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Evaluation of Lingual Fracture Pattern of the Mandible After Bilateral Sagittal Split Osteotomy with and Without Inferior Border Osteotomy

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Abstract--The Purpose of the study was to evaluate the pattern of lingual split when performing a bilateral sagittal split osteotomy

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(BSSO) with different osteotomy methods. A total of 15 dry human cadaveric mandibles was taken for the study. The classical Epker technique of BSSO was performed on the left side. The same was done on the right side along with an-additional inferior border osteotomy. There resultant split was assessed based on modified lingual split scale. The maximum torque force that was needed to split the mandible was recorded and the fracture pattern was observed. Similar osteotomies were performed in 15 fresh goat mandibles which acted as control group. The human cadaveric dry mandible recorded an average torque of 12.6 +2.4 Nm (SD: 0.32) with a maximum of 16.0 Nm and a minimum of 8.0 Nm on left side.80% of the mandible were Type I fracture pattern and 20% had Type III fracture pattern.

Keywords--bilateral sagittal, cadaveric mandible, inferior alveolar nerve, modified lingual, split osteotomy.

Introduction

Bilateral Sagittal split Osteotomy of the mandible is one of the commonest surgical procedures used in orthognathic surgery. Since its introduction many modifications of the original technique have been described to decrease the risk of bad splits, to avoid non-union and to prevent trauma to the alveolar nerve. Obwegeser¹.The lateral osteotomy cut was made horizontally from the distal region of the second molar to the posterior border well above the mandible angle. Dalpont² modified the Obwegeser technique by lateral osteotomy cut was made in the distal to the molar to inferior border of mandible. Epker³ modified the obwegeser and dalpont technique by J osteotomy cut in inferior border of mandible. In1990, Wolford⁴ introduced the concept of the additional inferior border split along with Obwegeser Dalpont technique. A specially designed saw was used to cut the inferior border from the inferior side. This modification was deemed necessary because of their observation that, in the conventional method, the split usually occurred in the lingual cortical plate. The high lingual side split made the placement of the inferior border screw difficult because of the lack of bone to screw below the neurovascular bundle or canal. The other disadvantage of the split on the lingual side was that the nerve frequently went with the proximal fragment and was thus more difficult to visualize and to separate.

However, with the modified Wolford technique⁴, the inferior border of mandible is weakened by an osteotomy, thus creating a new line of minor resistance. In this way it was hoped to reduce the osteotomy depth and additionally reduce the torque necessary for the splitting process. This should make the splitting man oeuvre more controllable and lead to fewer complications in repositioning the mandible. It is interesting to evaluate whether the characteristics of the fracture line are influenced orcan be controlled, by adaptation of the length or direction of the medial and buccal bone cuts or whether the fracture line simply seeks the path at least resistance.

Aims and Objectives

The purpose of the study was to evaluate the various patterns of lingual split by using a novel digital gauge when performing a bilateral sagittal split osteotomy (BSSO) with Epker technique and compare with the modified BSSO technique with additional inferior border osteotomy.

Materials and Methods

The study was conducted at the Department of Oral and Maxillofacial Surgery. Ethical clearance was obtained from The Institutional Review Board prior to commencing the study. The overall study methodology is depicted in Fig 1.

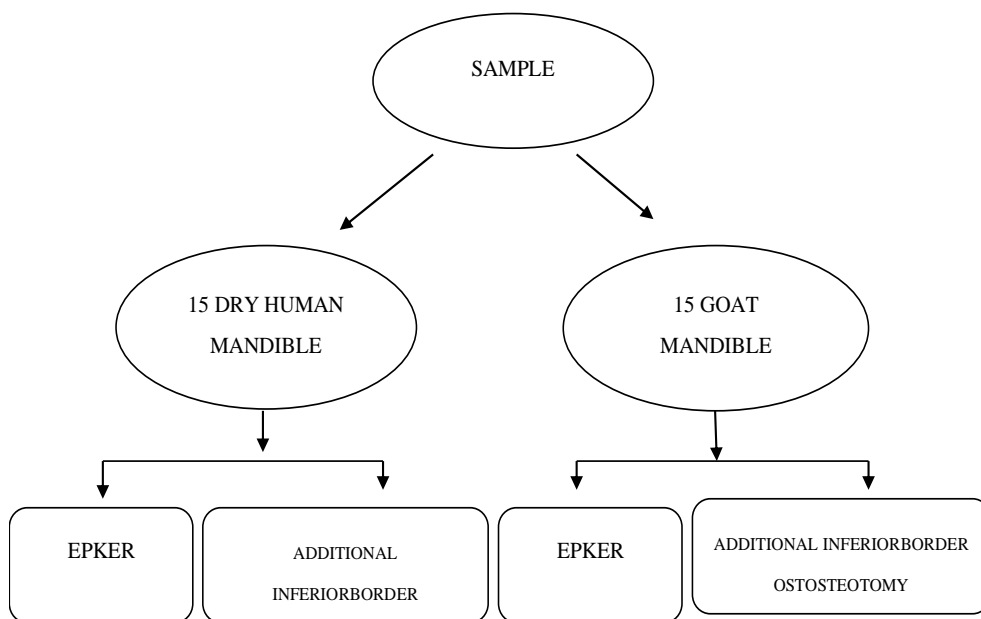


Figure1. The overall study methodology

Inclusion criteria

A total of 15 adult dry human cadaveric mandible belonging to the age group of 20-40 years and 15 fresh goat mandibles (sacrificed for the food) were included in the study only – intact mandibles were included in the sample.

Exclusion criteria

Any mandible with pathological or anatomical changes were excluded from the study.

Materials

Micromotor, straight hand piece, 703 bur, 701 bur, BP Blade with handle, Periosteal elevator, Osteotome-fine thin osteotomes, Mallet, Spreader Specially designed Torque gauge attached with the Spreader Fig-2

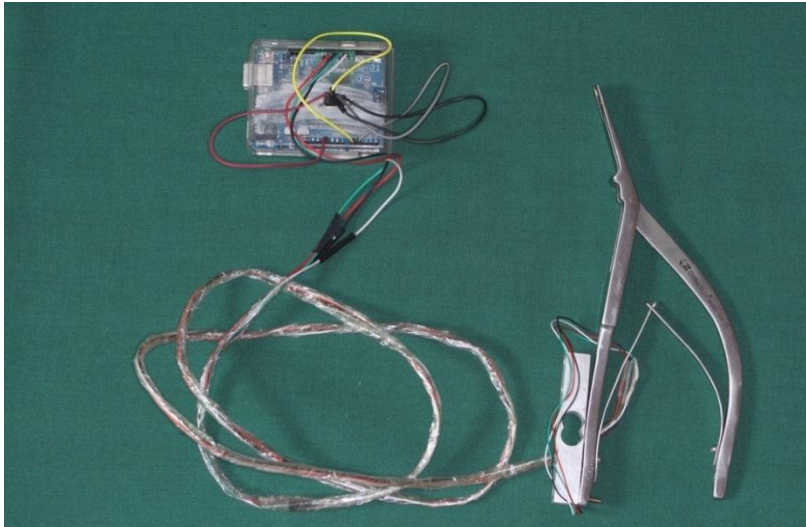


Figure 2. Smith spreader attached to the torque device

Digital gauge and its software: (Fig- 2) The clipper is fixed with load cell of 1 kg capacity and tightened with M3 screws. The handle where pressure is applied is fixed with load cell of 1 kg capacity. These load cell can measure force applied on it up to 10 N force or 10 Kgf. From the load cell the values are taken to Wheatstone bridge circuit or HX711 circuit for converting analog signals or resistance received from the load cell and convert it to digital signal. These digital signals are taken to the controller unit. The purpose of the controller unit is to send the signal to the display interface. The signal received from the HX711 is sent to computer / laptop using USB Ethernet data cable. Arduino Software (IDE) is used to detect the readings and program is done in this software for the load cell force calculation. Then standard weights are taken to calibrate the load the cell using the software and adjust the readings. After calibrating the load cell, it is fixed in the tool handle.

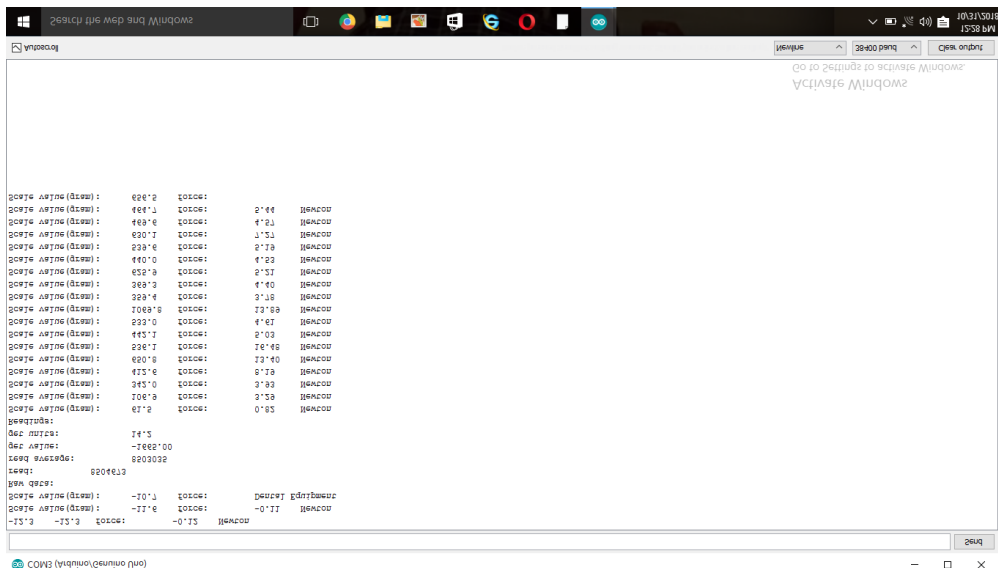


Figure 3. Screenshot of the recorded torque force

Surgical technique

Epker technique-The horizontal medial osteotomy was made just above the mandibular foramen through the cortical bone of the ramus. The vertical osteotomy was done at the lateral cortical bone mesial to the second molar tooth from the lower border of the mandible to the external oblique ridge. The horizontal medial cut and vertical lateral osteotomy cuts were connected by the oblique osteotomy cut running along the external oblique ridge. The lateral vertical osteotomy cut was extended as J cut at the inferior border to extend till the lingual side. In the goat mandible, the lateral vertical bony cut was performed at two-thirds of the total length distal to the mental foramen to mandibular foramen. A 703 or 702 surgical carbide bur was used for all of the osteotomies. After the osteotomy cuts were completed, an osteotome with an 18-mm width was inserted distal to the second molar at an angle of 45 degrees was driven into the mandibular body in the cranio-caudal direction no deeper than 2/3 of that length, and the entire osteotomy was deepened and gradual separation of the buccal cortical plate from the distal segment was done. Then proximal and distal segments were split using smith's spreader attached with a Torque gauge. The maximum torque force that was needed to split the mandible was recorded in computer and the fracture pattern was observed.



Figure 4. Application of spreader

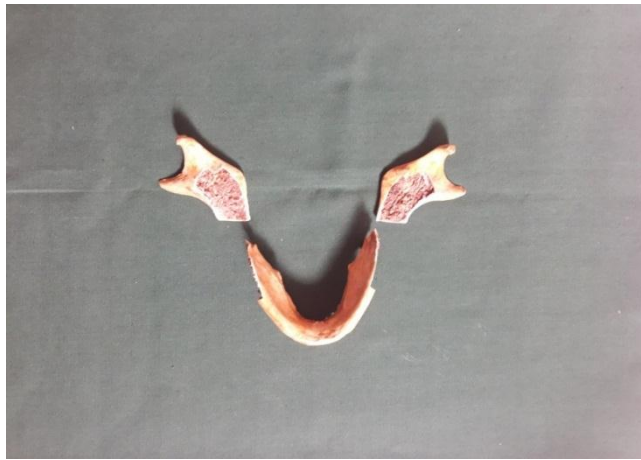


Figure 5. Lingual split of the mandible –right side and left side (inferior border)

Modified bssso technique with inferior border osteotomy³

Modified lingual split scale: Plooji 2009⁵

Type 1: The lingual fracture line started above and just behind the mandibular foramen and remained posterior and inferior to the mandibular canal but without the involvement of the lower border of the mandible. The lingual plate sagittally split above the level of the lower border of the mandible.



Figure 6. Lateral vertical cut

Figure 7 lingual split scale



Figure 7 a. Type -1

Figure 7 b. Type-2



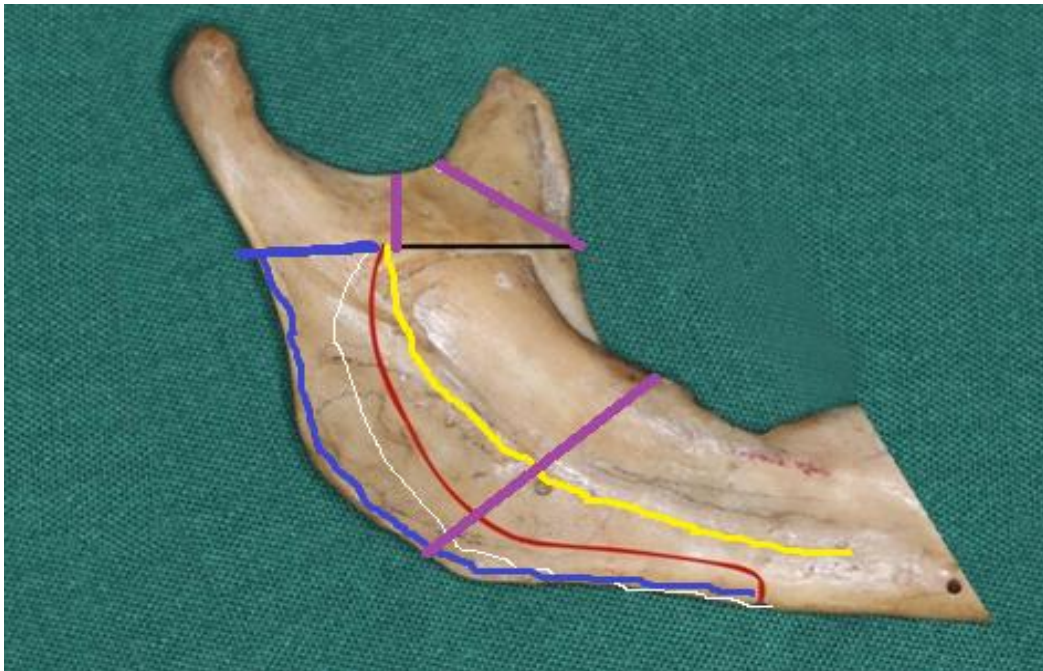
Figure 7 c. Type-A

Figure 7 d. Type-3 B



Figure 7 e. Type-4

Figure 7 f. Type-5



Type 2: The lingual fracture line started above and just behind the mandibular foramen and extended to the lower border and connected with the inferior border osteotomy resulting in sagittal splitting of the mandible through the middle of the inferior border of the mandible. The fracture line was posterior and inferior to the mandibular canal.



Figure 8. Oblique cut

Type 3: The lingual fracture line extended to the posterior border of the mandible and split the entire ramus of the mandible and extended anteriorly above or along the lower border of the mandible.

Type 4: The posterior fracture line started above and just behind the mandibular foramen and extended anteriorly in the mylohyoid groove or through the mandibular canal.

Type 5: The unfavorable split resulting in fracturing of the ramus, angle or buccal cortex of the mandible.

The digital torque gauge was used to record the force necessary to split the mandible.

Results

Cadaveric Dry Mandible: Group-1a(Epker)recorded an average torque of 12.6 ± 2.4 Nm (SD: 0.32) with a maximum of 16.0 Nm and a minimum of 8.0 Nm. Group 1b (Additional inferior border osteotomy along with Epker technique) recorded a maximal torque of 12.0 Nm and a minimal torque of 5.0 with an average required torque of 8.7 ± 2.1 Nm. Group-1b technique decreased the torque needed to split the jaw by 31 % when compared to the group-1a technique. The decrease in the torque required to complete the split with the additional lower rim osteotomy was statistically significant (P value-0.000023).



Figure 9. Right sideshowing additional osteotome (inferior cut) left side showing (J cut)

In Group-1a 80% of the mandibles demonstrated Type I fracture pattern and 20% recorded Type III fracture pattern. In Group-1b 93% of the cases split by

Table 1

Descriptive statistics for torque force on the cadaveric dry mandible (independent t-test)

	Minimum (N)	Maximum (N)	Mean	SD	P-value
BSSO with inferior border cut (Right side)	5.00	12.00	8.7333	2.12020	0.000023
BSSO without inferior border cut (Left side)	8.00	16.00	12.6667	2.35028	

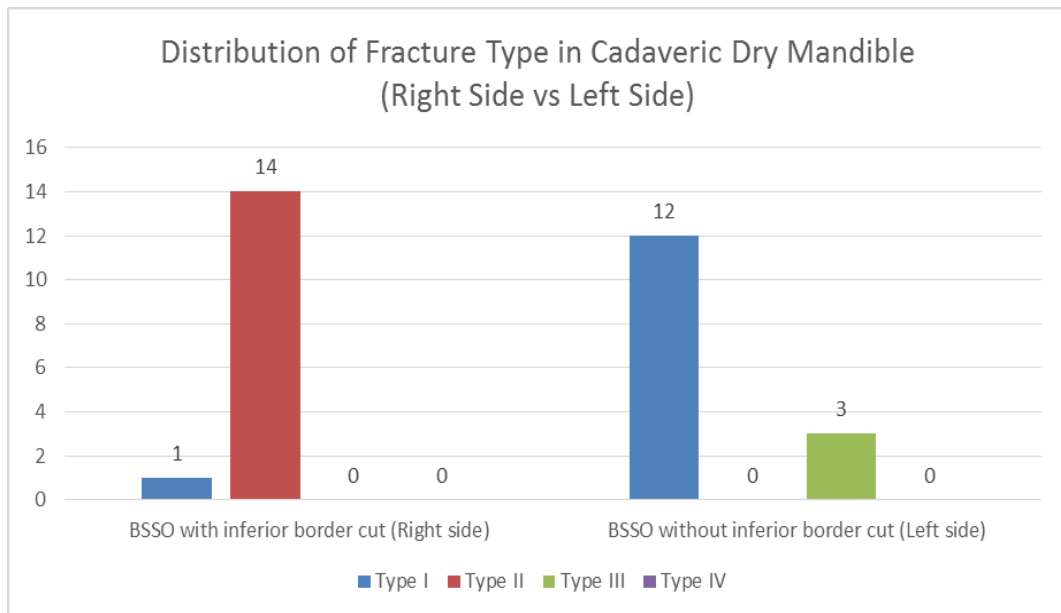


Figure 10. Distribution of fracture type in cadaveric dry mandible (right side vs left side)

Goat Mandible: In Group-2a the average force required to complete the split after the completion of osteotomy was $16.5 \text{ N} \pm 2.8 \text{ N}$ (Range 21 N to 12 N). Group-2b the average force is $9.2 \text{ N} \pm 2.9 \text{ N}$ (Range 6N to 18 N). Group-2b decreased the torque needed to split the jaw by 40 percent when compared to the Group-2a. The decrease in the torque required to complete the split with the additional lower border osteotomy was statistically significant. The same trends were noted with the splitting patterns. Most of the hemi-Mandibles (80%) split by type I fracture pattern in group-2a. In group-2b, the mandibular split was more predictable and 100% of hemi-mandibles split by Type II fracture pattern. The study outcome in the dry mandible correlates with that of the Fresh Goat mandible indicating the influence of the modified osteotomy in the fracture pattern of the mandible.

Statistical analysis of the data obtained was done using SPSS 22 software. The frequency of distribution of fracture patterns were calculated in both the groups. Also, descriptive statistics such as mean and standard deviations [SD] were calculated for the torque force observed in both the groups. We used Mann Whitney U test to observe the significance in the frequency of distribution of fracture patterns in both the groups and p-value less than 0.05 were considered statistically significant. Independent t-test to analyze the significance between torque forces measured in both the techniques (Epker and Modified Technique) in both the groups and p-value less than 0.05 were considered statistically significant.

Table 2
Mann Whitney u test for the frequency of distribution of fracture patterns in cadaveric dry mandible among type of technique

	Total	Type I (n)	Type II (n)	Type III (n)	Type IV (n)	Type V (n)	p-value	Significance
BSSO with inferior border cut (Right side)	15	1	14	0	0	0	0.840	Not Significant t at p < 0.05.
BSSO without inferior border cut (Left side)	15	12	0	3	0	0		

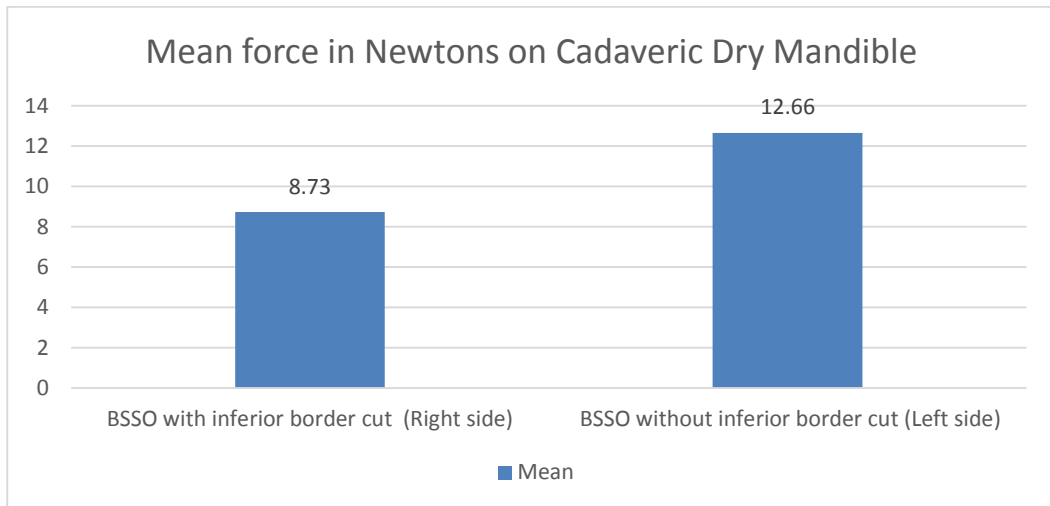


Figure 11. Mean torque force in newton on cadaveric dry mandible

Discussion

Sagittal split Osteotomy is considered to be the most established surgical technique used in orthognathic surgeries. Even though numerous modifications have been made, the conventional technique remains unchallenged as the sort after technique in orthognathic surgical procedure. Various modifications have been introduced to minimize the complications associated with the surgical procedure and improve the esthetic outcome of the surgery.



Figure 12. Application of spreader

Jop P. Verweij⁶ conducted a human cadaveric study on angled osteotomy design aimed to influence the lingual fracture line in bilateral sagittal split osteotomy. connecting sagittal bone cuts. The authors proposed that the angled osteotomy design promoted a more posterior lingual fracture which decreased the incidence of bad splits and inferior alveolar nerve entrapment. In theory, a technique which increases the depth of the osteotomy weakens the mandible adequately and directly facilitates the better outcome of the splitting process.

Table 3
Descriptive statistics for torque force on goat mandible (Independent t-test)

	Min (N)	Max (N)	Mean	SD	p-value
BSSO with inferior border cut (Right side)	6.00	18.00	9.2000	2.90812	< .00001
BSSO without inferior border cut (Left side)	12.00	21.00	16.5333	2.79966	

Modifications in the conventional approach may only allow adding osteotomies of the inferior and posterior borders to the Classic Epker procedure. The suggested modifications itself may be difficult mainly due to lack of ease in access to those regions with an intra oral approach; however, an osteotomy in the inferior border is achievable and is easily accessible than the posterior border of the mandible. There are not many studies that address the biomechanics of BSSO to optimize the technique and in prevention of surgical complications.

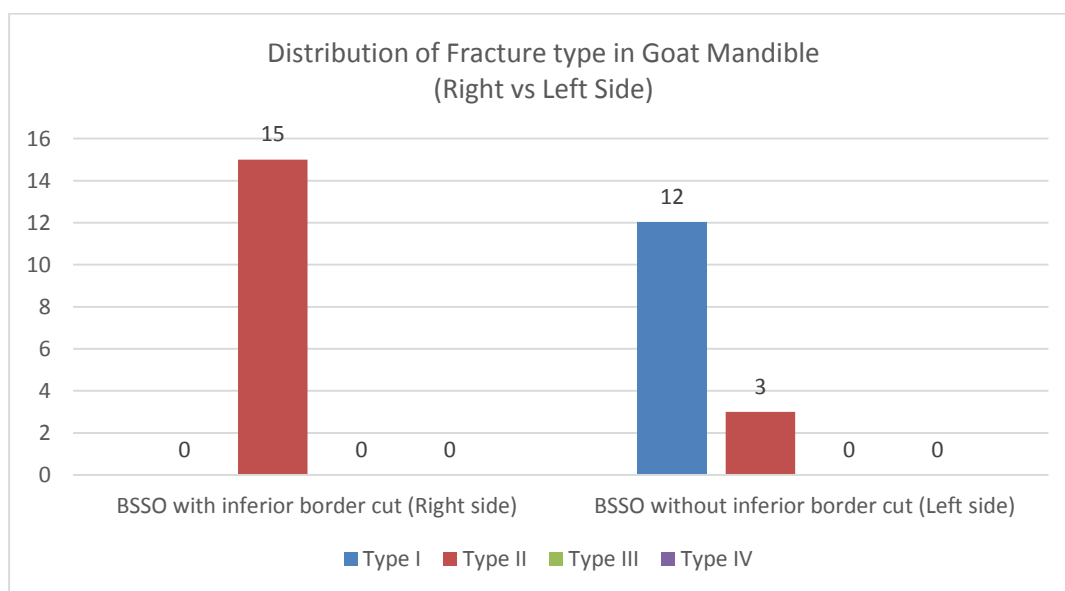


Figure 13. Distribution of fracture type in goat mandible (right side vs left side)

Several investigators have described the influence of the osteotomy design on the lingual fracture line^{7,8}. Plooij investigated mandibular ramus split patterns using three-dimensional computed tomography (3D-CT) and concluded that a longer

horizontal lingual bone cut ending behind the anterior border of the mandibular foramen resulted in more Lingual Split Scale-1 splits. In our study, longer horizontal medial osteotomy along with an additional osteotomy in the inferior border resulted in Lingual split scale-2 which ensured more predictable and safer osteotomy.



Fig 14. Goat mandible medial side of right side (additional osteotomy)

There are two points at which there is increased risk of damage to the IAN during surgical splitting; during manipulation of the medial side of the ramus and during fracturing, splitting. Majority of the authors have reported post-operative sensitivity deficits due to manipulation close to the IAN^{9,10,11}. A weakened mandibular body with additional osteotomy procedure could reduce the manipulation time on the lingual aspect, also preventing the need to chisel around the IAN because of the preformed splitting pattern, and it also could help to reduce the operative time. Such complications can be minimized by adding the inferior border osteotomy. We were able to achieve good splitting results with the modified technique in our study setting.

Table 4

Mann Whitney u test for the frequency of distribution of fracture patterns in goat mandible among type of technique

	Total	Type I (n)	Type II (n)	Type III (n)	Type IV (n)	Type V (n)	p-value
BSSO with inferior border cut (Right side)	15	0	15	0	0	0	1.000
BSSO without inferior border cut (Left side)	15	12	3	0	0	0	

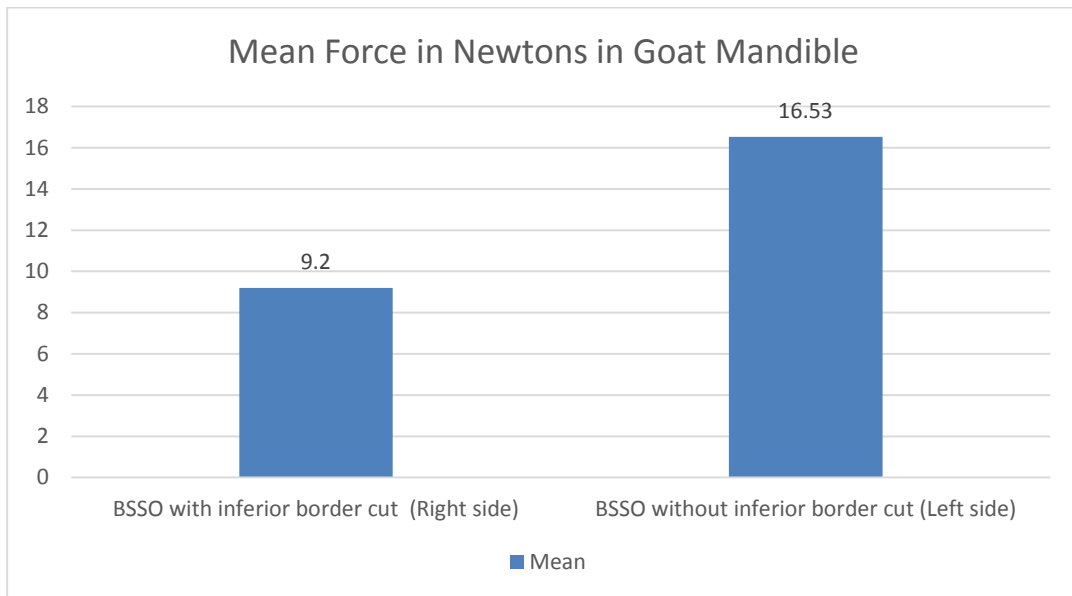


Figure 15. Mean torque force in newton on goat

Muto¹⁵ evaluated the mandibular ramus BSSRO split patterns with Epker technique using CBCT and reported 63% splits at the lingual side, 22% splits at the posterior border, and 15% splits at the buccal side of the mandibular ramus. Majority of the mandibular ramus split at the lingual side near the mylohyoid sulcus; while the remaining split at the posterior border of the mandibular ramus. No fracture lines were observed through the mandibular canal. In terms of the relevant anatomical features that influenced the split patterns, Plooij suggested that the split pattern was related to the end-position of the medial bone cut. Reyneke and Kriwalsky¹⁶ reported that the split pattern is also influenced by the presence of the third molar and the patient's age. In general, fractures or splits usually occur in a weaker region in terms of structure and biomechanics. The thinner the cortical bone, the weaker it is biomechanically, and therefore, easier to split. Ma¹⁷ reported that the lingual cortical is thinner than the buccal cortical. Hence, most of the splits (75.38%) ran as described by Hunsuck.



Figure 16. Goat mandible medial side of left side (J cut)

Ma also found that the shapes of the mandibular ramus in the axial plane varied among patients. In majority of the patients, the mandibular ramus is wider medio-laterally in the anterior border than the posterior border, but the width in the anterior and posterior border is similar in few patients. Ma also classified mandibular ramus into three types: the half-crescent, sim-triangle shapes (with wider anterior region as compared to the posterior region), and the well-distributed shape (with similar width of the anterior and posterior regions). The half-crescent and sim-triangle shapes have higher chances of Vertical pattern of fracture line to inferior border of the mandible during BSSO. However, the mandibular ramus usually split at the posterior border in the well distributed pattern. The mandibular angle contains less cancellous bone and more cortical bone. The attachment of the medial pterygoid and the masseter muscles in the mandibular angle compacts the medial and lateral plates in the mandibular angle region. The differential distribution and transmission of stress with respect to the different shapes of the mandible could be one of the reasons for the different split patterns of the mandibular ramus. But in our study, we have not evaluated the influence of mandibular angle on the fracture pattern.

Hou M¹⁸ studies have shown that the distribution and transmission of stress could be altered by an additional osteotomy at the inferior border of the mandible in the BSSO. The torque needed to split the mandible could increase if the degree of the mandibular angle is less. During the surgery they found that the mandibular body was initially split, and then the mandibular ramus was split gradually. When only the mandibular body is split, most of the mandibular ramus split smoothly near the mylohyoid sulcus in the hyperdivergent patients¹⁸. In contrast, due to the larger curvature of the mandibular angle in the hypodivergent patients, it is difficult to split the mandibular ramus at the lingual side near the mylohyoid sulcus¹⁸. In order to split the mandible completely in the hypodivergent patients, a deeper split is needed in the region of the mandibular angle and the mandibular ramus.

Along with the decreased force required to split the bone, adding an osteotomy at the lower border of the mandible also improved the ability to control the splitting process. Although, the outcomes of our study have been found to be significant and favorable, application of the modified technique must be done careful as it may be technique sensitive. It is also necessary to consider the bio-mechanical characteristics of dry cadaveric human mandible would be different from that of alive human mandible. To further recommend the use of the technique in clinical operative conditions, it may be relevant to consider using instrument that could easily facilitate a safe method to make an inferior border osteotomy via intra-oral approach. A notable suggestion would be the use of piezoelectric equipment¹⁹ with a hooked oscillating saw to facilitate an inferior border osteotomy. A rotating or oscillating saw could be used. Wolford and Davis²⁰ developed a reciprocating saw to cut the inferior border of the mandible in 1990. Using this they achieved mandible splitting without malleting. They described a more predictable split with fewer complications. The marginal branch of the facial nerve should be considered while attempting the technique in patients. According to the authors, this technique should only be used by experienced surgeons to avoid complications.

Gruber and Ueki²¹ described minor nerve impairment and a reduction in bleeding when using the piezo device for osteotomies. Piezo-surgery does not guarantee a safe bone split and is time consuming. Another possibility is the use of the Wethington osteotomes²². These were designed by Simpson to facilitate horizontal osteotomies but also aid osteotomy of the inferior border. The osteotomy was achieved using a triangular, V-shaped osteotome without soft tissue protection provided by the instruments themselves. Application of our modified technique with such proper armamentarium may produce a better and predictable outcome. However, it should also be considered that the split patterns are also influenced by the surgical factors including the experience of the surgeon performing the procedure along with the force and direction of the split. A randomized control trial with suggest instruments and in a standardized operating protocol will serve to be significant in establishing the technique.

In our study we found that this modified BSSO technique resulted in more predictable pattern of lingual fracture pattern along the lower border of the mandible away from the mandibular canal and with the less required force to split the mandible. However, the drawbacks of the study include practical difficulty of achieving lower border osteotomy through intra oral approach and the nature of dry mandible may be different from that of the alive mandible which may influence the outcome of the osteotomy. We recommend that this technique should be done with fresh cadaveric mandible through intra oral approach before attempting the technique in human orthognathic surgery.

Conclusion

The study was done to evaluate the influence of additional osteotomy at the inferior border of the mandible in addition to the classical Epker technique of BSSO. We did this study on 15 adult dry human cadaveric mandibles. We also included 15 fresh adult cadaveric mandible of the goat, sacrificed for the food as the control group because the physical properties of the dry human mandible would be different from that of fresh alive mandible which may influence the

outcome of the study. In each mandible, Classical Epker technique of BSSO was done in left side and modified technique with additional inferior border osteotomy was done in right side. Lingual fracture pattern was assessed based on modified lingual split scale. The maximal force required to complete the split was calculated by the specially designed torque gauge. From this study we conclude that

- In the cadaveric dry mandible, 80% of the mandibular split were Type I fracture pattern (along the mylohyoid sulcus) with the Epker technique. In contrast with the modified technique with an additional osteotomy at the inferior border of the mandible 93% of the cases split by Type II fracture (along the lower border of the mandible).
- The mean average force required to complete the split with the Epker technique was 12.6 ± 2.4 Nm. When using the modified technique with an additional osteotomy at the inferior border we recorded an average required torque of 8.7 ± 2.1 Nm. The new technique decreased the torque needed to split the jaw by 31 % when compared to the classical BSSO technique.
- The results of the adult human dry mandible highly correlate with that of the fresh goat mandible indicating that the obtained results are due to modification of the BSSO osteotomy rather by the change in the physical properties of dry mandible.
- The creation of a new osteotomy at the lower border of the mandible improved the ability to control the splitting process in a more predictable manner with reduced force.
- The goat mandibles were included in the study because the physio elastic properties of dry mandible would be different from that of fresh alive human mandible. So, fresh goat mandibles were included in the study as study group to evaluate whether the outcome was due to the influence additional inferior body osteotomy cut or due to the changes in the mechanical properties of the mandible.

Recently, software platforms have been introduced to reconstruct a 3D model from (cone-beam) CT data to analyze 3D data in a virtual operating room (VOR)¹². With these 3D models, a clear view of the lingual surface of the mandible can be achieved, enabling observation of the previously hidden lingual aspect of the fracture line. CBCT based evaluation of the BSSRO combined with the lingual split scale enabled objective evaluation of the surgical result, thereby adding a new dimension to the discussion of BSSO techniques¹³. On examining the split patterns of the mandibular ramus in BSSO through cone-beam computed tomography (CBCT) the investigators hypothesized that the thickness of the cortical bone of the ramus, the degree of the mandibular angle and the shapes of the mandibular ramus in the axial plane could be associated with these split patterns. In our study, we also measured the torque force used in the resulting fracture patterns. The Modified BSSO Technique with inferior border osteotomy resulted in 30% to 40% reduction of force required to split the mandible. It was correlating with the studies of Roland Böckmann¹⁴. In his study the device HTG2-10 gauge developed by IMADA (Toyohashi, Japan) has been used to evaluate the force required to split the mandible. Its accuracy was $\pm 0.5\%$, with a measurement frequency of 33 times per second. The applied force was recorded

with a PC and ZLINK 2 software, international edition, version 2.02E, obtained from IMADA.

References

1. Obwegeser H: A modification of lingual plastic surgery of the alveolar crest according to R. Trauner. *SSO Schweiz Monatsschr Zahnheilkd*, 63, 788–799, 1953.
2. Dal Pont G: Retromolar osteotomy for the correction of prognathism, *J Oral Surg Anesth Hosp Dent Serv*, 19, 42–47, 1961
3. Epker BN: Modifications in the sagittal osteotomy of the mandible. *J Oral Surg*, 35, 157–159, 1977.
4. Wolford LM, Davis: The Mandibular Inferior Border Split: A Modification in the Sagittal Split Osteotomy. *J Oral Maxillofac Surg* 1990.
5. Plooij JM, Naphausen MTP, Maal TJJ, Rangel TXIFA, Swennen G, Koning M, Borstlap WA, Berge SJ: 3D evaluation of the lingual fracture line after a bilateral sagittal split osteotomy of the mandible *Int. J. Oral Maxillofac. Surg*, 38, 1244–1249, 2009.
6. Jop P, Verweij Gertjan, Mensink M, Marta Fiocco, J.P. Richard van Merkesteyn, Presence of mandibular third molars during bilateral sagittal split osteotomy increases the possibility of bad split but not the risk of other post-operative complications, *J Craniomaxillofac Surg*, 42, 2014.
7. Mensink G, Gooris PJ, Bergsma JE,: Bilateral sagittal split osteotomy in cadaveric pig mandibles: Evaluation of the lingual fracture line based on the use of splitters and separators, *Oral Surg Oral Med Oral Pathol Oral Radiol*, 116:281, 2013.
8. Mensink G, Gooris PJ, Bergsma EJ, Is the lingual fracture line influenced by the mandibular canal or the mylohyoid groove during a bilateral sagittal split osteotomy? A human cadaveric study, *J Oral Maxillofac Surg*, 72:973, 2014.
9. W. Semper-Hogg, M. A. Fuessinger, T. W. Dirlwanger, C. P. Cornelius, The influence of dexamethasone on postoperative swelling and neurosensory disturbances after orthognathic surgery: a randomized controlled clinical trial, *Head Face Med*, 13, 19-1, 2017.
10. De Lima VN, Lemos CA2, Faverani LP, Santiago Júnior JF, Effectiveness of Corticoid Administration in Orthognathic Surgery for Edema and Neurosensorial Disturbance: A Systematic Literature Review, *J Oral Maxillofac Surg*, 75(7), 1-1528, 2017.
11. Sunanda Roychoudary, Neurosensory disturbances after bilateral sagittal split osteotomy- retrospective study. *J Oral Biol Craniofac Res*, (65-68), 2015.
12. Muto T, Takahashi M, Akizuki K: Evaluation of the mandibular ramus fracture line after sagittal split ramus osteotomy using 3-dimensional computed tomography, *J Oral Maxillofac Surg* 70:648, 2012
13. Bockmann R, Schön P, Neuking K, Meyns J, Kessler P, Eggeler G. In vitro comparison of the sagittal split osteotomy with and without inferior border osteotomy. *J Oral Maxillofac Surg*, 73, 316–23, 2015.
14. Muto T, Takahashi M, Akizuki K: Evaluation of the mandibular ramus fracture line after sagittal split ramus osteotomy using 3-dimensional computed tomography, *J Oral Maxillofac Surg*, 70:e648, 2012.

15. 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*, 46, 177–179, 2008.
16. Hou M, Yu T, Wang J. Evaluation of the mandibular split patterns in sagittal split ramusosteotomy, *J Oral Maxillofac Surg*, 73, 985–93, 2015.
17. S.C. Mohlhenrich, N. Ayoub, F. Peters, P. Winterhalder, A. Prescher, F. Holzle, M.Wolf, A. Modabber, Evaluation of the lingual fracture patterns after bilateral sagittal split osteotomy according to Hunsuck/Epker modified by an additional inferior border osteotomy using a burr or ultrasonic device.
18. Wolford LM, DavisThe Mandibular Inferior Border Split: A Modification in the Sagittal Split Osteotomy, *J Oral Maxillofac Surg*, 1990.