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Original Research Article

Morphometric Analysis of Retromolar Triangle in Eastern Indian Population

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ABSTRACT

Background: Retromolar triangle exhibits great variation related with the 3rd molar presence, their impactation grade, its loss. RMT bone can be used as autological graft. RMT presents foramina of variable number and dimension. RMF of variable diameter can be found in different regional populations. Present study explores a morphometric study of RMT and their relationship to the mandibular canal and other bony landmarks of clinical significance.

Materials and Method: After ascertaining the gender distinction, bilateral retromolar triangle areas were demarcated and its margins were identified. Thereafter using a magnifying zoom lens of 10X, the RMF was located. The location of RMF was assessed, dimensions measured using syringe of various gauge and their distance from the bony landmarks were noted.

Result: The present study describes RMT morphology as retromolar fossa, tubercle and plateau. Retromolar plateau (61 specimen) and retromolar fossa (60 specimen) were equi-proportion, retromolar tubercle being the least common (9 specimen). Prevalence of RMF in the present study is 60.77% (79 out of 130 specimen), being highest ever reported in the Indian population. Unilateral right sided foramina were exhibited by 9.2% (12 specimen) and left sided in 3.85% (5 specimen). Bilateral RMF was present in 47.69% (62 specimen). Most common variant exhibited was 26G(0.45mm) in 41.54% of the specimens. Presence of RMF at the apex is the most common variant (30%) followed by near the base (20%). On the right side there was statistically significant association between gender and location of RMF. Mean distance between the right third molar and RMF is 4.3±2.3 and Mean distance on the left between the third molar and RMF is 4.6 ±2.3mm

Conclusion: Presence of RMF and its greater dimension represent a collateral neurovascular route of mandibular canal causing inadequate analgesia and vascular complications. The close proximity of RMF with 3rd molar especially "near the base" variant; may damage the structures passing through RMF during 3rd molar extraction and causes postoperative hematomas due to rupturing of the blood vessels. Henceforth, RMT and RMF is of clinical importance in Dental and Oral & Maxillofacial Surgeries.

KEY WORDS: Retromolar triangle, Retromolar foramen, Mandibular canal, Third mandibular molar.

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INTRODUCTION

Coronoid process of the jawbone is rough and beveled near the margin of medial surface for the muscular attachment of temporalis fibres. Posterior margin of this bevelling often transforms into a crest like elevation running antero-inferiorly to the 3rd molar or its alveolar socket. To this temporal crest deeper part of lower fibres of temporalis tendon is attached after bifurcating. Between the inferior-most part of the crest and the posterior end of the oblique line is a tiny triangular retromolar area behind the 3rd molar. This junctional triangular area created between the bifurcation of the temporal crest of the mandible and the distal edge of the last mandibular molar is known as the Retromolar triangle (RMT) [1]. Henceforth, RMT is bounded anteriorly by the posterior margin of the last molar tooth, postero-laterally by the anterior margin of the ramus and postero-medially by the temporal crest [2].

RMT varies significantly about the third molar presence and its impaction grade, or the mandibular teeth loss and the alveolar bone resorption [3]. Bone of the retromolar triangle can be employed as an autological graft in bone deficit implant cases [4]. Mucosa in relationship with the RMT has an established dominance of piriformis papilla also referred as retromolar pad, useful to mandibular prosthetics cheek support [5].

RMT sparingly exhibit single or more foramina with varying frequencies, termed as retromolar foramen (RMF). It permits additional twigs of the inferior alveolar neuro-vasculature supplying the lower jaw molars, their alveolar processes, mucosa of the retromolar area and buccal area; often distributed to the temporalis and buccinators muscles as well. These retromolar apertures/foramina also enable the passage to the branches of the buccal artery that establish an inferior alveolar artery anastomosis [6]. Henceforth, mandibular canal is now appreciated as a major conduit with several smaller branches as collateral channels. These accessory canals mostly contain accessory branches of the inferior alveolar neurovascular bundles distributed to the dentition, mandibular alveoli, gingiva and even the lower lip. Retromolar canal (RMC) is considered as a bifurcated variation of the mandibular canal initiating as a single foramen or multiple foramina into the RMT dividing above the canal and traverses antero-superiorly within the bone. This RMF give passage to the retromolar accessory branches which supply the tissues at the retromolar trigone and beyond [7,8].

Though previously various studies have been conducted reporting the varying incidences and variants of RMT and RMF in different population groups around the globe, there is a lacunae in comprehensive detail especially the accuracy of measurement and localisation, which are of utmost clinical value [6,9-11].

Various Indian studies reported varying incidences of RMF in the different ethnic groups, nuances are still lacking [12-17].

A prominent issue is the nomenclature and categorization of RMF/RMC as reported in various literatures. Some authors considers that RMF/RMC as the bifid or trifid collateral of the main conduit, the mandibular canal, initiating at the mandibular canal and terminating at the retromolar trigone (RMT) [6-18]. While, Other researchers imply that RMC is as an unique separate entity, emphasizing its clinical relevance [19,20].

Embryologically the ventral portion of 1st pharyngeal arch cartilages, known as Meckel's cartilages, becomes a horseshoe-shaped mould which is the primordium of the lower jaw(mandible). As the cartilage regresses, the mandible forms in the primordium formed by the inferior portion of Meckel's cartilage by the intramembranous ossification as dense fibro-membranous tissue lateral to the inferior alveolar nerve and its incisive branch. Around the 6th week of embryonic development, a centre near the mental foramen causes each hemi-mandible to ossify which later fuse at symphysis menti. Ossification spreads from this node, antero-medially and postero-cranially to form the body and ramus, initially below, and then follows the inferior alveolar nerve as well as its incisive branch [2].

Henceforth, during the morphogenesis canal to innervations of the incisors appears initially, followed by that of the deciduous molars, and eventually by the solitary or more canals to the 1st permanent molars. Hence, it is likely that the inferior alveolar nerve travels via three distinct nerve pathways in the jaw, each of which originated at a separate developmental stage The canal openings eventually merge gradually as a result of the accelerated prenatal development of the ramus and bone remodelling [21]. Variability in the ossification especially related to the canal containing branch of permanent molars may lead to one or more retromolar foramina.

Moreover, there is wide variability in the frequency, location, and size of the canal in different population. It is of the utmost clinical importance to determine the exact localization of the mandibular canal as well as the identification its retromolar collaterals in posterior mandibular region surgical procedures. Injury to this neurovascular bundle during surgical procedures, such as 3rd/ 2nd molar extraction, dental implant or split sagittal osteotomy, may lead to paraesthesia, severe bleeding, or traumatic neuroma. The presence of RMC may also lead to insufficient/ aberrant anaesthesia of the mandibular region which necessitates alternative anaesthetic techniques [6].

Henceforth, current study was undertaken with the following objectives:

1. To take the various morphometric measurements of the RMT and to classify it based on the morphology

2. To ascertain the incidence and localization of the RMF.

3. To take the morphometric measurements of the RMF using hypodermic needle of various gauges

4. To take various morphometric measurements related to RMC from important anatomical landmarks.

MATERIALS AND METHODS

An observational cross-sectional study was conducted in the Medical college and tertiary care hospital situated in a Eastern part of India with tribal dominant population including all the 65 dry and fully ossified adult mandibles.

After ascertaining the gender distinction, right and left RMT areas were demarcated in each mandible and subsequently based on their morphology, were divided in three subgroups:

A. Retromolar fossa: centre of the triangle depressed than the edges

B. Retromolar plateau: centre of the triangle at the same level as the edges

C. Retromolar tubercle: centre of the triangle elevated than the edges.

Base, apex, medial, and lateral borders of the retromolar trigone were carefully ascertained. Thereafter the presence of RMF was noted using a dermatological light magnifying zoom lens of 10X (Refer. to Figure 4 to 7) The localization of the foramen/foramina was noted, and its dimension was measured using the hypodermic needle of various gauges ranging from 18G, 20G, 22G, 24G and 26G equivalent to 1.20mm, 0.90mm, 0.70mm, 0.55mm and 0.45mm respectively [22]. Wherever foramina were present these dimensions were measured and noted

i. The minimum distance of the RMF from the MF/MC

ii. The minimum distance of the RMF from the posterior margin of 3rd molar/alveolar socket

iii. The minimum distance of the RMF from the posterior margin of 2nd molar/alveolar socket

iv. The distance of the RMF from the lingula

The gathered descriptive data were compared using the Chi-Square test of independence or Fisher's exact test (where one or more of the cell counts in a 22 table is less than 5) and analysed using Jamovi software for Windows, Version 2.2.5.0. [23].

Duration- 12 months

Sample Size- 65 adult dry mandibles (male and female) available in the Department of Anatomy, of the medical college during the period of study.

Inclusion Criteria: Clean, dry, well-preserved human mandibles with intact 3rd molar or its alveolar socket

Exclusion Criteria: Damaged mandibles, Unossified mandibles, Mandibles with the resorption of 3rd molar.

RESULTS

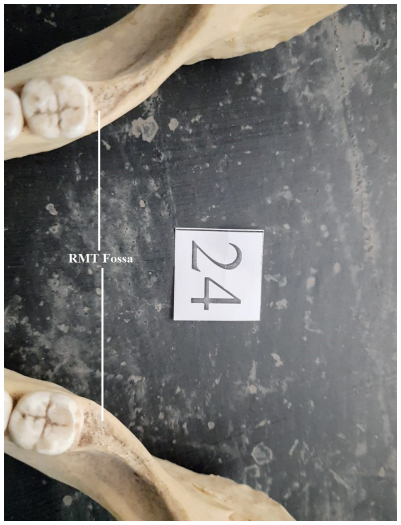

Fig. 1: Exhibiting bilateral RMT fossa.

Fig. 2: Exhibiting bilateral RMT tubercle.

Fig. 3: Exhibiting bilateral RMT plateau.

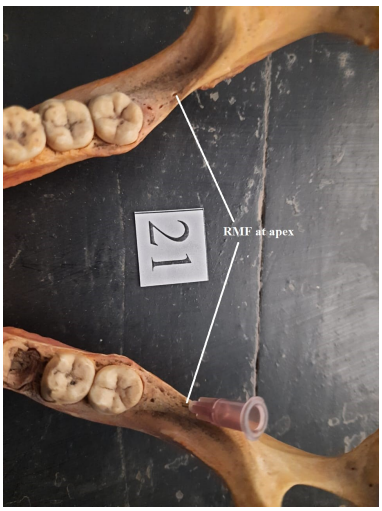

Fig. 4: Exhibiting bilateral RMF at the apex, size 26G.

Fig. 5: Exhibiting unilateral RMF at the base, size 26G.

Fig. 6: Exhibiting unilateral RMF near the centre, size 26G.

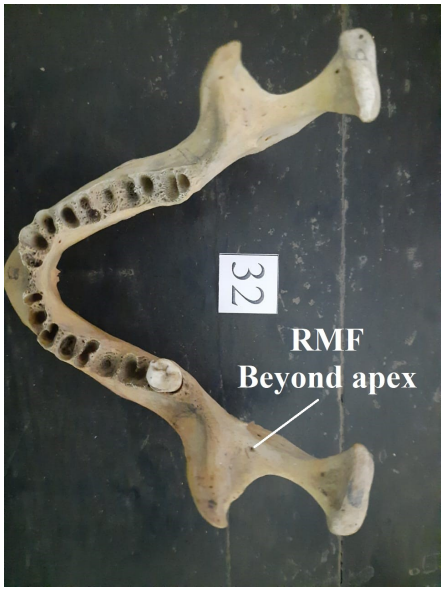

Fig. 7: Exhibiting unilateral RMF beyond RMT, size 26G.

Fig. 8: Exhibiting unilateral RMF at the apex, size 18G.

Table 1: Exhibiting gender wise distribution of RMT subtypes (n=130)

Gender	Retromolar fossa	Retromolar tubercle	Retromolar plateau	Retromolar fossa	Retromolar tubercle	Retromolar plateau
	Right side(n=65)			Left side (n= 65)		
Male	14(43.8%)	2(1.4%)	17(54.8%)	11(39.3%)	7(2.8%)	15(50%)
Female	18(56.2%)	0(0%)	14(45.2%)	17(60.7%)	0(0%)	15(50%)
Total	32(100%)	2(2%)	31(100%)	28(100%)	7(100%)	30(100%)

Table 2: Location of Retromolar foramen(as shown in Figure 4 to 7) in relation to gender (n=130).

Gender	Absent	Near the base	Near the central region	Near the apex	Beyond the apex	Absent	Near the base	Near the central region	Near the apex	Beyond the apex
	Right side(n=65)					Left side(n=65)				
Male	6 (27.3%)	10 (66.7%)	5 (83.3%)	12 (57.1)	0(0%)	14 (48.3%)	5 (45.5%)	3 (60%)	10 (55.6%)	1 (50%)
Female	16(72.7%)	5(33.3%)	1(16.7%)	9(42.9%)	1 (100%)	15(51.7%)	6 (54.5%)	2 (40%)	8 (44.4%)	1 (50%)
Total	22	15	6	21	1	29	11	5	18	2

Table 3: Size of Retromolar foramen in relation to gender (n=130).

Gender	Absent	Visible to naked eye	26G	24G	18G	Absent	Visible to naked eyes	26G	24G
	Right side (n=65)					Left side(n=65)			
Male	6(27.3%)	11(78.6%)	16(59.3%)	0(0%)	0(0%)	14(48.3%)	4(50%)	14(51.9%)	1(100%)
Female	16(72.7%)	3(21.4%)	11(40.7%)	1(100%)	1(100%)	15(51.7%)	4(50%)	13(48.1%)	0(0%)
Total	22	14	27	1	1	29	8	27	1

Table 4: Statistical analysis of RMC/RMF and its distance from strategic landmarks (n=130).

	Mean+/-SD	Minimum	Maximum	SE	Mann-Whitney U value	Z value	P value
RMF to MF (R)	14.31 ± 4.02	8.16	23.4	0.61	235	0.477	0.633
RMF to MF (L)	15.34 ±4.5	7.92	25.84	0.75	186.5	-0.749	0.454
RMF to Lingula (R)	15.83±2.3	11.2	19.6	0.36	315	2.48	**0.013**
RMF to Lingula (L)	8.58±7.94	0	18.49	0.985	263	1.19	0.233
RMF to 3rd molar (R)	4.3±2.3	1.08	11.3	0.35	121	-2.38	**0.017**
RMF to 3rd molar (L)	4.6 ±2.3	1.18	9.81	0.39	136	-2.03	**0.042**
RMF to 2nd molar (R)	14.0±2.3	10.24	21.28	0.35	197	-0.477	0.633
RMF to 2nd molar (L)	14.82±2.7	10.3	19.98	0.46	148	-1.72	0.084

A chi-square test of association was done comparing gender and shape of retromolar triangle (as exhibited in Fig 1, 2 and 3) on right side. Fisher's exact test was used as 2 cells had predicted cell counts lower than 5. No significant association was found between gender and shape of RMT on right side. $X^2(2) = 2.405$, p = 0.291.left side also 2 cells have expected cells count less than 5 hence fisher's exact test was applied .There was a significant association between gender and shape of retromolar triangle on left side $X^2(2) = 8.56$,**p =0.01**.

A chi-square test for association was conducted between gender and location of RMF. All expected cell frequencies were less than five so fisher's exact test was conducted. On right side there was statistically significant association between gender and location of RMF. Fisher's exact test = 9.97,**p =0.02**. Contrary to this on left side there was no significant association between gender and location of RMF. Fisher's exact test = 0.903, p = 0.97. Fisher's exact test was conducted as the cells have expected count was less than

five. On right side there was a significant association between gender and size of RMF. Fisher's exact test =11.802,p=0.007.On left side no significant association between gender and size of RMF. Fisher's exact test =1.080,p=1.0.

A statistical analysis of Retro-Molar Canal (RMC) and Retro-Molar triangle (RMT) and its distance from strategic landmarks was done. As the dimension RMC/RMT and various bony landmarks (Mandibular Foramen, Lingula, 2nd molar and 3rd molar) was not distributed normally distributed across the gender as tested by visual inspection of Q-Q plot. A Mann-Whitney U test was run to determine if there were differences in RMF/RMT and its distance from these variables. The Mid RMT to Lingula (R), U= 315, z=2.48, p= 0.013, Mid RMT to 3rd molar (R), U=121z=-2.38, p=0.017 and Mid RMT to 3rd molar (L), U=136, z=-2.03, p=0.042 was statistically significant.

DISCUSSION

Retromolar triangle area exhibits different shapes and presents foramina of variable number. The retromolar foramina of variable diameter can be found in different regional populations (North America, Africa, Europe, India, Asia North East) [5]. These retromolar perforations and foramina enable the passage of branches of buccal artery that establish an inferior alveolar artery anastomosis [6].

Present study intends to conduct an anatomical and morphometric study of retromolar triangle region and their relationship to the mandibular canal.

Shape of the RMT: Galdames et al. explained how the presence or absence of the third molar affected the variation in the triangle's shape. They discovered that the retromolar triangle form varied depending on whether the third molar walls were present or not. When the walls were present, the area took on a triangular shape (80%), but when they weren't present, it took on a tapering aspect (9.16%) or a drop shape (10.83 percent) [24].

Considering its shape, Park et al divided the RMT into three types: triangular, drop, and tapering, with triangular being the most prevalent [25]. However the present study describes it as retromolar fossa (Figure 1), tubercle (Figure 2) and plateau (Figure 3) depending on the appearance of edges of the trigone and its centre. Most common variant exhibited was retromolar plateau (61 specimen) followed by retromolar fossa (60 specimen). Mandible of female exhibited retromolar fossa variant more whereas that of male exhibited the retromolar plateau comparatively more. There was a significant association between gender and shape of retromolar triangle on left side. (Refer. Table 1)

RMF prevalence (Right vs left, Male vs female, location, sizes): Prevalence of RMF in the present study is 60.77% (79 out of 130 specimen), which is lesser than the prevalence reported by Park et al (26) (93.5%), followed Schejtman et al [27] (72%). However it is more Kawai et al [28] (52%), Rossi et al (29) (26.6%), Von Arx et al [20] (25.6%), Bilecenoglu et al (30) (25%)[31], Suazo et al [24] (12.9%) followed by Sawyer and Kiely [31] (7.7%) obversations. The highest prevalence of RMF was reported in Korean population [26].

Present study reported the total prevalence of RMF being 66.1% on the right (43 out 65 hemi-mandibles) and 55.3% on the left (36 out 65 hemi-mandibles). Unilateral foramina were exhibited by 2 specimens on the right side in the female and 10 specimens in the male, whereas unilateral left RMF was exhibited by 3 female specimens and 2 male specimens. Bilateral RMF was exhibited by 14 female specimens and 17 male specimens (Refer. Table 2). Table 2 also exhibited that presence of RMF at the apex is most common (30%) followed by near the base (20%). Also exhibited a statistically significant association between gender and location of RMF on the right side. As depicted in Table 3, size of RMF was measured using hypodermic syringe needle (18G to 26G). Most common variant exhibited was 26G in 41.54% of the specimens. Largest dimension of the foramina (18G) was exhibited by the right side of a female mandible. (Refer Figure 8)

RMF prevalence of the present study is also compared with the studies conducted in the

Indian population by various authors (Table 5). Prevalence of RMF in our study (60.77%) exceeds the finding of the prevalence reported by all the Indian authors viz. Narayana et al [12] (21.9%), Potu et al [15] (11.7%), Tiwari et al [16] (16%), Sathpriya et al [17] (20%), Athavale et al [32] (14.1%), Bilodi et al [33] (12.19%), Siddiqui et al [34] (17.14%), Akhtar et al [35] (14.3%) and Dave et al [36] (42%). As reported, RMF prevalence in Indian population are varying from 11.7% to 42%. This variability could be the result of diverse Indian population origins. Higher prevalence in the present study owing to the inclusion of minute foramina using gauzed hypodermic needle with measurement up to 0.45 mm (26G needle) and even including miniature foramina visible through naked eye. However, even after excluding these miniature foramina the prevalence of RMF is 43.85% which is still the highest prevalence reported in Indian studies.

Table 4, exhibits this study's finding that on the right side the mean distance between the 3rd molar and RMF is 4.3±2.3, range varying from 1.08mm to 11.30mm. Mean distance on the left between the 3rd molar and RMF is 4.6 ±2.3mm, range varying from 1.18mm to 9.81mm, which is equivalent to recently published literatures [7,8,11,17]. This close proximity of RMF with 3rd molar especially "near the base" variant; may produce postoperative hematomas secondary to blood vessel rupture and injury to the structures traversing the RMF during 3rd molar extraction. Sidorenko et al emphasized the possibility of anastomotic vascularity in the RMF, could be a potential source of infection or probable metastases from the oral cavity to the systemic circulation [6].

Akhtar et al reported the presence of RMF is more common in female and on the right side of mandible [35].

In present study, prevalence of RMF was 84.13% in males and 75.39 in females, hence is more common in males. Also, it was more on the right side of mandible (right, 65.08% and left 63.97%).

Table 6 shows the comparative measurements of RMF and its relation with other bony landmarks reported by different studies done in Indian population. In the study on south Indian mandibles Priya et al reported that bilateral RMF were of 2 mm in diameter [13]. According to Tiwari et al, the average RMF diameter in south Indian mandibles was 1.33 mm. The study also stated that the mean distance of retromolar foramen from the posterior border of socket for 3rd molar tooth and anterior border of ramus were 6.15 mm (2.23-12.10) and 8.02 mm (3.24-13.12) respectively [37]. Bilodi et al in his study on south Indian mandibles reported the mean diameter of RMF from 0.5 -2.00 [33]. In the current study, a substantial difference was found in the measured distances between the RMF and both sides' third molars and lingulae. The significant difference observed in these values signifying the need to be extra cautious in the mandibular nerve block or the procedure involving 3rd molar to prevent the complications. Additionally, equal vigilance is required because of the proximity to the second molar, especially in impaction cases. Inefficient nerve block, neuralgia, aberrant nerve anaesthesia following the inferior alveolar nerve block may also be explained based on size of the RMF, larger the size, more the collaterals. Initially, Sutton et al [38] described that RMF comprises extra sensory nerve fibres. He outlined the connection between the existence of this foramen and the inability to achieve analgesia using conventional anaesthetic methods. The cortical plate over the retromolar triangle is more cancellous and lighter than the bone around it. Regular anaesthetic, surgical, and implantation procedures always took into account the cancellous structure of the mandible in order to prevent the damage to the neurovascular bundles in the RMF. During dissection, Schejtman et al [27] also looked at the trajectory of neuro-vascularity coming from RMF. It was observed that post-emergence, these fibres were primarily dispersed to the buccinator, lower 3rd molar, related alveolar soft tissue and even to the temporalis tendon. The most consistent component of the RMC, as seen under a microscope, was a myelinated nerve fibre.

Table 5: Comparative Prevalence of RMF in Indian Studies.

Authors	Specimen (N)	Prevalence of RMF	Unilateral Prevalence on Right	Unilateral Prevalence on Left	Bilateral Prevalence
Narayana et al [12]	242	21.90%	10.70%	7.10%	4.10%
Potu et al [15]	94	11.70%	5.30%	3.20%	3.20%
Tiwari et al [16]	100	16%	3%	10%	3%
Sathpriya et al [17]	30	20%	10%	3.33%	6.67%
Athavale et al [32]	71	14.10%	5.63%	5.63%	2.82%
Bilodi et al [33]	41	12.19%	9.75%		2.43%
Siddiqui et al [34]	35	17.14%	5.71%	5.71%	5.71%
Akhtar et al [35]	224	14.70%	4.90%	3.10%	6.70%
Dave et al [36]	300	42%	21.90%	17%	17.66%
Present study	**130**	**60.77%**	**9.23%**	**3.85%**	**47.69%**

Table 6: Comparative analysis of Indian studies exhibiting RMF size and its distance from other strategic bony landmarks.

Authors	Size of RMF (Right vs Left)	Location of RMF (Right vs Left)	RMF to MF (Right vs Left)	RMF to Lingula (Right vs Left)	RMF to 3rd molar (Right vs Left)	RMF to 2nd molar (Right vs Left)
Priya et al [13]	2 mm (both)	-	-			
Potu et al [16]				4.43 ± 1.87	6.21 ± 2.01	
Sathyapriya et al [17]				15.18mm (R) 15.11mm (L)	8.23 mm (R) 7.86 mm (L)	
Athavale et al [32]					8.7 mm (R) 8.3 mm (L)	18.7mm (R) 17.1mm (L)
Bilodi et al [33]	0.1- 2.5 mm					
Akhtar et al [35]				6.08±1.62(R) 5±2.09 (L)	5.88±2.25(R) 8.32±2.15(L)	
Tiwari et al [37]	1.33mm (both)				6.15 ± 2.76	-
Senthil et al [39]	1.3mm			14.1mm (R) 12.6mm (L)	4.5mm (R) 4.00mm (L)	
Present study	1.20-0.45mm	Apical 30% Basal 20%	14.31±4mm(R) 15.34±4.5mm(L)	15.83±2.3mm(R) 8.58±7.94mm(L) **Significant difference**	4.3±2.3mm (R) 4.6±2.3mm (L) **Significant difference**	14 ±2.3mm (R) 14.82±2.7mm (L)

Henceforth, 3rd or 2nd mandibular molar extraction, mandibular sagittal-split osteotomies, dieresis operations, flap raise, and osseo-integrated implant should all be done with caution in light of the findings and measurements of the current study.

CONCLUSION

The study delineates almost equi-proportion of fossa and plateau variants of retromolar trigone. However least common (~7%) tubercle variant may be of concern in lean retromolar pad and flap creation. Study population also exhibits highest prevalence (66.77%) of retromolar foramina in Indian population owing to more precision in measurement. Moreover, it also highlights its distance from various bony landmarks which are of clinical significance to the Dental and Oral & Maxillofacial Surgeon. Additionally, its implication as a collateral in dental anaesthesia aberration can't be overlooked.

ABBREVIATIONS

RMT: Retromolar trigone/triangle

RMF: Retromolar foramen/foramina

RMC: Retromolar canal

MF: Mandibular foramen

Author Contributions

RR and RKK: Conceptualization and initial draft,

RR and RKK: Methodology,

RK and AS: Formal analysis and investigation

RR and RK: Writing

RR and BK: Writing - review and editing

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Conflicts of Interests: None

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