Original Article - Retrospective Study

Impacted third molars in sagittal split osteotomies in mandibular prognathism and micrognathia

Access this article online
Website:
www.amsjournal.com
DOI:
10.4103/2231-0746.133074
Quick Response Code:

S. M. Balaji
Director and Consultant, Balaji Dental and Craniofacial Hospital, Chennai, Tamil Nadu, India

Address for correspondence:
Dr. S M Balaji, Balaji Dental and Craniofacial Hospital, 30, KB Dasan Road, Teynampet, Chennai - 600 018, Tamil Nadu, India. E-mail: smbalaji@gmail.com

ABSTRACT

Background: The timing of removal of mandibular third molars (M3) in Sagittal Split Osteotomy (SSO) has been an issue of contention. The aim of this retrospective study is to identify the incidence of unfavorable fractures during SSO with the presence of M3 and to identify the association between unfavorable fractures with the factors specifically related to the M3. **Materials and Methods:** Retrospective analysis of consecutive bilateral sagittal split osteotomy (BSSO) patient's treatment records of 208 patients treated by a single surgeon was analyzed. The position of M3, fracture details, and demographics were collected. Descriptive statistics and Chi-square tests were employed in SPSS package. A $P \leq 0.05$ was taken as significant. **Results:** There were altogether 416 SSO performed. M3 was completely impacted in 88.9% of all instances, and in 85.6% of the instances, the bulk of the M3 was identified to be above the external oblique ridge. In 59.4% of the cases, M3 was positioned in alignment with the arch as observed during surgery. There were about 27 (6.5%) instances of unfavorable splits. A statistically significant relationship was observed with M3 root morphology and axial position of M3. **Discussion:** This study for the first time has confirmed the spatial positioning of M3 as one of the several causes of unfavorable splits during SSO. An impacted M3 that lies below the oblique ridge, distoangularly/vertically oriented, with divergent/supernumerary root would cause unfavorable splits when the spreader is not used properly. Potential causes and influencing factors of the unfavorable splits are discussed.

Keywords: Bad split, bilateral sagittal split osteotomy, favorable split, impacted third molar, impaction, jaw correction, mandibular impaction, mandibular prognathism, micrognathia, retrognathia, unfavorable split

INTRODUCTION

The ramus sagittal split osteotomy (SSO) is the most common type of osteotomy done owing to its suitability for both advancement and setback of the mandible. The technique was introduced by Schuchart, modified and popularized by Trauner and Obwegeser. SSO has been described in the literature as a technically sensitive procedure, with numerous possible intraoperative complications. This has led to further modifications of the SSO technique with an aim to try to decrease the frequency of intraoperative complications and to increase the stability and predictability of the post-surgical results.[1] Notable modifications of SSO are those proposed by Dal Pont[2] and Hunsuck.[3]

The timing of removal of third molars (M3) in Bilateral Sagittal Split Osteotomy (BSSO) has been an issue of contention. There are several studies that support the removal of the M3 during the BSSO procedure itself. Simultaneous removal of the M3 during SSO is reported to limit the risk, is cost-effective, minimizes unwanted post-surgical consequences, and provides a reliable guidance to identify inferior alveolar nerve, a mean by which planned surgery can be accomplished.[4-6] It has been suggested that timing of removal of M3 during SSOs should be decided based on the angulation, relative height, and root form of the third molar, and its morphological relation to the inferior alveolar nerve (IAN).[4]

On the contrary, there are several studies that support prior removal of the M3 at least by 6 to 9 months. The presence of unerupted M3 in SSO is reported to increase the operating time with increased technical difficulty. Moreover, the incidence of unfavorable fracture is greater, with reduced favorable sites for rigid fixation when impacted M3 is present. When an unfavorable fracture does occur, it is reported that operating time and technical difficulty are increased in the operation theater while in the postoperative period, local infection, nonunion, mal-union, prolonged neurologic symptoms, and enhanced chance of relapse occur more often after such an unfavorable fracture.[7,8]

The overall incidence of the unfavorable splits is reported to be 0.21-22.72%.[9] Anatomical variations in the posterior mandible render the split of SSO procedure more difficult, predisposing such patients to a higher risk of unfavorable fractures. The risk is higher when the split involves at or above a point of fusion between the external and internal cortical plates of the ramus, or when the ramus is thinner mediolaterally. It has been reported that the thickness of the mandibular buccal cortex decreases significantly from the second molar to the ramus region. Similarly, prognathic patients have been shown to have a generally thinner mandibular ramus, and a mandibular canal located more buccally, when compared to patients with retrognathia, making them more likely to have unfavorable splits and perioperative impairment of the inferior alveolar nerve.[10]

The aim of this retrospective study is to identify the incidence of unfavorable fractures during SSO with the presence of M3 and to identify the association between unfavorable fractures with the factors specifically related to the M3.

MATERIALS AND METHODS

Retrospective analysis of consecutive BSSO patient's treatment records of 208 patients treated in a single, tertiary center in the period of January 2006 to December 2010. Criteria for inclusion in this study were: 1) BSSO performed for correction of dentofacial deformity and malocclusion, 2) Presence of Impacted M3 (Partial/Complete) in both sides, 3) Completion of 2nd Molar root formation, 4) Impacted M3 removed after the split; and exclusion criteria: 1) Complete eruption of one M3, 2) Patients with diagnosed systemic illness or diseases that influence the morphology of mandible or bone structure, 3) Patients with syndromes, 4) Previously treated SSO or orthodontic treated cases, 5) History of mandibular fractures.

From the records, the data related to age, gender, and the position of M3 were recorded. The degree of impaction was categorized into: 1) Partially erupted and 2) Completely Impacted. The degree of development of M3 was subdivided into: 1) Incomplete crown formation, 2) Complete crown formation, and 3) Complete root formation. Based on angulation of M3, it was classified as 1) Mesioangular, 2) Distoangular, 3) Horizontal, and 4) Vertical. When the greater than 50% of bulk of M3 was placed below the shadow of the External Oblique Ridge (EOR), it was classified as below the ridge and otherwise above the ridge.

The M3 root morphology was classified as 1) Fused roots, 2) Divergent roots, 3) Fused roots with supernumerary roots, 4) Divergent roots with supernumerary roots, 5) Normal root. The orientation of the M3 in axial section was noted as 1) In line with arch (Straight) 2) Oblique. The type of BSSO was also noted down as a setback or advancement. The occurrence of an unfavorable fracture or a favorable split during SSO was also recorded. The extent of the unfavorable fracture was also subdivided into: 1) Complete proximal (buccal) segment fracture, 2) Incomplete (green stick) proximal segment fracture, 3) Complete distal (lingual) segment fracture, 4) Incomplete (green stick) distal segment fracture, 5) No unfavorable split.

All the surgery were performed by the single surgeon (Author; with 20 years of surgical experience) in the same setup. All osteotomies were performed using the same technique.[11] M3 were removed after the split. When situation warranted, tooth was bisected or full M3 was removed as assessed by the surgeon on the operation table.

All data thus collected were entered in Statistical Package for Social Service (SPSS, version 16.0, IBM, Chicago, IL, USA) Package. Descriptive statistics are presented for all variables. Chi-square test was employed to find the association of M3 with the normal and unfavorable split BSSO's. A group comparison of patients serving as their own control was also performed to analyze the importance of earlier findings. $P \leq 0.05$ was taken to be significant.

RESULTS

There were 208 cases fulfilling the exclusion and inclusion criteria. There were 91 (43.8%) males and 117 (56.2%) females. Eighty-six were aged 20 years and below. The demographics are described in Table 1. Of these 208 BSSO cases, there

Table 1: Demographics of the study group

Demographic parameter	N (%)
Age	21.53±3.06 years (17 to 27 years)
20 years and below	86 (41.1)
21 years and above	122 (58.9)
Gender	
Male	182 splits; 91 cases (43.8)
Female	234 splits; 117 cases (56.2)
Male: Female	1:1.29
Impaction of teeth	
Completely impacted	370 (88.9)
Partially impacted	46 (11.1)
Angulation of impacted teeth	
Mesioangular	278 (66.8)
Distoangular	90 (21.6)
Vertical	25 (6)
Horizontal	23 (5.5)
Degree of development of impacted teeth	
Incomplete crown	20 (4.8)
Incomplete root	236 (56.7)
Complete root	160 (38.5)
Position of bulk of impacted tooth	
Above ridge	356 (85.6)
Below ridge	60 (14.4)
Impacted tooth's root morphology	
Normal	78 (18.8)
Fused	251 (60.3)
Divergent	74 (17.8)
Divergent with supernumerary	11 (2.6)
Fused with supernumerary	2 (0.5)
Impacted tooth in axial section	
Straight	247 (59.4)
Oblique	169 (40.6)
Outcome of SSO	
No unfavorable split	389 (93.5)
Green stick fracture-distal	25 (6)
Fracture-distal complete	2 (0.5)
BSSO treatment needs	
Setback BSSO	350 (84.1)
Advancement BSSO	66 (15.9)

SSO = Sagittal split osteotomy, BSSO = Bilateral sagittal split osteotomy were altogether 416 SSO performed. M3 was completely impacted in 88.9% of all instances. M3 was mesioangular in 66.8% of the instances. Most of the M3 had incomplete root formation (56.7%), and in 85.6% of the instance, the bulk of the M3 was identified to be above the EOR. Only in 78 (18.8) cases, the root morphology was diagnosed to be normal. In 59.4% of the cases, the M3 was positioned in alignment with the mandibular arch as observed during surgery. There were about 27 (6.5%) instances of unfavorable splits. This occurred in 26 cases as one case had bilateral unfavorable split. The mean age of unfavorable splits cases was 21.44 ± 3.7 years while for the favorable splits cases was 21.54 ± 3.01 years. The difference was not statistically significant.

Of all fractures, distal green stick fractures were observed in 25 (6%) instances while complete distal fracture was identified in 2 cases (0.5%). There was statistical correlation between predictor variables and the type of fractures.

Table 2 depicts and compares the relationship of the predictor variables (gender, impaction status, impaction type, degree of development of M3, Bulk of M3, M3 root morphology, axial position of M3, and age group). A statistically significant relationship was observed with M3 root morphology and axial position of M3.

Table 2: Association of "unfavorable splits" with respect to normal SSO

	n (%)		*P* value
	No fracture	Fracture	
Mean age (in years)	21.54±3.01	21.44±3.7	0.876
Gender			
Male	168 (43.2)	14 (51.9)	0.25
Female	221 (56.8)	13 (48.1)	
Impaction status			
Completely impacted	346 (88.9)	24 (88.9)	0.59
Partially Impacted	43 (11.1)	3 (11.1)	
Impaction type			
Mesioangular	263 (67.6)	15 (55.6)	0.156
Distoangular	81 (20.8)	9 (33.3)	
Vertical	22 (5.7)	3 (11.1)	
Horizontal	23 (5.9)	0	
Degree of development of impacted tooth			
Incomplete crown	19 (4.9)	1 (3.7)	0.168
Incomplete root	225 (57.8)	11 (40.7)	
Complete root	145 (37.3)	15 (55.6)	
Bulk of tooth			
Above ridge	343 (88.2)	13 (48.1)	0.000
Below ridge	46 (11.8)	14 (51.9)	
Root morphology			
Normal	78 (20.1)	0	0.000
Fused	240 (61.7)	11 (40.7)	
Divergent roots	64 (16.5)	10 (37)	
Divergent-supernumerary root	7 (1.8)	4 (14.8)	
Fused with supernumerary roots	0	2 (7.4)	
Axial position of impacted tooth			
Straight	241 (62)	6 (22.2)	0.000
Oblique	148 (38)	21 (77.8)	
Age group			
20 years and below	230 (59.1)	12 (55.6)	0.432
21 years and above	159 (40.9)	13 (44.4)	

SSO = Sagittal split osteotomy

Internal comparison was performed for the unilateral unfavorable splits (*n* = 25 cases) with corresponding opposite side. A significant difference was observed with type of impaction, degree of M3 development, bulk of M3, axial position of M3 and marginally with M3 root morphology [Table 3].

DISCUSSION

The presence of M3 is reported to increase the chances of an unfavorable split in SSO. The data emanating from several studies are contradictory.[4,5] Several authors have reported no significant difference in the incidence of unfavorable splits with or without M3.[1,12,13] Others have found an increased incidence of unfavorable splits with impacted M3 molars in younger patients but not in patients over age of 20 years.[14] The pattern (extent and direction) of such unfavorable split appears not to be associated with presence of M3.[15] Age group did not appear to influence the outcome of unfavorable splits in present study that was in contrast to earlier reported literature.[14] However, the distribution of the age in that study was questioned.[5] In our study, there was no significant difference between the 2 split groups with regard to age.

The reported factors with regard to the splits in the presence of M3 during SSO includes the place of M3,[5,8] incomplete osteotomies, unfavorable bone thickness [Figure 1], unfavorable mandibular shape, incorrect direction of the osteotomies;[14] however, the role of angulation of M3, relative height, root form of the M3, and its morphological relation to the IAN has been previously suggested.[4] Till date, to the best of our knowledge, no study has considered the effect of M3-related parameters on the splits.

It has been proposed without a direct data that impacted M3 that lie just below the cortical bone result in a region of weakness,

Table 3: Comparison of unfavorable splits cases serving as controls (*n*=25)

	n (%)		*P* value
	Fracture	No fracture	
Impaction			
Completely impacted	23 (92)	24 (96)	0.5
Partially Impacted	2 (8)	1 (4)	
Impaction type			
Mesioangular	14 (56)	23 (92)	0.012
Distoangular	8 (32)	2 (8)	
Vertical	3 (12)	0	
Degree of development			
Incomplete crown	1 (4)	5 (20)	0.019
Incomplete root	10 (40)	15 (60)	
Complete root	14 (56)	5 (20)	
Bulk of tooth			
Above ridge	13 (52)	22 (88)	0.006
Below ridge	12 (48)	3 (12)	
Root morphology			
Normal	0	3 (12)	0.049
Fused	10 (40)	15 (60)	
Divergent roots	10 (40)	7 (17)	
Divergent-Supernumerary root	4 (16)	0	
Fused with supernumerary roots	1 (4)	0	
Axial position			
Straight	6 (24)	20 (80)	0.000
Oblique	19 (76)	5 (20)	

which in turn increases the likelihood of unfavorable split in SSO.[5,12] The present study supports the above view. In the present case series, when bulk of M3 lie below the dense region of the EOR, the incidence of the unfavorable splits increases. In 356 instances where bulk of M3 was above the ridge, only 13 cases (3.65%) had unfavorable splits while in 60 instances, when bulk of M3 was below the ridge, 14 cases (23.33%) of the cases had unfavorable splits [Figure 2a-h]. The differences between the incidences were statistically significant. The same was also highlighted when internal comparisons were employed.

The Finite Element Analysis model study has revealed that the functional stress is concentrated along the EOR. M3 often are at close relation with EOR. A high mechanical stress is often associated with normal loading on the EOR when bone in the region is manipulated.[16] Several studies have underlined the importance of the EOR in the osteotomy cut [Figure 3a and b]. [16,17] Moreover, Champy's lines of osseointegration is a very critical factor in the osteotomy[17] as well as while selecting the place for positioning the miniplates and screw. The number of Champy's lines and the number of bone lamellae and grains being involved in the cut would determine the outcome. The more the grains and lamellae gets involved, more the chance of unfavorable splits.

Figure 1: Thin mandibular ramus more likely to have unfavorable split

In the presence of impacted M3, the lingual cortex becomes thinned out, and owing to the spatial placement of the M3, there is a higher chance of bad splits in the lingual cortex (distal split).[5,8] This has been the experience in the present study group too. The strong EOR probably helps to withstand undesired stress and direct the stress in the opposite direction -lingually where the unfavorable splits commonly occur.[1,13] It has been observed that in young-aged males, after the removal of the M3, a perfect split often occur. In few cases, the lower border fails to split. This probably arises due to the fact that this border is the thickest. Hence, while performing a SSO in young males, after the removal of M3, should one require a further splitting under direct vision, care should be exercised to control the force needed to cause discontinuity in the lower border of mandible. This is essential owing to close proximity to the inferior alveolar nerve [Figure 4].

The root morphology of M3 appears to play a vital role in determining the unfavorable split. Normal root morphology had no splits while 4.38% of all fused roots, 13.5% of all diverged roots, 36.36% of all supernumerary roots with divergence, and all cases of supernumerary fused roots had bad splits. The difference was statistically significant. With internal controls too, this trend was observed. A large surface area of M3 (altered root morphology) would increase the number of bone lamellae, grains, and osteons being involved [Figures 5 and 6].

Among all the M3 that were oriented along the mandibular arch, only 2.47% had bad splits while 12.43% of all M3 that were obliquely oriented underwent bad splits. The difference was statistically significant. Similarly, an obliquely placed M3, relative to the mandibular arch, would involve more osteointegration planes, bone grains, and the number of bone lamellae being involved [Figures 7-10]. This would lead to poor stress distribution during the separation of the split bone. Multi-directional as well as force directed in a wrong direction would lead to unfavorable splits.

The direction, force of the spreader, and its efficient use is critical; as such requiring experience and expertise. A properly used spreader would cause a good split. In such cases, that does not respond favorably, a bur cut may be essential, below the bend of the M3, adjacent to proximal surface. This bur cut could damage

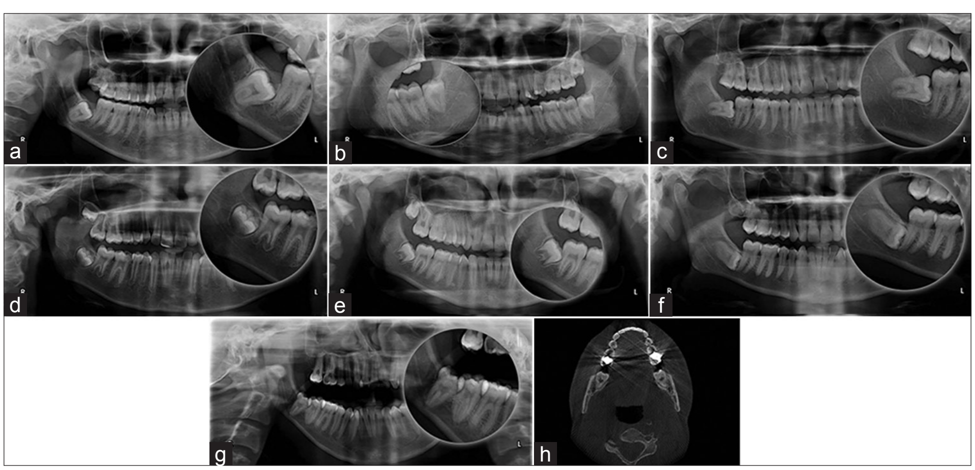

Figure 2: (a) Mesioangular, (b) Vertical, (c) Horizontal, (d) Incomplete crown, (e) Incomplete root, (f) Below ridge, (g) Fused root, (h) Straight in line with the arch- axial section

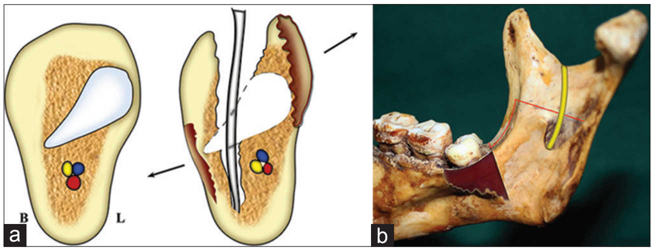

Figure 3: (a) Impacted tooth below oblique ridge and not in line with the arch (linguoverted impaction) , (b) Thin lingual cortex higher chance of bad split in the lingual cortex

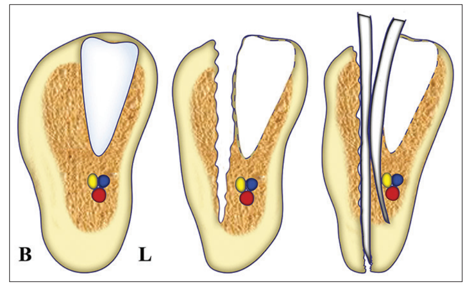

Figure 4: Thick lower border (young adult) - split under direct vision

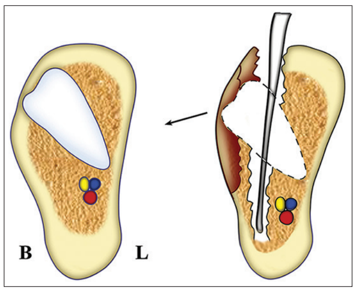

Figure 5: Buccoverted impaction - with thin buccal cortical plate

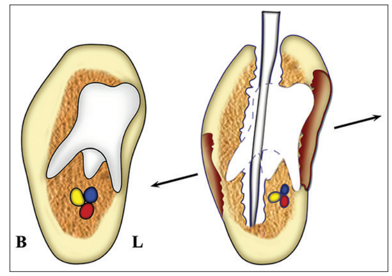

Figure 6: Altered root morphology - Involving more surface area

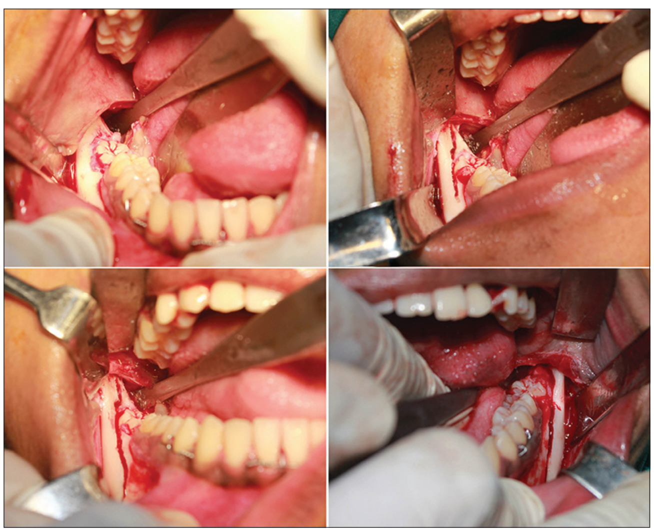

Figure 7: Case 1: BSSO - Sagittal cut before removal of impacted tooth

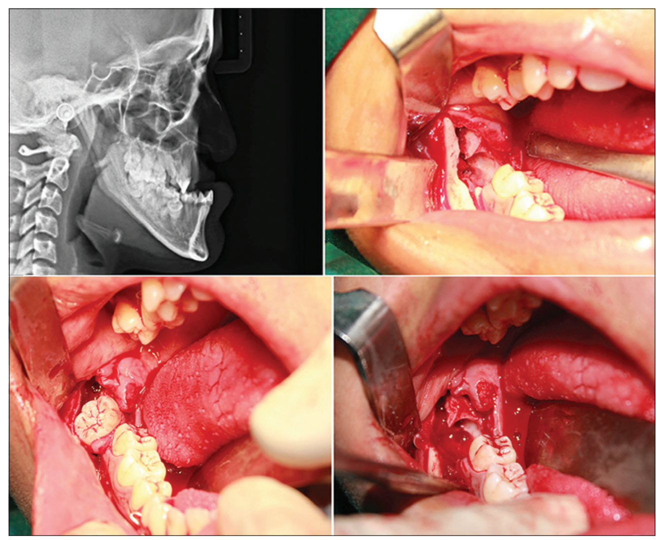

Figure 8: Case 2: BSSO - Sagittal cut before removal of impacted tooth

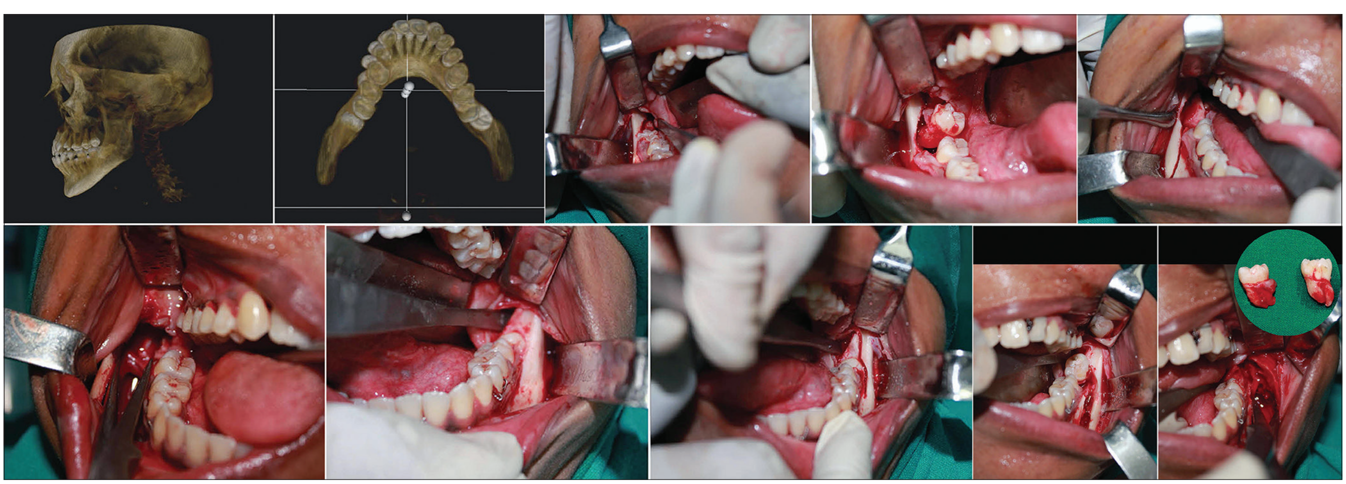

Figure 9: Case 3: BSSO with removal of impacted tooth - Note the application of spreader after sagittal cut for separation

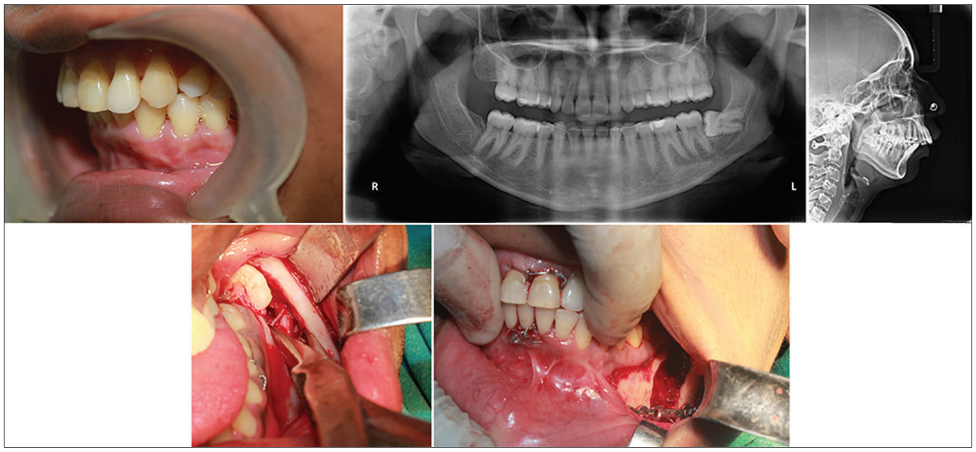

Figure 10: Case 4: Micrognathia- BSSO- Mandibular advancement of about 1.5 cm and simultaneous removal of horizontally impacted tooth

the underlying nerves, hence should be used with extreme caution. The adjoining area in the buccal part is the thickest part of the EOR. This imparts the much required resistance against stress. Presence of M3 in this region would be a natural weak line of resistance. An M3 whose bulk is situated above the EOR would be safe while that involves the EOR would weaken the natural lines of resistance. Similarly, an obliquely placed M3 will be a source of weakness.

An impacted M3 that lies below the EOR, distoangularly or vertically oriented, with divergent/supernumerary root would cause more unfavorable splits when the spreader is not used properly. Such impacted M3 can be planned in such a way that they alone can be removed earlier to the BSSO.

Previous studies have related the mandible and several other factors related to the third molar, and only select parameters of the spatial position of M3 have been studied. This study for the first time has confirmed the spatial positioning of M3 as one of the several causes of unfavorable splits during BSSO. Further Fine Element analysis studies would be useful to predict the outcomes of the effect of the osteotomy. Though there is no direct evidence to prove the role of the M3 in causing unfavorable splits during BSSO, this study provides enough circumstantial evidence with statistical significance that the morphology and spatial orientation of the M3 is one of the major factor in causation of unfavorable splits.

REFERENCES

1. Mehra P, Castro V, Freitas RZ, Wolford LM. Complications of the mandibular sagittal split ramus osteotomy associated with the presence or absence of third molars. J Oral Maxillofac Surg 2001;59:854-8; discussion 859.
2. Dal Pont G. Retromolar osteotomy for the correction of prognathism. J Oral Surg Anesth Hosp Dent Serv 1961;19:42-7.
3. Hunsuck EE. A modified intraoral sagittal splitting technique for correction of mandibular prognathism. J Oral Surg 1968;26:250-3.
4. Kriwalsky MS, Maurer P, Veras RB, Eckert AW, Schubert J. Risk factors for a bad split during sagittal split osteotomy. Br J Oral Maxillofac Surg 2008;46:177-9.
5. Precious DS. Removal of third molars with sagittalsplit osteotomies: The case for. J Oral Maxillofac Surg 2004;62:1144-6.
6. Witherow H, Offord D, Eliahoo J, Stewart A. Postoperative fractures of the lingual plate after bilateral sagittal split osteotomies. Br J Oral Maxillofac Surg 2006;44:296-300.
7. Falter B, Schepers S, Vrielinck L, Lambrichts I, Thijs H, Politis C. Occurrence of bad splits during sagittal split osteotomy. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2010;110:430-5.
8. Schwartz HC. Simultaneous removal of third molars during saggital split osteotomies: The case against. J Oral Maxillofac Surg 2004;62:1147-9.
9. Schubert W, Kobienia BJ, Pollock RA. Cross-sectional area of the mandible. J Oral Maxillofac Surg 1997;55:689-92; discussion 693.
10. Hallikainen D, Iizuka T, Lindqvist C. Cross-sectional tomography in evaluation of patients undergoing sagittal split osteotomy. J Oral Maxillofac Surg 1992;50:1269-73.
11. Bloomquist DS, Lee JJ. Principles of mandibular orthognathic surgery. In: Miloro M, editor. Peterson's Principles of Oral and Maxillofacial Surgery. Vol 2.Ontario, Canada: BC Decker Inc.; 2004.p. 1150-4.
12. Precious DS, Lung KE, Pynn BR, Goodday RH. Presence of impacted teeth as a determining factor of unfavorable splits in 1256 sagittal-split osteotomies. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1998;85:362-5.
13. Schwartz HC. The timing of third molar removal in patients undergoing a bilateral sagittal split osteotomy. J Oral MaxillofacSurg 2002;60:132-3.
14. Reyneke JP, Tsakiris P, Becker P. Age as a factor in the complication rate after removal of unerupted/impacted third molars at the time of mandibular sagittal split osteotomy. J Oral Maxillofac Surg 2002;60:654-9.
15. Plooij JM, Naphausen MT, Maal TJ, Xi T, Rangel FA, Swennnen G, *et al*. 3D evaluation of the lingual fracture line after a bilateral sagittal split osteotomy of the mandible. Int J Oral Maxillofac Surg 2009;38:1244-9.
16. Szucs A, Bujtár P, Sándor GK, Barabás J. Finite element analysis of the human mandible to assess the effect of removing an impacted third molar. J Can Dent Assoc 2010;76:a72.
17. Takahashi H, Moriyama S, Furuta H, Matsunaga H, Sakamoto Y, Kikuta T. Three lateral osteotomy designs for bilateral sagittal split osteotomy: Biomechanical evaluation with three-dimensional finite element analysis. Head Face Med 2010;6:4.

Cite this article as: Balaji SM. Impacted third molars in sagittal split osteotomies in mandibular prognathism and micrognathia. Ann Maxillofac Surg 2014;4:39-44.

Source of Support: Nil, **Conflict of Interest**: None declared.