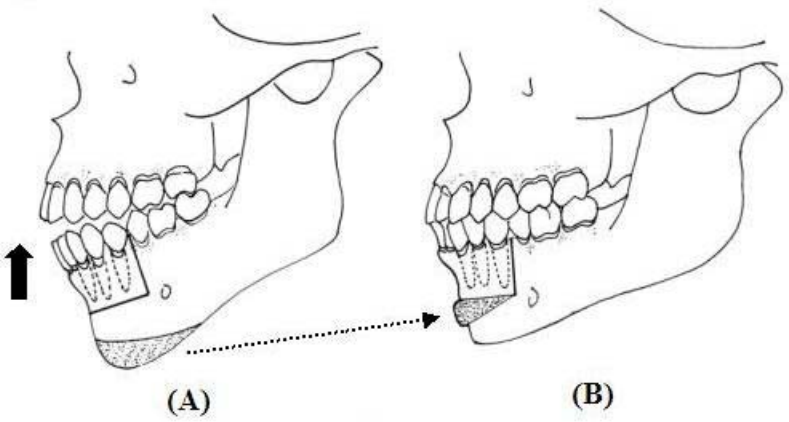

Fig.3 Köle procedure
The Köle procedure is used to correct minor anterior open bite and reduce the vertical height of the symphysis. Sufficient bone must be preserved between the anterior segmental dentoalveolar osteotomy and the horizontal osteotomy of the lower border of the mandible. The transverse cut of the dentoalveolar osteotomy is made at least 5 mm below the apices of the teeth (A). The anterior open bite has been closed, and the resulting defect is filled with bone taken from the inferior border of the symphysis (B).

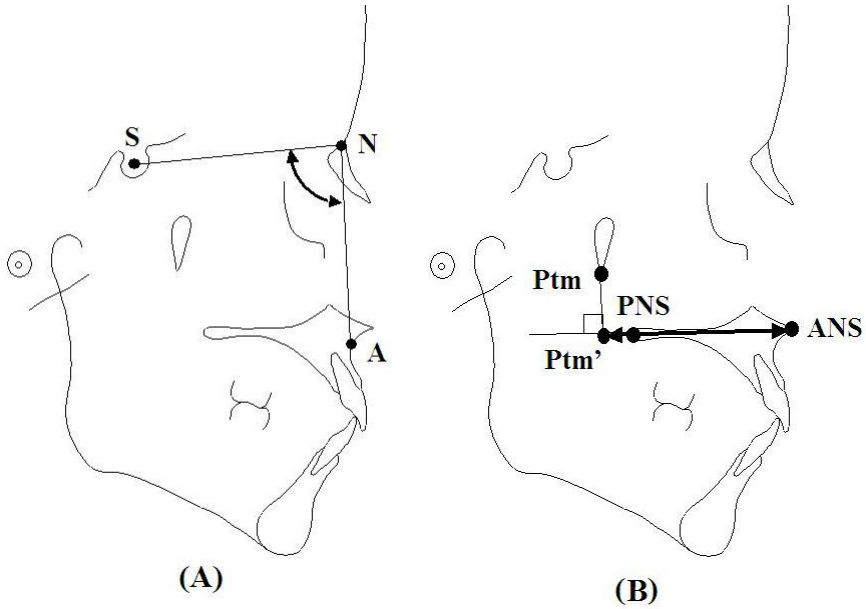

Fig.4 Cephalometric landmarks and SNA angle and length of Ptm'-ANS
S: Sella - geometric centre of the pituitary fossa located by visual inspection. **N**: Nasion - located at the most anterior point of the nasofrontal suture in the midsagittal plane. **Point A**: Subspinale - the most posterior midline in the concavity between the anterior nasal spine (ANS) and prosthion (the most inferior point on the alveolar bone overlying the maxillary central incisor.) **ANS**: Anterior nasal spine - the most anterior point of the nasal floor. **PNS**: Posterior nasal spine - the posterior spine of the palatine bone constituting the hard palate. **Ptm**: Pterygomaxillary fissure - the contour of the pterygomaxillary fissure formed anteriorly by the anterior curve of the pterygoid process of the ahenoid bone. The lowest point of the opening is used as the landmark. **Ptm'**: (Pterygomaxillary fissure)' - the point of Ptm running perpendicular to the ANS-PNS line (palatal plane). **SNA** (A) is the angular landmark often used to determine the degree of protrusion or retrusion of the maxilla relative to the cranial base (SN line). **Ptm'-ANS** (B) is the landmark of the length used to determine the degree of protrusion or retrusion of the maxilla.

Table 1: Patients (1-5: Previously untreated group, 6-9: Previously treated group)

Patient	Sex	Age	Fracture	Cranial injury	Occlusal condition	Orthognathic surgery
1	M	25	Mx, Zy	+	Reversed occlusion	Le Fort I
2	F	20	Cd	+	Anterior open bite	SSRO
3	M	20	Mx	+	Reversed occlusion	SSRO
4	M	39	Mx, Zy	+	Reversed occlusion	Le Fort I
5	M	38	Mx	+	Reversed occlusion	Le Fort I
6	M	30	Mx, Md, Cd	−	Anterior open bite	Le Fort I + SSRO
7	F	60	Mx, Md, Zy	−	Reversed occlusion	Le Fort I
8	M	26	Mx, Zy	−	Reversed occlusion	SSRO
9	M	19	Cd, Md	−	Anterior open bite	Köle (iliac bone graft)

Mx: Maxillary fracture
Zy: Zygomatic fracture
Cd: Bilateral condylar fracture
Md: Mandibular body fracture
SSRO: Sagittal splitting osteotomy

RESULTS

(1) SNA angle

In the group with jaw deformities, the mean difference between the actual and predicted extent of repositioning was -0.17° (SD: 0.5). In *the previously untreated group*, the difference was 0° for patient 1, -1.0° for patient 4, and 0° for patient 5, so that the actual and predicted values were almost the same. In *the previously treated group*, however, the difference was -4.0° for patient 6 and -7.5° for patient 7, suggesting marked restrictions of maxillary anterior-inferior rotation (Table 2).

(2) Ptm'-ANS length s

In the group with jaw deformities, the mean difference between the actual and predicted repositioning values was 0.72 mm (SD: 1.1). In *the previously untreated group*, the difference was 0 mm for patient 1, -1.0 mm for patient 4, and 0 mm for patient 5, indicating that the predicted and actual values were similar. In *the previously treated group*, the difference was -6.0 mm for patient 6 and -3.0 mm for patient 7, showing a marked restriction of maxillary anterior repositioning (Table 2).

Table 2: Cephalometric analysis of Le Fort I osteotomy

	Malunited fracture			Jaw deformity
		Case	Difference *	Difference *
SNA angle (unit: angle)	Previously untreated group	1	0	− 0.17 (SD 0.5)
		4	− 1.0	
		5	0	
	Previously treated group	6	− 4.0	
		7	− 7.5	
Ptm'-ANS length (unit: mm)	Previously untreated group	1	0	0.72 (SD 1.1)
		4	− 1.0	
		5	0	
	Previously treated group	6	− 6.0	
		7	− 3.0	

Difference * = Post-operative − Predicted

CLINICAL CASES

Four representative cases of old malunited fractures of the jaw treated with orthognathic surgery are presented. Patient 4 was in *the previously untreated group*, and patients 7, 8 and 9 were in the *previously treated group*.

(1) Patient 4

A 39-year-old man had old malunited bilateral maxillary and right zygomatic fractures with reversed occlusion because of maxillary posterior deviation. Cheek depression and enophtalmos was attributable to the right zygomatic fracture. The maxillary and zygomatic fractures had become old because priority had been given to the treatment of a complication arising from a cranial base fracture and subarachnoid haemorrhage. Seven months after the injury, maxillary reduction by Le Fort I osteotomy with a new osteotomy line and zygomatic reduction by means of a bilateral temporo-occipital incision were performed; in addition, non-vascularized free iliac bone grafting into the bone defect of the orbital floor was carried out. When the fracture line showed complete bone healing, surgery using a method similar to that for common jaw deformity was performed. After this surgery, the cheek depression, enophtalmos, double vision and the occlusion all improved (Fig.5).

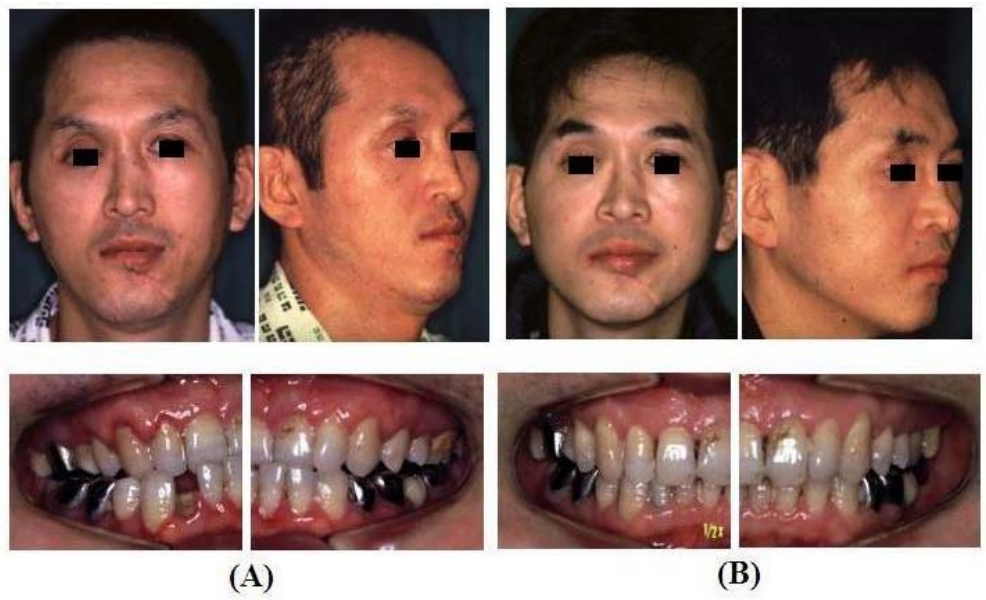

Fig.5 Patient 4: (A) pre-operative; (B) post-operative

(2) Patient 7

A 60-year-old woman sustained bilateral maxillary, right zygomatic and right mandibular fractures. Although reduction surgery was carried out immediately after the injury, a sensation of midfacial depression and reversed occlusion remained because of inadequate initial reduction surgery. Six months after the injury, Le Fort I osteotomy with a new osteotomy line was carried out. Difficulties encountered with maxillary repositioning were caused by severe scar formation attributed to the initial surgery, and selection of the site for refixing the mini-plate was also problematic. The results of both repositioning and fixing were unsatisfactory because the midfacial depression remained even though the reversed occlusion improved to an edge-to-edge bite achieved with difficulty. In short, good results were not obtained (Fig.6).

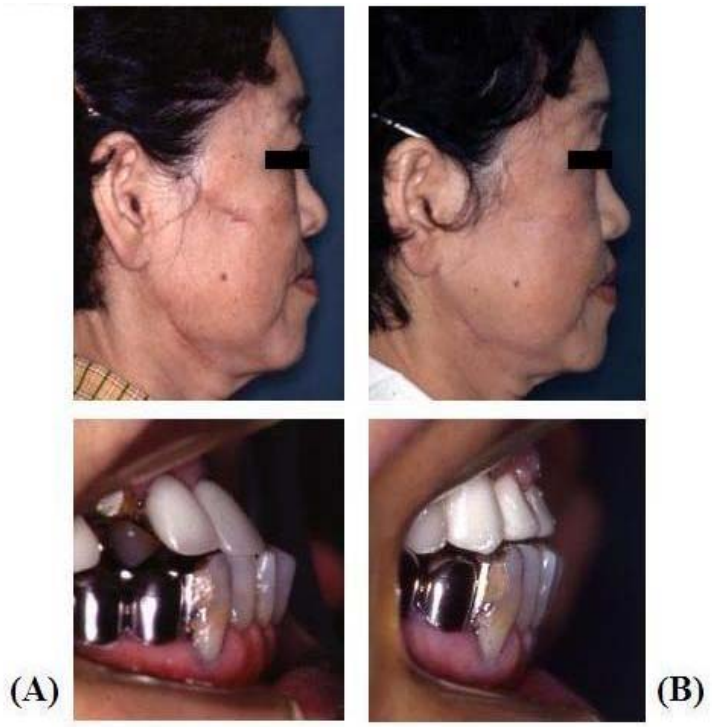

Fig.6 Patient 7: (A) pre-operative; (B) post-operative

(3) Patient 8

A 26-year-old man experienced a sensation of midfacial depression and an edge-to-edge bite because of posterior maxillary deviation resulting from right complex maxillary and zygomatic bone fractures sustained in a traffic accident. While anterior repositioning of the injured maxilla is the usual procedure for aesthetic and occlusal recovery, in view of the results of cephalometric analysis and for a balanced profile, mandibular posterior repositioning by SSRO was selected. Considering scar formation and the many mini-plates placed during the initial operation, repositioning was selected in view of the poor results for patient 7. The outcomes for this patient were satisfactory, aesthetically as well as functionally (Fig.7).

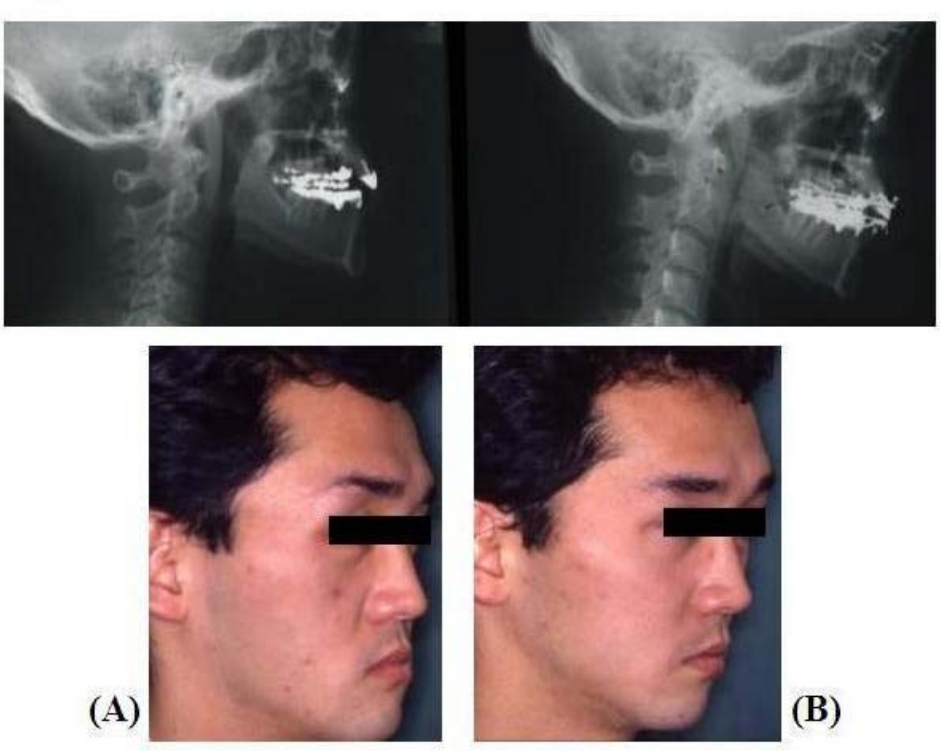

Fig.7 Patient 8: (A) pre-operative; (B) post-operative

(4) Patient 9

A 19-year-old man sustained a bilateral condylar fracture and a right mandibular body fracture, resulting in an anterior open bite because of inappropriate treatment for occlusion. Six months after the initial reduction, the mandibular body fracture and malalignment of the dental arch, as well as the results of various analyses, prompted us to select mandibular anterior alveolar osteotomy using Köle's procedure for improvement of the anterior open bite. Because of careful consideration of the resultant profile, the iliac bone rather than the chin bone was grafted into the interosseous space at the chin. Subsequent occlusal detailing initiated as part of the orthodontic treatment was discontinued because of the patient's personal reasons. Prosthodontic treatment then completed the procedure (Fig.8).

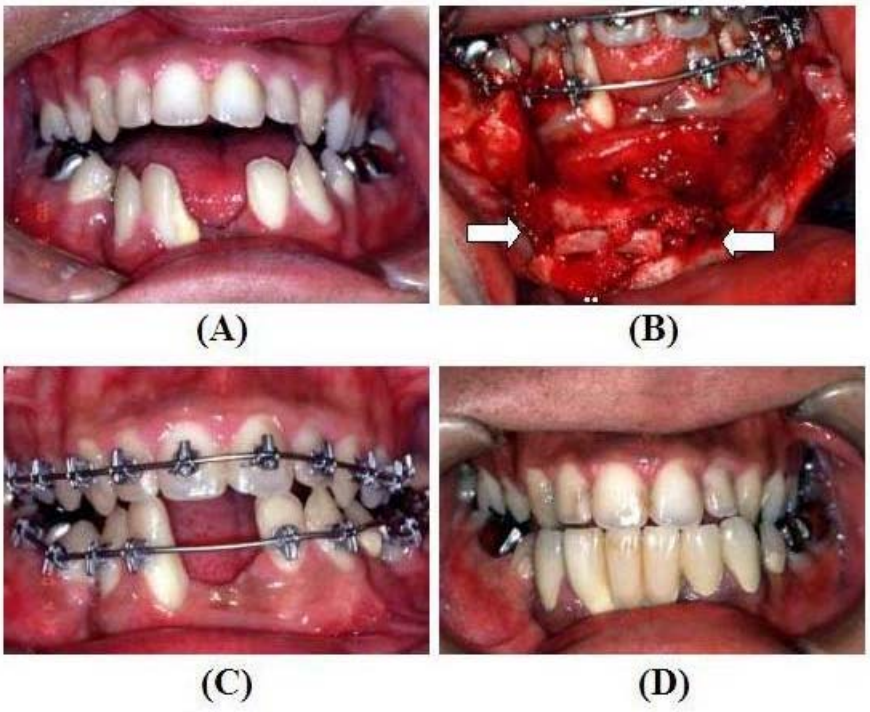

Fig.8 Patient 9: (A) pre-operative; (B) iliac bone graft; (C) post-operative; (D) final occlusion achieved with prosthodontic treatment

DISCUSSION

Our study found that one of the two causes of malocclusion in old malunited fractures of the jaw was the non-treatment of the jaw fractures because priority had been given to the treatment of other organs, resulting in the fractures becoming old. Patients whose malocclusion was due to these circumstances were classified as *the previously untreated group*. The other cause was that occlusion was not taken into consideration despite relatively early reduction surgery because of inaccurate diagnosis and inappropriate treatment of occlusion. The patients in these circumstances were classified as *the previously treated group*. In *the previously untreated group* because external force had been applied to 1/3 of the cranial area of the face, cranial injury was regarded as a related complication, and the jaw fractures were treated later (5,6). In the patients of *the previously treated group*, no cranial injury was observed since external force had been applied only to the lower half of the face, so that most patients had mandibular fractures. Early reduction surgery of the jaw was thus possible because of the absence of cranial injury.

Jaw fractures that have become old are difficult to restore to their pre-injury state by means of re-reduction. Therefore, orthognathic surgery is the established first choice of treatment, particularly for deviations of the entire jaw. In old maxillary malunited fractures, the Le Fort type fracture often results in reversed occlusion due to deviation of the entire posterior maxilla (patients 1, 3, 4, 5, 7, 8). In the mandible, on the other hand, condylar fractures result in anterior open bite because of deviation of the entire posteriosuperior mandible (patients 2 and 6) (10). In such cases, re-reduction at the fracture site is very difficult, and orthognathic surgery for recovery of the occlusion is the best treatment (2). Re-reduction is indicated for patients with malalignment of the dental arch attributable to complications such as mandibular body fracture. In the posterior area, however, re-reduction is very difficult because of the involvement of the mandibular canal. For such patients, occlusal reconstruction by means of alveolar segmental osteotomy as well as orthodontic and prosthodontic treatment is needed (patient 9) (1, 8).

The patients in *the previously untreated group* with maxillary malunited fractures (patients 1, 3 and 4) underwent orthognathic surgery an average of 7 months after they incurred their injuries. The fracture line showed complete bony healing (3, 7), and surgery was carried out with a procedure similar to that for common jaw deformity. For patients in *the previously treated group* with maxillary malunited fractures (patients 6 and 7), satisfactory results were not attainable because of severe scar formation of the wound after the initial reduction and the restricted site for mini-plate fixation. Analysis of the SNA angle and Ptm'-ANS length showed that repositioning of the bone segment, as preoperatively predicted, could not be achieved, so that for such patients it is highly probable that surgical approaches to the injured maxilla will be unsuccessful. The key for successful surgical results is therefore mandibular posterior repositioning and the avoidance of maxillary approaches. In these cases, repositioning of the entire mandible is necessary, and orthognathic surgery such as SSRO is indicated (patients 3 and 8).

CONCLUSION

Early surgery for jaw fractures is best when occlusion is a major concern. However, when diagnosis of occlusion is inaccurate and treatment is inappropriate, revision surgery becomes very difficult and often produces poor results. Surgeons should therefore take this possibility into careful consideration.

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