International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 7s, 2025
https://www.theaspd.com/ijes.php

Evaluation Of Sagittal Split Fix System And Bicortical Screw Fixation In Bilateral Sagittal Split Osteotomy. A Randomized Prospective Comparative Study

Prashanth V[1], Selvakumar T[2*], Komagan Prabhu N[3], Shanmugasundaram S[4], Guruprasad T[5], Krishnakumar Raja V.B[6]

[1]Consultant, Oral and Maxillofacial Surgeon.
[2] Reader, SRM Dental college, Bharathi Salai, Ramapuram, Chennai.
[3]Reader, SRM Dental college, Bharathi Salai, Ramapuram, Chennai.
[4]Professor, SRM Dental college, Ramapuram, Chennai.
[5]Assistant professor, JIPMER, Pondicherry
[6]Professor and Head, SRM Dental college, Ramapuram, Chennai.
Corresponding Author: Selvakumar T, Reader, SRM Dental college, Barathi Salai, Ramapuram, Chennai.

ABSTRACT

Background: *Relapse following sagittal split osteotomy is more common in mandible advancement surgeries. The dynamic action of masticatory muscle attached proximal to osteotomised bone plays an important role paving necessity for a rigid stable fixation.*

Objective: *The aim of this study is to assess the efficacy of bicortical screws and sliding plates after Bilateral Sagittal Split Osteotomy for rigid fixation of osteotomised segments.*

Methods: *The study included two groups (group A and group B) who underwent BSSO to correct their mandibular discrepancy. Group A consisted of (10 patients) who had osteosynthesis using Sliding Split Fix Plates (SYNTHES®, GERMANY), Group B consisted of (10 patients) who had osteosynthesis using Bi- cortical screws (BIOMET®). Skeletal relapse was assessed on 1st month, 3rd month, and 6th month post operatively. Series of lateral cephalogram was taken at the time of follow up and compare with pre op radiograph. Statistical analysis for relapse was done by Mann Whitney test. The P value is 0.99 which was not significant in linear dimension.*

Results: *The relapse percentage assessed after one-year post surgery in Group A [patients with sliding split fix plates] along Sn-v axis was 14.42 %, and 21.5% was observed along 0-meridian. In Group B [Bicortical screws] along Sn-v axis the relapse percentage was 9.68% and 10.85% along 0-meridian.*

Conclusion: *Based on the interpretation of study results, the maximum intercuspation in molar region was achieved in Bicortical screw fixation when compared to sagittal split fix plates. The percentage of relapse in bicortical screw fixation is lesser when compared with sagittal split fix plates.*

Keywords: *Sagittal split osteotomy, split fix system, Bicortical screw fixation, relapse in sagittal split osteotomy.*

1.INTRODUCTION

The mandibular Sagittal Split Osteotomy, popularly called as Bilateral Sagittal Split Osteotomy (BSSO) is a versatile surgical procedure to correct dentofacial deformities affecting the mandible[1]. Trauner and Hugo L Obwegeser in 1953 performed Bilateral Sagittal Split Osteotomy (BSSO) for correcting mandibular prognathism which was later modified by Dalpont in 1961, Hunsuck in 1967 and Epker in 1977 [2].

One of the main challenges following BSSO is the post-surgical relapse and stability. Factors like fixation techniques, muscle forces, condylar growth contributes to relapse. Many literature reports states that post-surgical relapse following Sagittal split osteotomies is directly related to muscle forces acting along the proximal segment during surgery, the amount of bone advancement, method and fixation technique

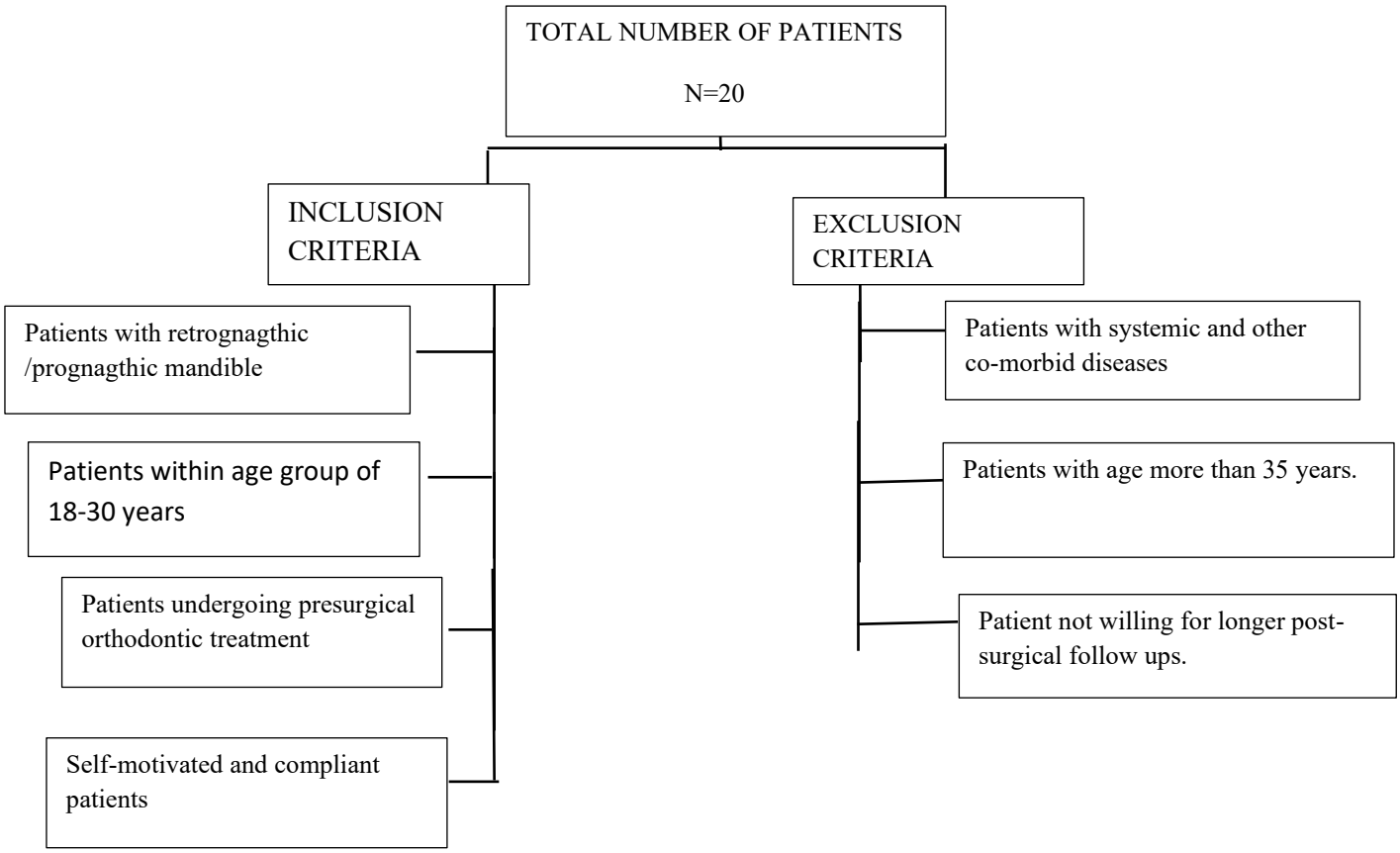
used[3]. Other factors such as the presence of condylar sag, unfavourable postsurgical growth, inadequate healing at the osteotomy site and the surgeon's experience level also contributes to the stability[4].
The wide contact healing between osteotomized segments performed during Bilateral Sagittal Split Osteotomy (BSSO) is achieved by precise and adequate stable internal fixation techniques[5]. Many techniques like non-rigid and rigid fixation were used for segment stabilization. A stable internal fixation with titanium mini plates and screws helps to eliminate the need of Inter Maxillary Fixation (IMF), thereby preventing the risk of postoperative aspiration, improving postoperative oral hygiene facilitating early recovery[1]. Titanium miniplates with monocortical screw fixation was introduced following its wide application in reduction of maxillofacial fractures[5].
Resorbable plates and screws are also being used for stabilizing the segments following BSSO and several studies were performed to evaluate its stability[6]. Apart from the miniplates, bicortical screws are being widely used for better fixation of the segments. The use of bicortical screws were described in 1970s. Various studies states that these screws have capability to tolerate maximum masticatory force, with high mechanical stability and more rigid against shear stress. Recent advancements in various fixation systems have substantially reduced postsurgical relapse and improved stability, one such fixation hardware is the sliding titanium plates or sagittal split fix plate system [7]. Our study compares the efficacy of Bicortical screws and Sliding plates after Bilateral Sagittal Split Osteotomy for fixation of osteotomized segments.

2. MATERIALS AND METHODS

2.1 Study design

The randomized prospective study was performed on patients who reported to the Department of Oral and Maxillofacial Surgery at our institution. 20 patients, diagnosed with skeletal class II and class III malocclusion were randomly selected for the study after obtaining their consent for treatment acceptance and subsequnt surgical follow ups. The study was undertaken after being reviewed and approved by Institutional Review Board (SRMDC/IRB/2015/MDS/403). The study was split into two groups (group A and group B), where 10 patients were randomly assigned into each group. Bilateral sagittal Split osteotomy either for mandible advancement or setback was performed for patients in both the groups and combined Lefort I osteotomy for maxilla was done in seventeen patients. In group A osteotomy segments were stabilized using Sliding Split Fix Plates (SYNTHES®, GERMANY), In Group B osteotomy segments were stabilized using BI CORTICAL screws (BIOMET®). The inclusion criteria designated for the study included self-motivated and compliant patients, patients undergoing pre surgical orthodontics, patients diagnosed with Prognathic and Retrognathic mandible. Patients aged more than 35 years, who are not willing for long term follow up with systemic and co-morbid diseases, were excluded from the study (see fig1).

Fig1. Flow chart of patient enrolment



Digital lateral cephalographs were taken pre-operative, 5th day, 1st month and 6th month postoperatively. The cephalometric data included two linear measurements and two angular measurements (Sn-V to Pogonion, 0 meridian to Pogonion, SNB & ANB angle). Sub nasale Vertical (Sn-V) was drawn perpendicular to the horizontal plane (HP) passing through the Sn point. Perpendicular measurement was made from the subnasale Vertical (Sn-V) to the soft tissue Pogonion. 0 meridian was constructed by a perpendicular line drawn from the horizontal plane passing through soft tissue Nasion. SNB angle formed between the Sella (S) point to the Nasion (N) and point B (supramentale) was measured along with ANB angle formed between the point A (subspinale) to Nasion and point B. Linear measurements were taken from Sn-V to B point.

To improve the size congruence, the distances between the Sella entrance point to Nasion (S-N) and between the Nasion to Anterior nasal spine (N-ANS) were used as references, to eliminate the dimension error between preoperative and postoperative changes.

To examine stability immediately after surgery and more than 6 months after surgery, the amounts of movement at Sn-v to chin pogonion and 0-meridian to chin pogonion between the 2 fixation groups were compared.

Condylar sag was clinically evaluated postoperatively after removing intermaxillary fixation, after 1 week and after 1 month.

To compare variables between Sliding plates and Bicortical groups Mann Whitney test was used. To analyse the data SPSS (IBM SPSS Statistics for Windows, Version 22.0, Armonk, NY: IBM Corp. Released 2013) was used. Significance level was fixed as 5% ($\alpha = 0.05$).

2.2 Surgical Procedures

After pre-surgical assessments, Bilateral Sagittal split osteotomy was performed according to the Epker's modification.

2.2.1 Procedure for Bi-cortical screw fixation:

International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 7s, 2025
https://www.theaspd.com/ijes.php

A stab incision was made transbuccal to gain access for insertion of trocar and cannula whenever it was necessary. Depth gauge was used to find out the depth of the bone for fixation of screws. Fixation was performed between the proximal and distal segments with three bicortical screws, which had a profile of 2mm diameter and lengths varying from 11mm, 13mm, and 15mm. Fixation was done in a conventional reverse L-shaped pattern with two screws on upper border and one screw in lower border. All three screws were fixed along superior border for 3 cases (Fig 2).

2.2.2 Procedure for sliding split fix plates**:**

Fixation was performed between the proximal and distal segments with a sliding split fix plate, which was composed of 2 round holes at both the ends and 1 sliding plate with single hole. Two monocortical screws were placed on the proximal segment of the mandible. On the distal segment, one monocortical screw was placed into the sliding hole with the slider. This screw was tightened maximally and then loosened about half of a turn. Then the distal segment was fixed with two monocortical screws and the slider along with the screw was removed (Fig 3).

Fig 2 Bi-cortical screw fixation

Fig 3 Fixation with sliding plates

3. RESULTS

A total of 20 patients who had undergone BSSO during the study period were reviewed prospectively. Condylar sag was observed as central type in 1 patient and peripheral type in 1 patient categorised under Group A. In Group B 3 patients was noted with type II peripheral sag.

In our study the relapse percentage assessed after one-year postsurgery in Group A [patients with sliding split fix plates] along Sn-v axis was 14.42 %, and 21.5% was observed along 0-meridian. In Group B [Bicortical screws] along Sn-v axis the relapse percentage was 9.68% and 10.85% along 0-meridian. The amount of relapse percentage was clinically significant for bicortical screws showing better stability than sliding plates (Table1). Graphical representation of percentage relapse in both the groups is shown in Fig4, 5.

Table 1: Relapse Comparison between Sagittal Split Fix Plates and Bicortical Screws

SAGITTAL SPLIT FIX PLATES					BI CORTICAL SCREWS FIXATION			
	Sn-V (Linear)-pog	0-Meridian-pog	SNB (Angular)	ANB (Angular)	Sn-v (Linear)-pog	0-Meridian-pog	SNB (Angular)	ANB (Angular)

CASE 1	6.7 %	0	1.3 %	50%	20%	16.7%	0	20%
CASE 2	0	0	0	0	7.1%	N/A	12.5%	3.8%
CASE3	50%	33.3%	1.2%	50 %	8.3%	20%	1.2%	16.7%
CASE4	14.3%	16.7%	2.4%	50%	0	0	1.2%	10%
CASE5	6.7 %	0	1.3%	0	0	N/A	0	0
CASE6	6.7 %	0	1.2%	50%	22.2%	16.7%	2.5%	0
CASE7	21.4 %	25%	5%	50%	11.1%	16.7%	2.5%	11.1%
CASE8	6.7 %	50%	1.3%	50 %	6.7%	0	0	0
CASE9	25 %	40 %	1.2%	50%	14.3%	16.7%	1.2%	0
CASE10	6.7 %	50 %	1.3 %	50 %	7.1%	0	2.5%	50%
MEAN	**14.4%**	**21.5%**	**1.63%**	**40%**	**9.68%**	**10.85%**	**2.36%**	**11.16%**

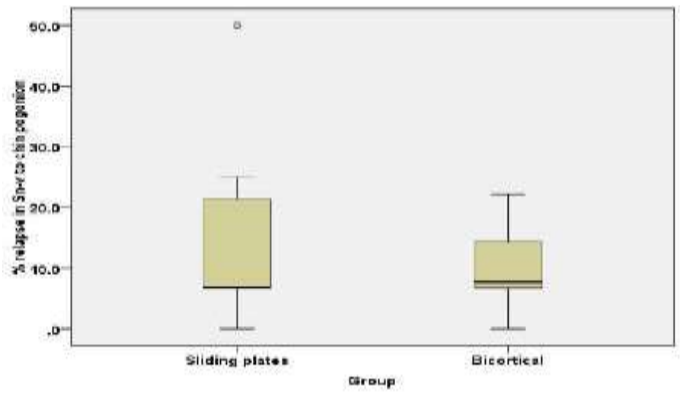


Fig 4 Percentage Relapse of Sn-v to chin pogonion

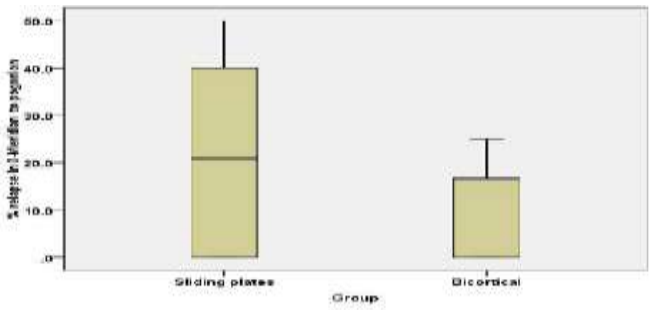


Fig 5 Percentage Relapse of 0-Meridian to chin pogonion

Table 2 Percentage Relapse of Sn-v to chin pogonion using Mann-Whitney test.

Sn-v to chin pogonion	Group	N	Mean Rank	P-Value
Percentage Relapse	Sliding plates	10	10.50	0.999
	Bicortical	10	10.50	

Table 3 Percentage Relapse of 0-Meridian to chin pogonion using Mann-Whitney test.

0-Meridian to pogonion	Group	N	Mean Rank	P-Value
Percentage Relapse	Sliding plates	10	11.65	0.370
	Bicortical	10	9.35	

4. DISCUSSION

The successful outcome of orthognathic surgery is determined by minimal post-surgical relapse rate and the stability of the hardware type being used during fixation. Mandibular orthognathic procedures have shown to exhibit more relapse as masticatory muscle forces constantly act that in turn directly influences the stability of the plating system. Among many fixation methods in BSSO, bicortical screw fixation and monocortical plates and screws are more common[8].The bicortical screws follows the principle of rigid fixation system as they engage both the buccal and lingual cortices of the mandible. One of the recent advances in fixation of BSSO includes sliding plates, also known as a condylar repositionable plate, follows the principle of semi-rigid fixation. Many studies were performed to compare the various fixation systems for evaluating the stability and its role in long term post- surgical relapse. Relapse may occur due to the tension on the distal internal ramus segment including the elongation of residual internal pterygoid muscle fibres. This was especially important when the sagittal split occurs posteriorly and through the posterior inferior aspect of the angle. The elongation of the sphenomandibular ligament leads to tension within the ligament indirectly predisposing relapse of the advanced segments. Attempts to detach the ligament from the lingula may lead to inadvertent injury to the inferior alveolar nerve and hence avoided.

Even if it is detached some traction is present on the internal ramus segment because spheno mandibular ligament is only a thick part of the much wider structure known as inter pterygoid fascia. The amount of skeletal advancement, duration of intermaxillary fixation and suprahyoid muscle pull were additional factors that can influence the stability of results but to a lesser degree.

Joe I-Chiang Chou, et al demonstrated that the hard tissue relapse at Pog was 21% 1 year after surgery. Although mandibular prognathism could be grossly improved by bilateral sagittal split osteotomy mandibular setback, a significant amount of relapse occurred within 1 year after surgery[9].

Identifying the contributing factors to skeletal relapse by analysing cephalometric changes after bilateral sagittal split ramus osteotomy was stated by Nicole Eggensperger et al. An advancement of greater than 7 mm is associated with an increased tendency to relapse, but setback of more than 12 mm with a decreased tendency. The retrognathic patients with a high mandibulo-nasal plane angle had 30% higher relapse rate[10].

In our study, significant relapse is noted in 19.38% of group A cases with sagittal split fix plates over one year period of time. On the other hand, Group B cases with bi-cortical screws have shown 8.5% relapse.

Bernardo Ferreira Brasileiro et al., in 2009 suggested that installation of a bicortical positional screw in the retromolar region may significantly optimize the resistance of the miniplate and monocortical screw fixation[11].

E. A. Al-Moraissi et al., in 2016 demonstrated that bicortical screw fixation tends to be more rigid and less susceptible to deformation than a monocortical plate[12].
Mark W. Ochs et al., in 2003 explained that bicortical screws are the most rigid type of fixation in maintaining the segments in position. Intentionally placing the screws at divergent (nonparalleling) paths leads to further enhanced rigidity. There is no difference in operating time between placing either 3 bicortical screws or 1 miniplate with monocortical screws. In general, the use of 3 bicortical screws offers the most cost effective, rigid, and predictable way to fix osteotomized segments. There are numerous screw patterns that can be used, taking advantage of location, angulation, and regions of bone contact or gapping. Individualized intraoperative screw placement pattern and sequencing should be undertaken to optimize the outcome[13].
P. Reyneke et al., in 2002 stated that examination and understanding various patterns of occlusal changes can reliably identify condylar sag intra-operatively. Condylar sag can be defined as an immediate or late change in position of the condyle in the glenoid fossa after surgical establishment of a pre-planned occlusion and rigid fixation of the bone fragments, leading to a change in the occlusion[14].
Assessing the condylar position by observing the occlusion after removal of the IMF has obvious benefits. Condylar orientation in the glenoid fossa is not only critical, but the most demanding step in the BSSO operation. The surgeon needs to understand the mechanisms of condylar sag and the specific patterns of malocclusion that it may produce. This will help to make a diagnosis and to implement the appropriate corrective measures, providing the opportunity for immediate correction of the condylar position, and thereby skipping the need for a second operation or orthodontic compromise.
In our study in Group A (sliding plates) 2 patients had occlusal discrepancy, 1 patient was diagnosed intra operatively and one patient diagnosed post operatively. The patient diagnosed with condylar sag with anterior open bite, which may be due to over impaction of the maxilla. The patient was taken up for resurgery and corrected. The patient was diagnosed with condylar sag intraoperatively was peripheral type II unilateral with posterior open bite and was corrected using sagittal split fix plates. In group B(bicortical screws) out of 10 cases 3 patients had mild occlusal discrepancy post operatively with posterior open bite which was managed with elastics postoperatively and occlusion was settled by orthodontic treatment post surgically.
The fixation methods of osteotomized segments after sagittal split osteotomy has been upgraded from the monocortical miniplates to bicortical screws. The sagittal splitfix system also known as condylar repositioning plates and resorbable plates is one of the recent advances in fixation methods.

5. CONCLUSION

In Conclusion maximum intercuspation was achieved in bicortical screw fixation compared to sagittal split fix plates. The percentage of relapse in bicortical screw fixation was lesser when compared with sagittal split fix plates for a better understanding of relapse we need a larger sample size and follow up period should be more. Bi cortical screws are cost effective when compared with sagittal split fix plates and would be an ideal method of rigid fixation in cases which require mandibular setback where the surface area contact would be more between proximal and distal segments.

Conflict of interest: None

REFERENCES

1. De Oliveira LB, Reis JM, Spin-Neto R, Gabrielli MA, Oguz Y, Pereira-Filho VA. Mechanical evaluation of six techniques for stable fixation of the sagittal split osteotomy after counterclockwise mandibular advancement. Br J Oral Maxillofac Surg. 2016; 54(5):573-8.
2. Nooh N. Stability of the mandible after bilateral sagittal split osteotomy: Comparison between positioning screws and plate. Saudi Dent J. 31;21(3):123-6.
3. Franco JE, Van Sickels JE, Thrash WJ. Factors contributing to relapse in rigidly fixed mandibular setbacks. J Oral Maxillofac Surg. 1;47(5):451-6. 47:451-456, 1969.

4. Peterson GP, Haug RH, Van Sickels J. A biomechanical evaluation of bilateral sagittal ramus osteotomy fixation techniques. J Oral Maxillofac Surg. 30; 63(9):1317-24.
5. Pereira FL, Janson M, Sant'Ana E. Hybrid fixation in the bilateral sagittal split osteotomy for lower jaw advancement. J. Appl. Oral Sci.;18(1):92-9.

6. Stockmann P, Böhm H, Driemel O, Mühling J, Pistner H. Resorbable versus titanium osteosynthesis devices in bilateral sagittal split ramus osteotomy of the mandible–the results of a two centre randomised clinical study with an eight-year follow-up. J Craniomaxillofac Surg. 31;38(7):522-8
7. Roh YC, Shin SH, Kim SS, Sandor GK, Kim YD. Skeletal stability and condylar position related to fixation method following mandibular setback with bilateral sagittal split ramus osteotomy. J Craniomaxillofac Surg. 31;42(8):1958-63
8. Sato FR, Asprino L, Consani S, de Moraes M. Comparative biomechanical and photoelastic evaluation of different fixation techniques of sagittal split ramus osteotomy in mandibular advancement. J Oral Maxillofac Surg. 31;68(1):160-6.
9. Joe I, Chou C, Fong HJ, Kuang SH, Gi LY, Hwang FY, Lai YC, Chang RC, Kao SY. A retrospective analysis of the stability and relapse of soft and hard tissue change after bilateral sagittal split osteotomy for mandibular setback of 64 Taiwanese patients. J Oral Maxillofac Surg. 31;63(3):355-61.
10. Eggensperger N, Smolka W, Rahal A, Iizuka T. Skeletal relapse after mandibular advancement and setback in single-jaw surgery. J Oral Maxillofac Surg. 31;62(12):1486-96.
11. Brasileiro BF, Grotta-Grempel R, Ambrosano GM, Passeri LA. An in vitro evaluation of rigid internal fixation techniques for sagittal split ramus osteotomies: setback surgery. J Oral Maxillofac Surg. 30;70(4):941-51.
12. Al-Moraissi EA, Ellis E. Stability of bicortical screw versus plate fixation after mandibular setback with the bilateral sagittal split osteotomy: a systematic review and meta-analysis. . Int J Oral Maxillofac Surg. 31;45(1):1-7.
13. Ochs MW. Bicortical screw stabilization of sagittal split osteotomies. J Oral Maxillofac Surg. 1;61(12):1477-84.
14. Reyneke JP, Ferretti C. Intraoperative diagnosis of condylar sag after bilateral sagittal split ramus osteotomy. Br J Oral Maxillofac Surg. 31;40(4):285-92.