Indications to the Use of Condylar Repositioning Devices in the Surgical Treatment of Dental-Skeletal Class III

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Purpose: The aim of this report was to compare the clinical and radiographic findings observed at the 12-month follow-up in 2 groups of 15 patients who underwent Le Fort I and bilateral sagittal split osteotomy for the correction of dental-skeletal Class III. In the first group, the condylar positioning devices were used, whereas in the second group, an alternative method was used for the intraoperative assessment of mandibular repositioning.

Materials and Methods: All of the patients of our study in the immediate presurgical period were without temporomandibular joint disorders and with a normal anatomic relationship between condyle and fossae. The condyle position and morphology were examined at the 12-month follow-up through cephalometric measurements and the postsurgical findings in both groups were compared with those observed in the presurgical period.

Results: In all of the 30 patients in our study, no relapse or postsurgical temporomandibular joint disturbance was observed at the 12-month follow-up. Variations in condyle position of more than 2 mm or 2° were not observed in the 15 patients treated with condylar positioning devices. Changes in condyle position between 2 and 4 mm and 2° and 4° were observed in 6 of the 15 patients treated without the devices.

Conclusions: The use of condylar positioning devices can be avoided in patients with dental-skeletal Class III without presurgical temporomandibular dysfunction. The manual positioning of the mandibular condyle is easier, but it requires the utmost care and an experienced operator.

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According to several authors,[1-6] the surgical repositioning of the mandible may modify the morphology and position of the mandibular condyle, thus causing postsurgical temporomandibular joint (TMJ) disturbances and relapse. Condylar positioning devices (CPDs) have been introduced in orthognathic surgery to hold the mandibular condyle stable in all 3 planes of the space during the surgical treatment of maxillomandibular malformations. CPDs were used for the first time in 1976[7] for mandibular repositioning and in the mid-1980s for bimaxillary surgical treatments.

CPDs have led to longer operative times, the necessity to keep intermaxillary fixation as stable as possible during their application,[8] and the risk of partial bone disruption of the maxilla. Their use has also caused the need for precision during the construction of the splint or intraoperative wax bite[5,8-10] and the prevention of mandibular autorotation.[8] Therefore, their use is controversial and their indications are still under discussion.

The purpose of this report was compare clinical and radiographic results 12 months after Le Fort I (LFI) and bilateral sagittal split osteotomy (BSSO) in 30 patients without signs and symptoms of TMJ dysfunction. Half of the 30 patients were treated with CPDs, whereas the other 15 were treated with manual control of mandibular positioning.

Materials and Methods

Thirty skeletal Class III patients who underwent LFI and BSSO between January 1, 1998, and December

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31, 1999, at the Maxillofacial Surgery Department of the University of Rome "La Sapienza" were included in the study. The 30 patients formed an homogeneous sample because all of them were without presurgical signs and symptoms of TMJ dysfunction and in all cases BSSO were fixed with 3 bicortical screws. Presurgical orthodontic therapy, based on both plaster cast examination and 3-dimensional clinical assessment of the occlusion, was carried out in all patients during an average period of 6 to 8 months, until a correct dental alignment was achieved. The 30 patients were divided into 2 equal groups based on the technique of condylar positioning technique used. In the first group, the presurgical condyle position was reproduced through the application of CPDs, whereas, in the second group, it was not.

All of the patients in the presurgical period underwent a 3-dimensional clinical, functional, and aesthetic assessment as well as radiographic examinations such as orthopantomography radiography and posteroanterior and lateral cephalography. In the preoperative period, neuromuscular function was assessed through electrognathomyographic examination (Biopack System; BioResearch Associates Inc, Milwaukee, WI). The Biopack system is composed of 3 parts: an electromyograph with 8 channels, a cephalostate kinesiograph (Siemens, Munich, Germany), and a software for recording and processing data. The electrognathomyographic examinations were standardized in all of the 30 patients as follows. The 8 electrodes were placed on the masseter, temporalis (2 points), and the sternocleidomastoid bilaterally. Muscular activities were recorded during chewing, swallowing, and maximal contraction and at rest. Muscular function was analyzed, and neuromuscular balance of stomatognathic apparatus was assessed in each patient. Finally, the recordings were saved in a computer. In the presurgical period, electromyographic examinations revealed good neuromuscular function in all of the 30 patients.

The condyle-fossae relationship was examined with cephalometric measures obtained after bilateral TMJ radiographic tomography and submentovertex radiographs, in accordance with Iannetti[11] and Kawamata et al[12] (Figs 1, 2). In all cases, presurgical radiographs were taken with patients in centric occlusion, without the application of splints or bite registration material. The examination showed a normal relationship between mandibular condyle and glenoid cavity and no maxillomandibular asymmetries, hypoplasias, and/or mandibular deviations.

All patients underwent a combined approach with LFI osteotomies and BSSO. Stabilization of the up maxilla was achieved with 2 miniplates anteriorly, 2 osteosynthesis wires and 2 steel suspension wires

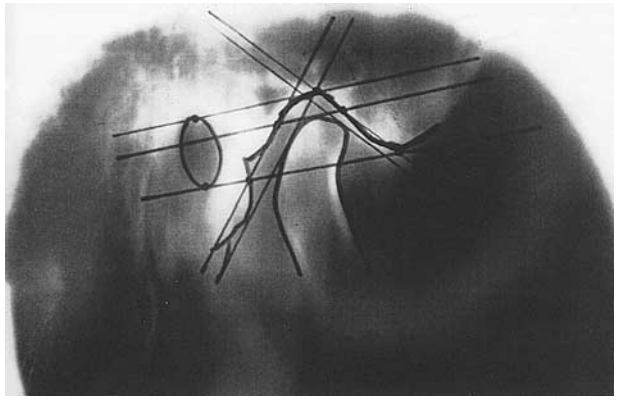

FIGURE 1. Cephalometrics from TMJ tomography: condyle sagittal position is given by the distance between the uppermost point of condylar head and the uppermost point of glenoid fossa, the foremost point of condylar head and the foremost uppermost point of fossa, from the rearmost point of condylar head to the rearmost uppermost point of fossa.

were positioned posteriorly. Three bicortical screws were placed on each side of the BSSO.

Eight males and 7 females (mean age, 25.3 years) were treated with CPDs. The use of CPDs required the construction of a wax bite in the presurgical period to replicate the desired condyle position during surgery. The wax bite was made with patients awake and in centric occlusion. Four of the 15 patients underwent bimaxillary repositioning that included maxillary intrusion, whereas the remaining 11 cases underwent both intrusion and advancement. The average amount of maxillary intrusion was 4.6 mm, whereas the average amount of maxillary advancement was 3.4 mm (Table 1).

The second group of 15 patients was composed of 7 males and 8 females (mean age, 25.7 years). They were all treated without CPDs, using an alternative intraoperative assessment method of condylar positioning. Five patients underwent bimaxillary repositioning with maxillary intrusion, whereas the remaining 10 patients underwent both intrusion and advancement. The average value of maxillary intrusion was 4.4 mm, whereas the average value of maxillary advancement was 3.5 mm (Table 1).

SURGICAL TECHNIQUE

The CPD used in 15 patient was a 4-holed L-shaped plate. After having marked the osteotomy lines on the upper and lower jaws, the wax bite, which was prefabricated in centric occlusion with patients awake, was installed to maintain the presurgical proper condylar position, and maxillomandibular fixation (MMF) was temporarily applied. The CPD was adapted and then attached by means of 2 screws to the external side of the mandibular ramus and by 1 screw on the

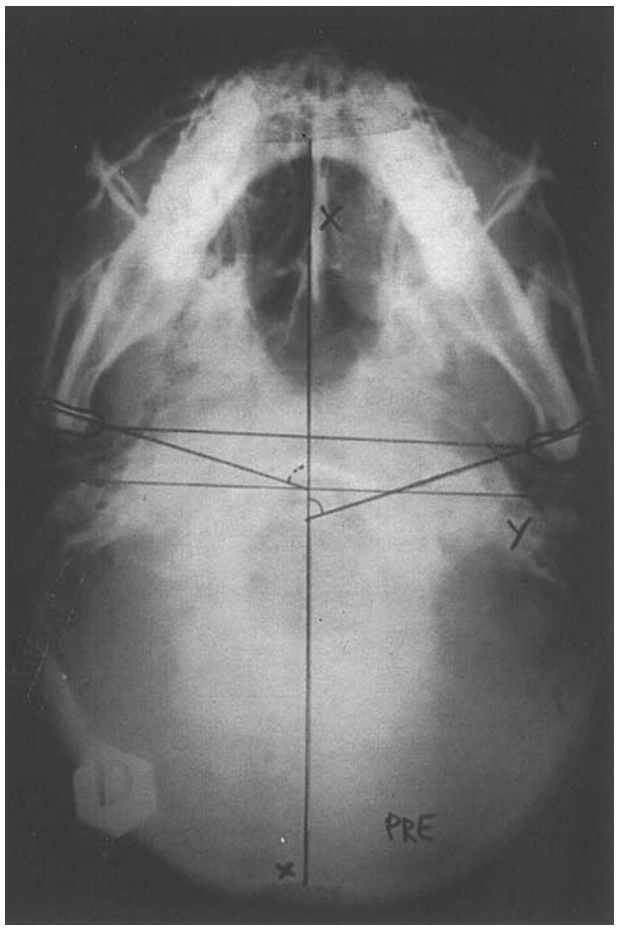

FIGURE 2. Cephalometrics from submentovertex radiographs: intercondylar width (Y) is measured between the most internal points of condyles, and the condylar angle is measured at the intersection of the sagittal line (X) with the projection from the condylar axis.

maxilla above the osteotomy line. Positioning plates were then removed together with MMF and wax bite, and the maxilla was first repositioned and stabilized, before mobilization of the mandible. After BSSO, the mandible was mobilized and the proper occlusion was obtained. The CPDs, were then reattached, and a second temporary intraoperative MMF was applied. Fixation of the mandible was performed with 3 bicortical screws on each side. The repositioning plates were then removed together with the MMF, and the occlusion was checked.

In the 15 patients of the second group treated without CPDs, we made 2 mandibular reference lines astride the BSSO before splitting, and we used them to help visualize the correct positioning before performing the fixation by means of 3 bicortical screws (Fig 3). The first reference point was at the level of the mandibular vestibular osteotomy line, and the second one was at the level of the sagittal osteotomy line of the mandibular ramus (Fig 3). The BSSO was completed and the mandible was mobilized. The proper occlusion was now restored, and a temporary intraoperative MMF was applied. The free mandibular proximal segment was gently positioned posteriorly in a symmetric way with the controlateral ramus. After having accurately checked the mandibular displacements by means of a millimetric caliper, the mandibular segments were fixed by means of 3 bicortical screws on each side. Finally, the MMF was removed and the occlusion was checked.

In both groups of patients, postoperative splints or bite registrations were not applied and postsurgical MMF was not used.

Table 1. ASSESSMENT OF SURGICAL MAXILLARY REPOSITIONING

Group I (15 Patients Treated With CPDs)		Group II (15 Patients Treated Without CPDs)	
Patient	Upper Jaw Surgical Repositioning	Patient	Upper Jaw Surgical Repositioning
1	4-mm intrusion, 3-mm advancement	16	4-mm intrusion, 2-mm advancement
2	3-mm intrusion, 3-mm advancement	17	3-mm intrusion, 2-mm advancement
3	4-mm intrusion, 3-mm advancement	18	3-mm intrusion, 3-mm advancement
4	5-mm intrusion, 3-mm advancement	19	3-mm intrusion, 3-mm advancement
5	4-mm intrusion, 3-mm advancement	20	5-mm intrusion, 4-mm advancement
6	4-mm intrusion, 4-mm advancement	21	4-mm intrusion, 3-mm advancement
7	4-mm intrusion, 3-mm advancement	22	5-mm intrusion, 4-mm advancement
8	6-mm intrusion, 4-mm advancement	23	5-mm intrusion, 3-mm advancement
9	6-mm intrusion, 4-mm advancement	24	6-mm intrusion, 6-mm advancement
10	5-mm intrusion, 4-mm advancement	25	5-mm intrusion, 5-mm advancement
11	4-mm intrusion, 3-mm advancement	26	5-mm intrusion
12	5-mm intrusion	27	5-mm intrusion
13	5-mm intrusion	28	5-mm intrusion
14	5-mm intrusion	29	4-mm intrusion
15	5-mm intrusion	30	4-mm intrusion

Abbreviation: CPD, condylar positioning device.

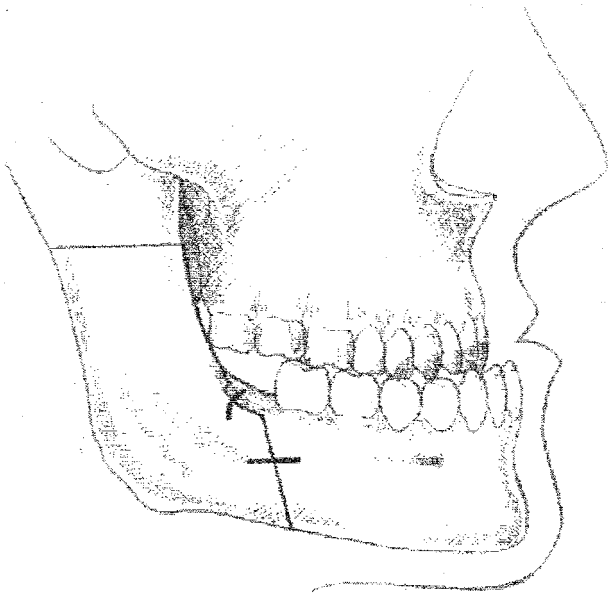

FIGURE 3. Mandibular reference points astride the BSSO.

Both groups were followed for 12 months using both clinical and radiographic examinations. The aesthetic results were assessed after an objective clinical examination, whereas the skeletal repositioning was analyzed with radiographic examinations, such as radiographic orthopantomography and posteroanterior and lateral cephalography. The stomatognathic muscle function was assessed using electrognathomyographic examination (Biopack; Bioresearch Inc) as previously mentioned, and the condyle position and morphology were examined through cephalometric measurements performed using bilateral TMJ radiographic tomography and submentovertex radiographs, according to Iannetti[11] and Kawamata et al,[12] (Figs 1 and 2). In all cases, postsurgical radiographs were taken with patients in centric occlusion, without the application of splints. The postsurgical clinical and radiographic results were compared with those in the presurgical period, and linear changes ranging from 0 to 2 mm or 0° to 2° were considered as errors resulting from radiographic variables.

Results

From the clinical and radiographic viewpoint, in the 12-month follow-up the 15 patients of the first group treated surgically with CPDs did not exhibit any relapse or postsurgical TMJ disturbances; after the electrognathomyographic examination, no neuromuscular dysfunction was reported. In 3 of the 15 patients, the cephalometric evaluations of the condyle-fossae relationship showed changes in condyle position (Table 2). All 3 cases presented linear variations that were within the confidence interval (0 to 2 mm, 0° to 2°).

For the 15 patients treated surgically without CPDs, the radiographic and clinical examinations in the 12-month follow-up did not show any skeletal and occlusal relapse or postsurgical TMJ disturbances. The electrognathomyographic examination elucidated no neuromuscular complications. The postsurgical cephalometric analysis showed that 8 of the 15 patients treated with manual control of condyle position had modest changes in condyle position (Table 2). In 2 cases, the linear variation fell within the confidence interval, whereas the remaining 6 patients presented

Table 2. VARIATION OF THE INTERCONDYLAR DISTANCE AND OF THE RIGHT AND LEFT CONDYLE ANGLES AFTER SURGICAL TREATMENT

Group I (15 Patients Treated With CPDs)			Group II (15 Patients Treated Without CPDs)		
Patient	Intercondylar Distance (mm)	Right/Left Condyle Angle (°)	Patient	Intercondylar Distance (mm)	Right/Left Condyle Angle (°)
1			16	1	0/2
2	1	1/2	17		
3			18	3	2/2
4	2	1/0	19		
5			20	4	3/1
6			21	4	2/3
7			22		
8			23	3	1/3
9			24	3	2/3
10			25		
11	1	1/1	26	2	1/1
12			27		
13			28	3	2/1
14			29		
15			30		

Abbreviation: CPD, condylar positioning device.

variations between 2 and 4 mm and 2° and 4°. Those changes in condyle position did not lead to the onset of postsurgical relapse or TMJ disturbances.

Change in the morphology of the condyle was observed in 28 patients after bilateral TMJ radiographic tomography, among which were 15 patients treated without CPDs and 13 with CPDs. Such changes were very modest and did not determine TMJ and/or masticatory dysfunctions; normal condyle-fossae relationships were recorded in all cases.

Discussion

Surgical repositioning of the jaws may cause changes in condyle position and subsequent remodeling of its morphology. Changes in condyle position modification may cause relapse and postsurgical problems in the TMJ. Therefore, replicating the presurgical condyle position in the surgery is considered by many to be an important factor in achieving valid and lasting functional results.[1,2,6,12-17]

The use of CPDs requires stable intermaxillary fixation during their application and poses some difficulties such as an increase in operative times[8] and the risk of partial bone disruption at maxilla during their application. It also poses biomechanical problems requiring the utmost precision during the construction of the splint or of the temporary intraoperative wax bite[5,8-10] and when used in cases requiring mandibular autorotation.[8]

The 3-dimensional precision of condylar position stability depends on the proper application of the CPDs. The use of positioning devices requires the construction, when the patient is awake in the presurgical period, of an occlusal wax bite capable of recording and reproducing the centric relation of the patient to obtain a precise guide of the desired condyle position. As advocated by Ellis,[8] Kovaleski and De Boever,[18] and Jankelson,[19] the accuracy and the precision in the construction of the occlusal wax bite and, consequently, in the exact reproduction of the desired condyle position, are determined both by the neuromuscular tension of the patient and by the operator guidance.

Mandibular autorotation occurs when the maxilla is intruded, invoking complicated neuromuscular adaptive mechanisms to the new vertical dimension.[8,20] Through mandibular autorotation, the orientation and the length of the masticatory muscles are gradually modified in accordance with the new vertical height of the face,[19] and the subsequent functional adjustment of the masticatory muscles produces muscular forces that tend to stabilize the occlusal relationships.[20] Through the use of the CPD, the proximal segment is fixed in the position defined presurgically, and it does not allow the autorotation of the proximal segment, thus inhibiting subsequent physiologic adjustments.

Because of the surgical and biomechanical problems mentioned and according to our experience and to what the existing literature has advocated, the use of CPDs for the surgical treatment of dental-skeletal III Class patients must be limited and is indicated only in the presence of TMJ dysfunction in the presurgical period[5,8,21] or in case of insufficient experience of the operator.[2,5]

CPD maintains condylar position stability in all 3 planes of space during surgery, whereas manual reposition permits small changes, as our analysis revealed. Such changes, although modest, are not acceptable in patients with presurgical TMJ dysfunction, requiring the exact replication of the asymptomatic condylar position.

As reported by several authors in the past few years,[12,22-24] the use of positioning devices is also indicated to avoid risks of condylar resorption and dental-skeletal relapse. Dental-skeletal malformation-related postsurgical recurrences may be subdivided into immediate and medium long-term relapse. In accordance with the literature, immediate relapse is due to the distraction of the condyle from the glenoid fossa during surgery. Therefore, it may be wiser to make use of CPDs when there is insufficient experience of the operator. Medium long-term relapse is reported after a period of 6 months or 1 year from the surgical treatment, and condylar resorption may be the cause.[1,23,25] Condylar resorption is determined, according to Hoppenrejis et al,[22,24] and Kerstens et al,[26] by the compression of the condyle against the glenoid cavity due to posterior condylar displacement. This is defined by Arnett and Tamborello[27] as the modification of the normal condyle into one of low height and thin structure, responsible for a decrease in the posterior facial height, characterized by skeletal instability and reduced mouth opening.

In cases of mandibular and maxillary repositioning without presurgical TMJ dysfunctions, the CPD may not be used, depending on the operator's experience,[2,5] and the mandibular ramus may be repositioned manually, as suggested by Tuinzing[28] and Mori et al.[2]

In the 15 patients who underwent surgical treatment without the use of condylar repositioning plates, 2 points of mandibular reference were marked through 2 brief transverse furrows: one along the sagittal osteotomy line and the second along the vestibular osteotomy line (Fig 3). The 2 reference points allow 3-dimensional measurements, by means of a caliper, the correct symmetry of the mandibular displacements and the precise correspondence with the movements made in the maxilla. All of the patients of our study, in fact, presented no presurgical alteration

of the occlusal plane and/or hypoplasias or relevant mandibular asymmetries.

In patients of both groups of our study without presurgical TMJ disorders the clinical, radiographic, and instrumental assessments carried out in 12-month follow-up did not show postsurgical TMJ disturbances or relapse, and they showed proper joint function in all tables.

The electrognathomyographic examination performed in 12-month follow-up showed that all of the patients of our analysis had normal muscular and jaw function, similar to the presurgical examination.

Our experience and the existing literature allow us to recommend the use of CPDs only in case of presurgical joint dysfunction, to maintain the asymptomatic presurgical condyle position. For patients with dental-skeletal Class III and with normal presurgical joint function, the use of CPDs is unnecessary but the experience of the operator remains a factor of paramount importance in the maintenance of the condyle position.[2-5] The manual positioning of the mandibular condyle reduces operative times and avoids biomechanical and surgical problems related to the use of CPDs, but it requires the utmost competence and experience of the operators.

References

1. Joos U: An adjustable bone fixation system for sagittal split osteotomy: Preliminary report. Br J Oral Maxillofac Surg 37:99, 1999
2. Mori Y, Sugahara T, Hiraki T: Improvement of a condylar positioning system for the mandibular ramus sagittal split osteotomy. J Oral Maxillofac Surg 53:340, 1995
3. Rebellato J, Lindauer SJ, Sheats RD, et al: Condylar positional changes after mandibular advancement surgery with rigid internal fixation. Am J Orthod Dentofac Orthop 116:93, 1999
4. Magalhaes AEO, Stella JP, Tashrui TH: Changes in condylar position following bilateral sagittal split osteotomy with setback. Int J Adult Orthognath Surg 10:137, 1995
5. Hiatt WR, Schelkun PM, Moore DL: Condylar positioning in orthognathic surgery. J Oral Maxillofac Surg 46:1110, 1988
6. Helm G, Stepke MT: Manteinance of the preoperative condyle position in orthognatic surgery. J Craniomaxillofac Surg 25:34, 1997
7. Leonard M: Preventing rotation of the proximal fragment in the sagittal ramus split operations. J Oral Surg 34:942, 1976
8. Ellis E III: Condylar positioning devices for orthognatic surgery: Are they necessary? J Oral Maxillofac Surg 52:526, 1994
9. Neubert J, Bitter K, Somsiri S: Refined intraoperative repositioning of the osteotomized maxilla in relation to the skull and TMJ. J Craniomaxillofac Surg 16:8, 1988
10. Rotskoff KS, Herbosa EG, Villa P: Maintenance of condyle-proximal segment position in orthognathic surgery. J Oral Maxillofac Surg 49:2, 1991
11. Iannetti G: Chirurgia Maxillo-facciale. Roma, CISU Ed. Universitaria, 1992
12. Kawamata A, Fujishita M, Nagahara K, et al: Three-dimensional computed tomography evaluation of postsurgical condylar displacement after mandibular osteotomy. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 86:371, 1998
13. Crawford JG, Stoelinga PJW, Blijdorp PA, et al: Stability after reoperation for progressive condylar resorption after orthognatic surgery: Report of seven cases. J Oral Maxillofac Surg 52:460, 1994
14. Cutbirth M, Van Sickels JE, Thrash WJ: Condylar resorption after bicortical screw fixation of mandibular advancement. J Oral Maxillofac Surg 56:178, 1998
15. Kundert M, Hadjianghelou O: "Condylar displacement after sagittal splitting of mandibular rami. J Maxillofac Surg, 8:278, 1980
16. Epker BN, Wylie GA: Control of the condylar-proximal mandibular segments after sagittal split osteotomies to advance the mandible. Oral Surg 62:613, 1992
17. Merten HA, Halling F: A new condylar positioning technique in orthognathic surgery: Technical note: J Craniomaxillofac Surg 20:310, 1992
18. Kovaleski WC, De Boever J: Influence of occlusal splints on jaw position and musculature in patients with temporomandibular joint dysfunction. J Prosthet Dent 33:321, 1975
19. Jankelson B: Functional position of occlusion. J Prosthet Dent 30:559, 1973
20. Trockmorton GS, Finn RA, Bell WH: Biomechanics of differences in lower facial height. Am J Orthod 77:410, 1980
21. Harada K, Ono J, Okada Y, et al: Postoperative stability after sagittal split ramus osteotomy with condylar-positioning appliance and screw fixation: Asymmetric versus symmetric cases. Oral Surg Oral Med Oral Pathol 83:532, 1997
22. Hoppenrejis TJM, Stoelinga PJW, Grace KL, et al: Long-term evaluation of patients with progressive condylar resorption following orthognathic surgery. Int J Oral Maxillofac Surg 28: 411, 1999
23. Scheerlink JPO, Stoelinga PJW, Blijdorp PA, et al: Sagittal split advancement osteotomies stabilized with miniplates: A 2-5 years of follow-up. Int J Oral Maxillofac Surg 23:127, 1994
24. Hoppenrejis TJM, Freihofer HPM, Stoelinga PJW, et al: Condylar remodelling and resorption after Le Fort I and bimaxillary osteotomies in patients with anterior open bite. Int J Oral Maxillofac 27:81, 1998
25. Van Sickels JE, Richardson DA: Stability of orthognatic surgery: A review of rigid fixation. Br J Oral Maxillofac Surg 34:279, 1996
26. Kerstens HCJ, Tuizing DB, Golding RP, et al: Condylar atrophy and osteoarthrosis after bimaxillary surgery. Oral Surg 69:274, 1990
27. Arnett GW, Tamborello JA: Progressive Class II development: Female idiopathic condylar resorption. Oral Maxillofac Surg Clin North Am 2:699, 1990
28. Tuinzing DB: Factors influencing condylar position after the bilateral sagittal split ostetomy fixed with bicortical screws (discussion). J Oral Maxillofac Surg 57:654, 1999