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SYSTEMATIC REVIEW

Variation in Anatomical Position of Lingula in relation to Ramus Osteotomy assessed by Cone Beam Computed Tomography (CBCT): A Systematic Review

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***ABSTRACT*:**
Dentofacial deformities can occur in both maxilla and mandible. The available treatment modality for treating such cases is Bilateral Sagittal Split Ramus Osteotomy (BSSO) in case of mandibular deformities. Identification of position of lingula plays a key role while placing medial cut to prevent damage to inferior alveolar nerve during BSSO. Various diagnostic aids are available to identify the position of lingula. This systematic review sought scientific evidence regarding the best available diagnostic aid which may be considered gold standard. A systematic search of the PubMed/MEDLINE, Elsevier/Scopus, and Cochrane Library databases was conducted to include articles published from 1st January 2000 up to May 2017. Following the application of inclusion criteria, 6 articles were selected for detailed analysis. These studies included a total of 861 patients (mean age 25 years), with higher prevalence of females. There is significant variation in position of lingula when compared in males and females with varying skeletal patterns. In conclusion, use of CBCT in identification of position of lingula can be considered as a gold standard diagnostic aid prior to BSSO.
Key words: Mandibular lingula, Cone Beam Computed Tomography. Sagittal split ramus osteotomy, Mandibular foramen.

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INTRODUCTION:

Human facial skeleton is made up of complex anatomy and mandible is a part of it. It serves as an attachment for various muscles to function in harmony with the skull base. The lingula is a tongue shaped bony landmark which serves as an attachment for sphenomandibular ligament. Mandibular foramen is an orifice located lateral to this linguala on the medial aspect of mandibular ramus, which serves as a passage for blood vessels that supply nutrients to the mandible, mandibular teeth, periodontal tissues, and lower lip and for the nerves responsible for sensory perception in these regions.[1]
Complex anatomy of mandible makes it crucial for a Maxillofacial Surgeon to carry out various surgical procedure's which includes exodontia, disimpaction, pre-prosthetic surgery, reduction of the fractured segments, resection or orthognathic surgeries. Thus, locating the accurate anatomical position of thisregion is critical in achieving more successful anaesthesia and preventing complications in orthognathic surgery.[1]
Mandibular deformities like retrognathia, prognathia, and asymmetry are corrected with Bilateral Sagittal Split Osteotomies (BSSO) which include advancement and setback. There are three osteotomy sites in BSSO. The first cut is made through the lingual cortex superior to the mandibular foramen above mandibular lingula parallel to the occlusion. The second corticotomy is made through the buccal cortex in a vertical direction at the level of the first or second molar.The third corticotomy is made along the external oblique ridge, connecting the first two osteotomy lines. The prepared bone is then split into proximal and distal segments before it is fixed into the desired position.[2]
Bilateral Sagittal Split Ramus Osteotomy (BSSO) procedure can result in good functional and cosmetic

outcomes; however, neurosensory disturbance of the inferior alveolar nerve (IAN) is common with an incidence of 9-85%.[3,4]Sensory alteration in the IAN that is confirmed with neurosensory testing after BSSO ranges postoperatively from 54% to 86% at 4-8 days, 41% to 75% at 1 month, 33% to 66% at 3 months, 17% to 58% at 6months, and 15% to 33% at 1 year.[5] Thus, location of lingula plays an important role in success of BSSO.

No human being is identical to each other, hence there is also a change in their skeletal anatomy. Similarly, there is variation of shape and location of lingula in individuals having normal and skeletal Class II and Class III malocclusion. Various diagnostic modalities have been used and studied in past like OPG, CT scan and few newer aids such as CBCTs have been used at present to know the exact location of lingula to prevent the damage to IAN during surgical procedures. Preoperative evaluation of exact location of the mandibular lingula using 3D imaging technique of Cone Beam Computed Tomography(CBCT) can be identified and used as gold standard at preliminary diagnostic tool prior to performing Bilateral Sagittal Split Osteotomy (BSSO).Hence, the present systematic review is carried out to identifythe position of mandibular lingula while doing ramus osteotomy.

Methods:

This systematic review was performed according to the PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) 2015 checklist: recommended items to address in a systematic review protocoland the Cochrane Handbook for Systematic Reviews of Interventions.

Eligibility Criteria:

Inclusion Criteria is articles in English or those having detailed summary in English, studies published between 1st January 2000 to May 2017, studies that provide detailed information about radiological position of mandibular lingula, studies that provide information about mandibular lingula and articles reporting studies on humans and cadavers will be included.

Exclusion Criteria is studies that provided inadequate information and systemic review, research papers, case reports etc

PICO

P- Humans and cadavers having mandibular deformity.

I - Cone Beam Computed Tomography (CBCT).

O- Position of mandibular lingual.

Search strategy and selection criteria

The initial bibliographic research was performed in the MEDLINE (via PubMed), Google Scholar, Institutional Library, CTRI databases, using five lines of search elements.

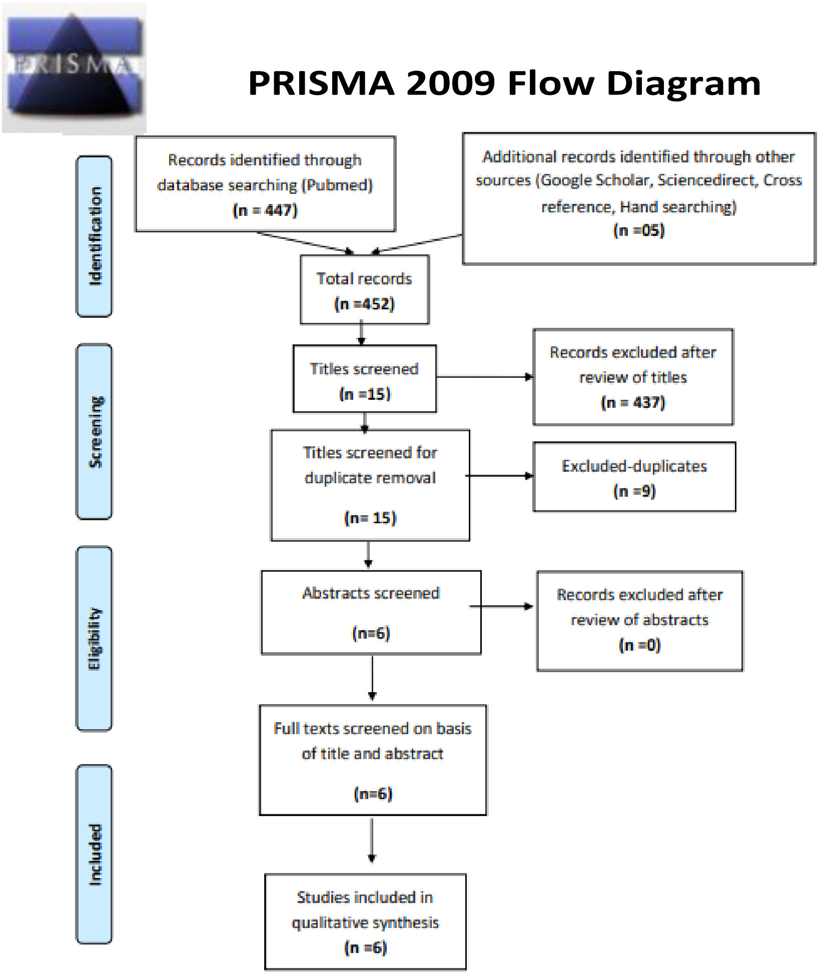
Sr No	Search Strategy Sr No.	Keywords used	No. Of articles found	No. Of articles selected
1	Search Strategy 1	Mandibular lingula	11	02
2	Search Strategy 2	Mandibular foramen AND Mandibular Foramen	03	01
3	Search Strategy 3	Mandibular Lingula AND Cone Beam Computed Tomography	07	04
4	Search Strategy 4	Cone Beam Computed Tomography AND Sagittal Split Ramus Osteotomy	15	03
5	Search Strategy 5	Mandibular Lingula OR Mandibular Osteotomies	411	05

For the initial selection, two independent reviewers (DK and LS) reviewed the title and/or abstract of the articles against established inclusion criteria and full text articles were selected. Any disagreement between the two reviewers was resolved after discussion.

Preliminary screening consisted of 447 studies which were screened, and 437 studies were excluded for not meeting the eligibility criteria. Out of the remaining 15 studies 9 were removed for being duplicates. Thus, total 6 studies were included in qualitative analysis with a total of 15 estimates

Data collection process:

A standard pilot form in excel sheet for data extraction was initially used and then all heading not applicable for the review were removed. Data extraction was done for 1 study and this form was reviewed by an expert and finalized. From the studies included in the final analysis the following data was extracted.



Author	Year	No of participants	Method of CBCT specifications	Groups		Anterior border of ramus (in mm)	Sigmoid notch (in mm)	Inferior border of ramus (in mm)	Posterior border of ramus (in mm)
Tengku Shaeran T.A. et al	2016	51	Not specified.	Group A#		12.48 ±2.16			
				Group B#		15 ± 2.16			
Huang. C et al	2015	32	iCAT Visions 1.62software with a voxel size of 0.4x0.4x0.4mm	Group A*	Right side	6.7 ± 1.6	14.3 ±2.6		
					Left side	6.4 ±1.6	14.3 ±2.3		
				Group B*	Right side	5.9 ±1.6	14 ±2.8		
					Left side	6.4 ±1.7	13.9 ±2.8		
				Group C*	Right Side	6.1 ±1.3	15.5 ±3		
					Left Side	6.4 ±1.3	15.3 ±2.8		
Park. H et al	2015	30	paranomic view usingInvivo5.1,PHT-60FO	Group Aǂ		19.4 ±2.1	21.5 ±2.4		
				Group Bǂ		19 ±1.8	20.4 ±2.8		
				Group Cǂ		19.8 ±2	18.7 ±2.4		
Senel. B et al	2015	63	i-CAT CBCT unitoperating at 120 kVp, 8mA, with 0.25 mm voxel size and field of view of 13 cm			18.5 ±2.3	18.1 ±3.6	38.3 ±5.3	16.9 ±3.5
Findik. Y et al	2014	139	Planmeca Romexis; voxel size, 400 mm; image size, 401x 401 x 401; Finland, 2011			15.57 ±2.4	14.85±2.39	24.86 ±3.67	13.86 ±3.6
Sekerci A.et al	2013	412	Newtom 5G, QR, Verona, Italy			16.77 ±2.74	15.32±2.46	33.43 ±3.68	13.02 ±2.31

\# Group A: Mandibular Prognathism, Group B: Without mandibula prognathism
*Group A: Normal occlusion, Group B:Reterognathism, Group C: Prognathism
ǂ Group A: Normal Occlusion, Group B: Skeletal Class II, Group C: Skeletal Class III malocclusion

DISCUSSION:

According to Archer (1975) dentofacial deformities can occur in maxilla, mandible, or both jaws. If the deformities develop in the mandible, there can be overgrowth (prognathism), undergrowth (retrognathia), or uneven growth (laterognathia).[6] Corrections of these dentofacial deformities can be done by the surgical method of Bilateral Sagittal Split Osteotomy (BSSO).[7] BSSO was first introduced in 1957 by Obwegeser and modified thereafter to prevent complications by several oral-maxillofacial surgeons.[8-14.] During the surgical procedure of BSSO osteotomy cut is made on the medial surface of the mandibular ramus, a sagittal osteotomy cut along the anterior border of the mandibular ramus and internal oblique line and a vertical body osteotomy cut. Lingula is an important clinical landmark which is needed to be identified prior to BSSO and failure to do so may land up in intraoperative complications such as haemorrhage, unfavourable fracture, and nerve injury.[15-20.]

Various diagnostic modalities such as Orthopantomograph (OPG), Computed Tomography (CT), Cone Beam Computed Tomography (CBCT) have been used by far till date. Conventional Computed Tomography (CT) provides a 3-Dimensional view when compared to Orthopantomograph (OPG) which provides a 2-Dimensional(2D) view and overcomes drawbacks of OPG but its higher cost and radiation exposure limits its use. Evaluation of morphological differences between patients with mandibular prognathism and patients without prognathic mandible regarding all osteotomy sites in BSSO can be analysed and studied in 3D ways using Cone Beam Computed Tomography(CBCT). Unlike CT, CBCT is cost effective and radiation exposure of patient is reduced and thus its use can be implicated as gold standard for diagnosis in maxillofacial deformities and patients undergoing orthognathic surgery. [2] Hence this review aims at focusing the use of CBCT for exact identification of anatomical location of lingula prior to orthognathic surgery to prevent intraoperative complication.

Tengku Shaeran TA, *et al* in 2016 conducted a study on 51 patients from the Department of Oral and Maxillofacial Surgery of Hospital Universiti Sains Malaysia and Hospital Raja Perempuan Zainab II. Using purposive sampling method an age group of 18-35 years was considered and 17 patients having skeletal Class IIIpattern and 34 patients with Class I were included in the study. For the study group CBCT were taken prior to orthognathic surgery and for controlgroups CBCT images were taken as a part of investigations which had midfacial fractures or third molar surgery. All the results were analysed using IBM SPSS Statistic Version 20 and it was found that patients with mandibular prognathism (MP) had a higher average lingula level 18.87mm (SD 4.7) thanpatients without mandibular prognathism (WMP) 15.62mm(SD 4.33). The distances from the anterior border of ramus were shorter 12.48mm (SD 2.16). Hence, the author concluded that in patients having mandibular prognathism (MP) the position of lingula is at a higher level and has a shorter distance from the anterior border of ramus when compared to patients having normal skeletal Class I occlusion.[2]

Huang *et al* in 2016 conducted a study which was carried out between 2008 to 2010 and included patients with Class I, II, and III dentofacial relationships confirmed using lateral cephalograms. Ninety-six patients in age group of 18 to 45 years were included with 32 (16 women and 16 men) in each of the three groups (i.e., normal dentition, retrognathism, and prognathism) which had undergone CBCT imaging using an iCAT vision 1.62 software (Imaging Science International, hatfield, PA, USA) with a voxel size of 0.4x0.4x0.4mm. Statistical analyses were performed using SPSS 15.0 statistics software (SPSS Inc., Chicago, IL, USA). Individuals in the prognathism group were significantly younger than those in the retrognathism group (mean age, 23.4 years vs. 29.8 years; $p < 0.001$). A two-tailed value of $p < 0.05$ was considered statistically significant. There was no difference in the distance from the lingula tip to the ramus notch between the three groups (for all, $p > 0.05$). There was no difference between the three groups the distance from the lingula tip to fusion of the buccal and lingula plates, except for the right side of male patients in whom the distance from the lingula tip to the fusion of the buccal and lingual plates in the retrognathism group was significantly shorter than the distance in the normal group (mean distance, 5.2 mm vs. 6.7 mm p Z 0.016). The maximum and minimum distance from the lingula tip to the fusion of,the buccal and lingual plates (anterior border of ramus) was 10.3 mm and 3.6 mm, respectively. No significant difference was observed in the distance from the lingula tip to the fusion of buccal and lingual plates between the three groups, which indicated a similar chance of unfavourable fractures between the three groups during medial osteotomy. A medial osteotomy line 3 mm superior to the lingula and carried to the depth of the medial surface of the buccal cortex is suggested because the minimum distance from the lingula tip to fusion of the buccal and lingual plates is 3.6 mm. Thus, the author concluded that the results of their study showed no significant difference in the IAN canaldirection in patients with normal dentition, retrognathism, and prognathism, which suggests that no group is more vulnerable to IAN injury during BSSO but during BSSO, surgeons should be very careful at the point halfway between the lingula and the anterior ramus border where the IAN is nearest the cortical bone.[21]

Park. H *et al* 2015 conducted a study which included 100 patients who visited the Dankook University Dental Hospital from January 2013 to June 2014. Cephalometric analysis was carried out to classify the patients into three groups: 30 with normal occlusion, 40 with skeletal class II malocclusion, and 30 with skeletal class III malocclusion. Subjects were 18 to 31 years of age as of the dates when the CBCT radiographs were obtained. Included in the skeletal class II group were 30 patients in division 1 and 10 patients in division 2 of this class. CBCT radiographs taken using PHT-60F0 (VATECH Corp., Hwa-Sung, Korea) were reconstructed in a panoramic view using In vivo 5.1 (Anatomage, San Jose, CA, USA). In CBCT images reconstructed in a panoramic view, items were measured in the mandibular ramus on both sides. First, the measurements were made in the three groups of patients (those with normal occlusion, those with skeletal class II malocclusion, and those with skeletal class III malocclusion). Next, same-gender comparisons were made among the three groups. Men and women within the same group were compared, followed by a comparison between male and female patients in the entire cohort. Finally, within the skeletal class II malocclusion group, the two subsets of patients in division 1 and division 2 were compared. Statistical analyses were done using ANOVA and Tukey test to verify the results. Significant difference in distance from mandibular foramen to sigmoid notch (V) and distance of mandibular foramen (MF) up to extended line along the occlusal plane (P), the vertical position of the mandibular foramen ($p < 0.05$). The average V measurements(s-MF) were 21.59 mm in the normal occlusion group, 20.49 mm in the skeletal class II malocclusion group, and 18.77 nun in the skeletal class III malocclusion group. The average P measurements (1-MF) were 0.10 mm below the occlusal plane in the normal occlusion group, 0.03 mm below the occlusal plane in the skeletal class II malocclusion group, and 2.79 mm higher the occlusal plane in the skeletal class III malocclusion group. Following results indicate progressive increases in the length of mandibular ramus from the skeletalclassIImalocclusion group to the normal occlusion group to the skeletal class III malocclusion group. the position of the mandibular foramen varies from person to person, and in the skeletal class III malocclusion patients it was located higher than the position in the other two groups.[22]

Senel. B *et al* conducted a study in 2015 in 63 patients who underwent implant therapy. Thirty-five patients were males and 28 were females with an average age of 45 years, ranging from 25 to 70 years. CBCT imaging was done for all the patients using an i-CAT CBCT unit (Imaging Sciences International, Inc., Hatfield, PA, USA) operating at 120 kVp, 8 mA, with 0.25 mm voxel size and field of view of 13 cm. Once the 3D images of every sample had been processed, the data was analysed with i-CAT Vision software (Imaging Sciences International). The shape and position of lingula was studied on CBCT and the results were analysed by Student's t- test for right and left hemiarch and x2 test was used to compare the distribution types according to gender with minimum significance level of 5%. it was observed that, the comparison of each mandibular measure according to hemi-arch, the mean height of the lingula was 7.8 ± 2.4 mm and it was 7.4 + 2.7 mm on the left side and 8.3 ± 2.2 mm on the right side. The lingula was located at 18.5 ± 2.3 mm from anterior border of mandibular ramus, 16.9 ± 3.5 mm from the posterior border of the ramus and 18.1 ± 3.6 mm from the mandibular notch. The mean distance of lingula from the lower border of mandible was 38.3 ± 5.3 mm. Hence, no statistically significant difference between the locations of the mandibular foramen according to hemi-arch was noted.[23]

Findik. Y *et al* conducted a study in 2014 in 139 patients which reported at Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, University of SüleymanDemirel (Isparta, Turkey) for radiographic diagnosis and/or surgical treatment. The results were retrospectively analysed between 2012 to 2013. One hundred and thirty-nine patients (98 women and 48 men) underwent CBCT scanning (PlanmecaRomexis; voxel size, 400 mm; image size, 401 x 401 x 401; Finland, 2011) and were grouped into age from 9 to 18 years (growth group) and 19 to 71 years (adult group). The SPSS version 18.0 for Windows (SPSS, Inc, Chicago, IL) was used for data analysis. Statistical comparison of measurements of the right and left sides was performed with paired samples t-test. Statistical significance was predetermined as $P< 0.05$. The Pearson correlation analysis was used to assess the relationship between the measurements of the right and left sides. After analysing the data, it was found that mean average distance of lingula from the anterior border of ramus in men was 15.78 (SD 2.45) on right side and 15.84 (SD 2.63) on left side. In females the average distance was found to be 15.47(SD 2.40) on right side and 15.68 (SD 2.27) ($P = 0.018 < 0.05$).[24]

Sekerci. A *et al* conducted a retrospective study in 2013 which included CBCT (Newtom 5G, QR, Verona, Italy) of 2013 patients who presented to the Dento-maxillofacial Radiology service at the Erciyes University, Dentistry Faculty between June 2011 and January 2013. The data analyses were performed by using the Statistical Package for the Social Sciences (SPSS), version 16.0 (SPSS Inc, Chicago, Ill, USA) and statistical significance was determined at the level of $p< 0.05$. The distances were calculated for each of the measurements on right and left sides and comparison of mean values of the right and left sides were made by using t tests. The mean height of the lingula was 7.97 ± 1.84 mm and it was 8.01 ± 1.47 mm on the right side and 7.89 ± 1.84 mm on the left side. The lingula was located at 16.77 ± 2.74 mm from the anterior border of mandibular ramus, 13.02 ± 2.31 mm from the posterior border of the ramus, 15.32 ± 2.46 mm from the mandibular notch. The ratio of lingula RL in the present study was found to be 0.56 ± 0.04 mm.25 Ratio of the lingula (RL) indicates the position of lingula on the mandibular ramus. Lesser the RL, more anteriorly placed would be the lingula. The lingual nerve passes anterior to the linguala and an anteriorly positioned lingula would locate the lingual nerve closer to the anterior border of the ramus, and hence, at a greater risk to lingual nerve damage. [26,27]

LIMITATIONS:

1. The study has been specifically carried out in group of population.
2. All the values required to identify the location of lingula are not specified in some articles.
3. Type of CBCT software used for evaluation is not same in all the cases. Hence, there is a probability for variation in values.

CONCLUSION:

Anatomical position of lingula may vary in population and use of CBCT may provide an efficient diagnostic aid prior to any surgical intervention to avoid complications resulting due to inferior alveolar nerve injury

FUTURE IMPLICATIONS:

Compared to other available radiological diagnostic methods CBCT can be considered as gold standard for locating the exact position of lingula prior to any surgical intervention and prevent complications of inferior alveolar nerve injury.

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