Original Article

Anatomical Study of the Middle Turbinate and Its Applied Importance

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Abstract

Introduction: Endoscopy is widely recognized as a safe, convenient, and cost-efficient tool for examining and treating nasal ailments. The middle turbinate is an important landmark of the lateral nasal wall during endoscopy. Knowledge regarding the anatomy of the middle turbinate and its variations is beneficial to the endoscopic surgeons. **Material and Methods:** The shape and size of the middle turbinate were studied in hundred hemisected adult Indian cadaveric heads. **Results:** The middle turbinate is classified into three types according to the shape of its anterior border: Type 1 (38%), Type 2 (42%), and Type 3 (20%). The mean distance between the anterior attachment of the middle turbinate and the anterior attachment of the superior turbinate (MS) is 19.22 mm. The mean heights of the middle turbinate at its intersection with the anterior attachment (M1), the middle portion (M2), and at the posterior end (M3) of the superior turbinate are 12.83 mm, 9.14 mm, and 5.61 mm, respectively. **Discussion and Conclusion:** The study has described the anatomy of the middle turbinate with its clinical implications, especially in Type 1 and Type 3 middle turbinates, and precautionary measures should be taken while performing partial turbinectomy to avoid destabilizing the middle turbinate and to maintain patency of the middle meatus postoperatively. The documentation of these various types and their frequencies would be useful for the otorhinologists while performing endoscopy.

Keywords: *Endoscopic, middle, surgeons, turbinate*

Introduction

The nose is an important feature of the face. A person with a well-defined nose can walk around with more confidence. A Chinese fortune-teller regards the nose as a hill of the face generating willpower and representing intellectual capabilities. Moreover, especially in the present scenario with the advanced modalities of treatment, nasal anatomy with respect to nasal conchae has become very significant for the otorhinologists.[1] Considerable experience is required for nasal endoscopy (endoscopic sinus surgery [ESS]) to identify significant findings, as there is a wide normal variation in the middle meatal anatomy.[2,3]

There have been many reports describing the anatomy of the lateral nasal wall; however, there are few reports describing the middle turbinate which is believed to be a very important landmark when performing ESS. Hence, this present study was designed to examine the anatomy of the middle turbinate in fully exposed hemisected nasal cavities.

The aim was to study the anatomy of the middle turbinate and enumerate variations in the anatomy which may have clinical implications and thus provide guidelines to ENT surgeons, especially in Indian populations.

The objectives of this study on the middle turbinate are as follows:

1. To study the shape and size of the middle turbinate
2. To classify middle turbinate according to the shape of the anterior border[4]
3. Comparing the results on the basis of types and side
4. To provide Indian data for the above-mentioned parameters.

Material and Methods

One hundred hemisected adult Indian cadaveric heads were used in this study. These were obtained from the cadavers used for gross anatomical dissections by different medical and dental colleges. Due permission was obtained from the ethics committee and the concerned authorities of these medical colleges, prior to beginning the study. Consent was not required for a cadaveric study.

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Fifty-two of these hemisected adult cadaveric heads involved the right side and 48 involved the left side. Their ages ranged from 25 to 75 years. Eighty-six specimens were obtained from male cadavers and 14 were from females. No specimen showed evidence of prior nasal surgery or gross pathology of their middle turbinates.

Wherever available, the "body cutting machine" was used to obtain the hemisections. At other places, a saw was used for the same. Wherever present, the nasal septum was cut with the help of long scissors, scalpel and toothed forceps, so as to view the lateral nasal wall directly. Any secretions, dust, etc., were cleared off from the surface and underneath the superior turbinate, middle turbinate, and inferior turbinate. This made the area of the study clearly visible.

1. Hemisected heads of Indian cadavers were obtained
2. Of these, the cadavers without evidence of prior nasal surgery or gross pathology of their middle turbinates were selected
3. The measurements were taken from the lowermost portion of the limen nasi, the anterior-most landmark when inserting the endoscope and other surgical instruments
4. Vernier caliper and a protractor were used for measurements. The protractor was leveled with the help of "acrylic cutting machine"
5. The shape, pattern and size of the middle turbinate were studied.

Results

Types of the middle turbinate

The middle turbinate is classified according to the shape of the anterior border as:

1. Type 1, where the anterior border of the middle turbinate runs directly posteroinferiorly from its attachment to the conchal plate, as seen in 38% of the cases [Figure 1 and Schematic Figure 1]
2. Type 2, where the anterior border of the middle turbinate initially coursed f - inferiorly from the conchal plate and then turned in a posteroinferior direction, as seen in 42% of the cases [Figure 2 and Schematic Figure 2]
3. Type 3, where the anterior border s - bulges anteriorly before coursing posteroinferiorly, as seen in 20% of the cases [Figure 3 and Schematic Figure 3].

Size of the middle turbinate

The length and heights of the middle turbinate were measured [Figure 4 and Schematic Figure 4: Mean sizes of MS, M1, M2, and M3].

1. The mean distance between the anterior attachment of the middle turbinate and the anterior attachment of the superior turbinate (MS) is 19.22 ± 4.01 mm
2. The mean height of the middle turbinate at its intersection with the anterior attachment of the superior turbinate (M1) is 12.83 ± 2.51 mm

Figure 1: Type 1, where the anterior border of the middle turbinate runs directly posteroinferiorly from its attachment to the conchal plate

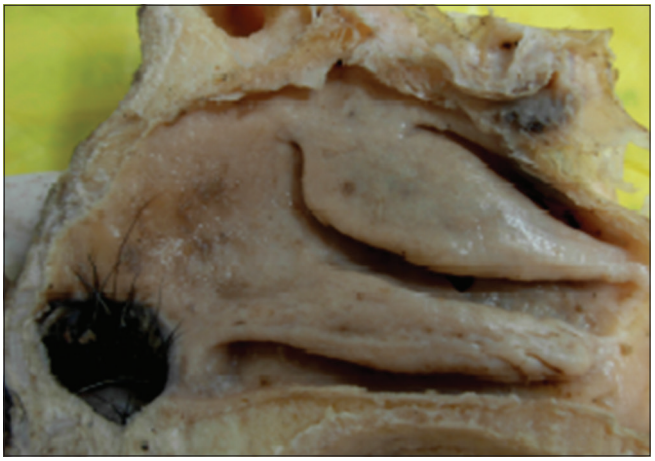


Figure 2: Type 2, where the anterior border of the middle turbinate initially courses f - inferiorly from the conchal plate and then turns in a posteroinferior direction

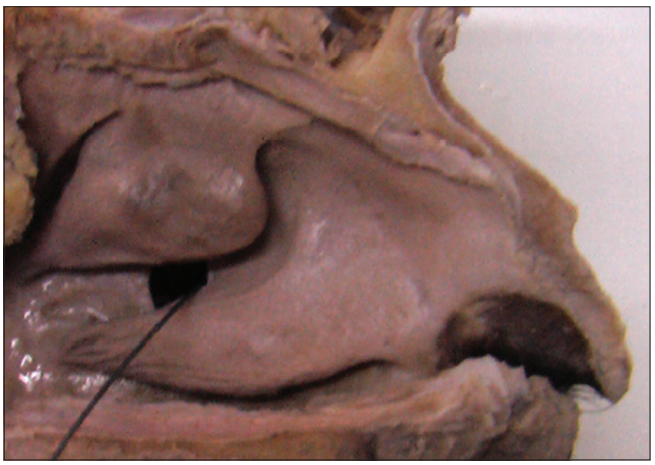
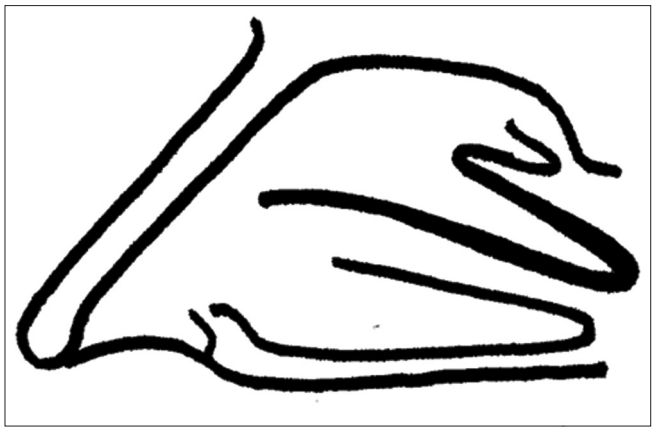


Figure 3: Type 3, where the anterior border bulges anteriorly before coursing posteroinferiorly

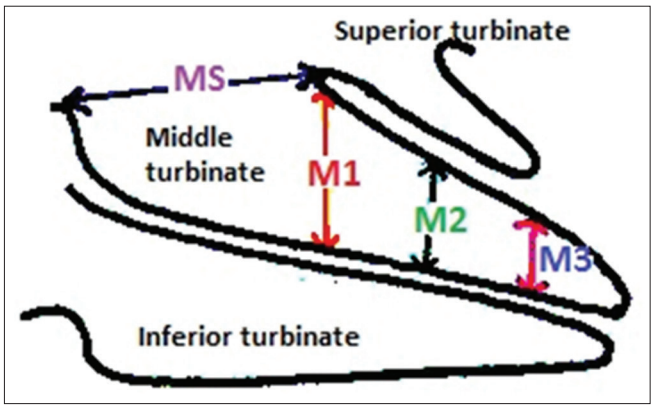
3. The mean height of the middle turbinate at its intersection with the middle portion of the superior turbinate (M2) is 9.14 ± 2.34 mm



Schematic Figure 1: Type 1 middle turbinate

Schematic Figure 2: Type 2, where the anterior border of the middle turbinate initially courses interiorly from the conchal plate and then turns in a posteroinferior direction

Schematic Figure 3: Type 3, where the anterior border bulges anteriorly before coursing posteroinferiorly



Schematic Figure 4: Mean sizes of MS, M1, M2, and M3

4. The mean height of the middle turbinate at the posterior end of the superior turbinate (M3) is 5.61 ± 1.24 mm
5. Frequency distribution tables for each of these parameters were prepared [Tables 1-4]
   a. The maximum readings for MS are found in the 15–19.99 mm interval, as seen in Table 1
   b. The maximum readings for M1 are seen in the 10–14.99 mm interval, as shown in Table 2
   c. The maximum readings for M2 are observed in the 5–9.99 mm interval, as seen in Table 3
   d. The maximum readings for M3 are found in the 5–9.99 mm interval, as seen in Table 4.
6. Comparison of these readings in different types of turbinates was done with the help of unpaired Student's *t*-test [Figures 5-8].
7. Comparison: Another test used was Fisher's test and its critical value was found. Anova: Single factor. Anova signifies analysis of variance. df is the degree of freedom. SS is sum of squares. F crit is the critical value for Fisher's test. $P = 0.05$ is significant in case of M1 [Tables 5 and 6]
8. Comparison between the left and right sides for MS, M1, M2, and M3 was done. It is observed that the overall mean readings for the right side are higher as compared to the left side. They are statistically not significant [Figure 9].

Discussion

There have been many reports describing the anatomy of the lateral nasal wall (Sato *et al*.,[5] Yoon *et al*.,[6] Kim *et al*.[7,8]). However, there are few reports describing the middle turbinate, which is believed to be a very important landmark when performing ESS. Few variations such as concha bullosa or paradoxical middle turbinate have been described when viewing from the anterior to the posterior direction.[3] Concha bullosa is a common anatomic variant.[9] Familiarity with such anatomy is important to optimize surgical treatment of sinus disease while avoiding complications.[10]

Lee *et al*.[4] in a similar study have found Type 1 to be 45.3%, Type 2 to be 44.2%, and Type 3 to be 10.5%, respectively. These slight differences may suggest ethnic differences [Table 7].

Preservation of the middle turbinate is thought to be important whenever possible. However, cases are frequently encountered when a partial turbinectomy is unavoidable when performing ESS, especially some endoscopic surgeons advocated routine removal of the middle turbinate during surgery so as to improve intraoperative and postoperative access. However, postoperative frontal recess stenosis and subsequent frontal sinusitis have been reported in such cases.[11]

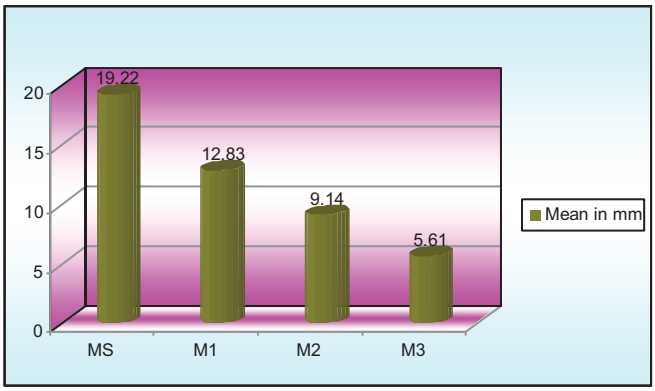


Figure 4: Mean sizes of MS, M1, M2, and M3

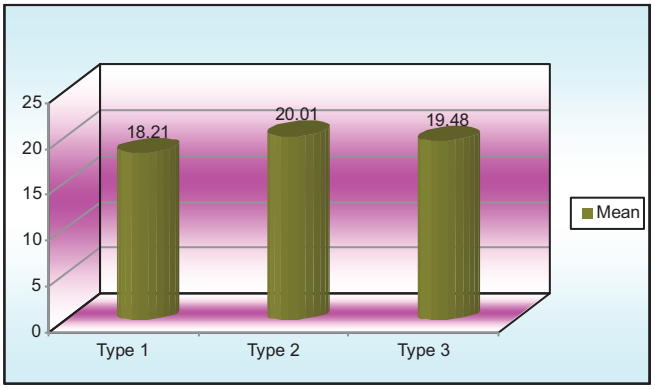


Figure 5: Comparison between means of MS in Type 1, Type 2, and Type 3

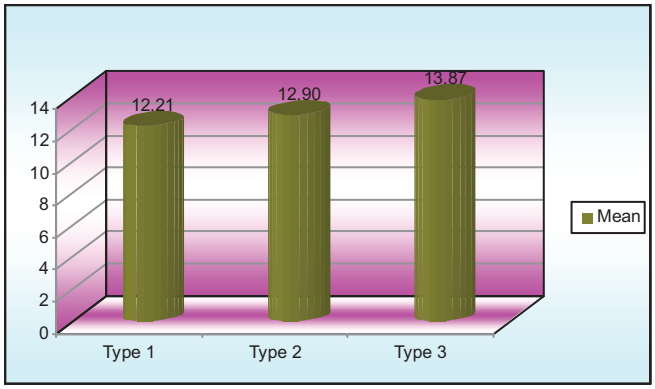


Figure 6: Comparison between means of M1 in Type 1, Type 2, and Type 3

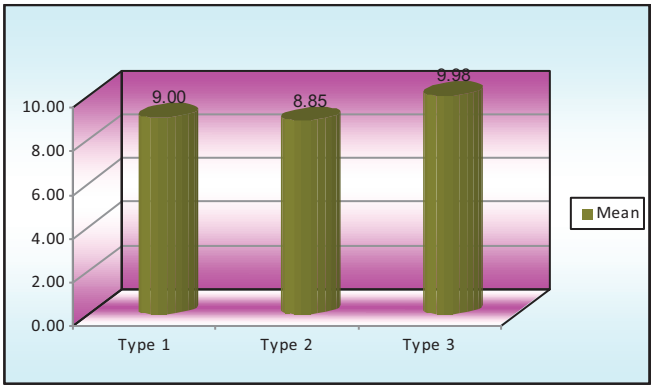


Figure 7: Comparison between means of M2 in Type 1, Type 2, and Type

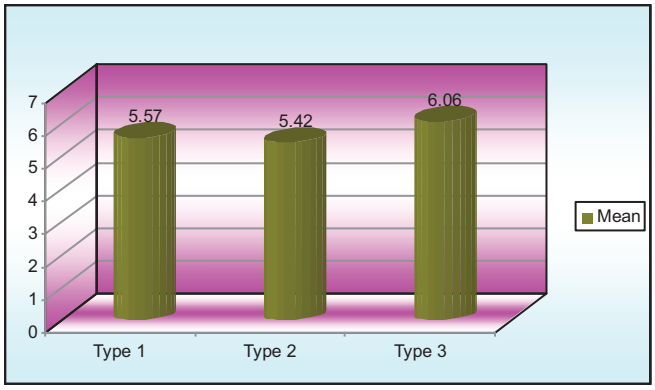


Figure 8: Comparison between means of M3 in Type 1, Type 2, and Type 3

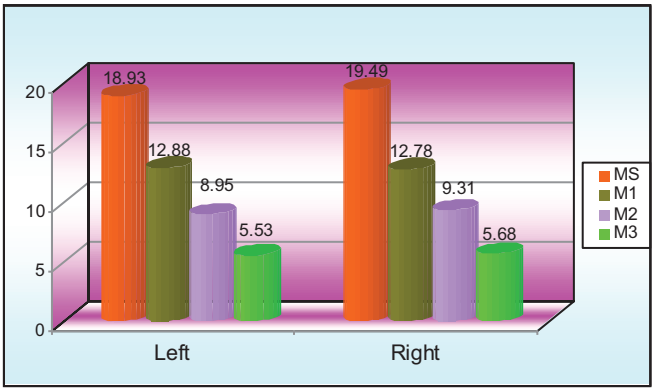


Figure 9: Comparison between the left and right sides for MS, M1, M2, and M3

Portions of the middle turbinate should be removed when significantly involved in disease or when the bone is devitalized and osteitic. Similarly, removal of a part of the middle turbinate may be required when it has a markedly paradoxical shape and in the presence of other anatomic variations leading to the middle meatal obstruction.[2]

LaMear *et al*.[12] reported that anterior partial middle turbinectomy may greatly improve the surgical outcome in cases such as a paradoxical middle turbinate, a high septal deviation, lateralization of the middle turbinate, a narrow nasal pyramid, septal mucosal hypertrophy, or anterior bulging of the middle turbinate where the patency of the middle meatus cannot be easily maintained even after surgery.

Giacchi *et al*. reported that a partial middle turbinate resection enhances the surgical access to the middle meatus during ESS.[4] Kim *et al*.[13] suggested that to avoid olfactory dysfunction after partial turbinectomy, special care must be taken not to fracture the conchal plate because the olfactory nerve filaments course within the conchal plate bone.

It is important in case of Type 1 middle turbinates to avoid destabilizing the middle turbinate when a partial middle turbinectomy and posterior ethmoidectomy are

Table 1: Frequency distribution table for MS

MS (mm)	Freq.	%
10-14.99	17	17
15-19.99	42	42
20-24.99	33	33
>25	8	8
Total	100	100

MS=Distance between anterior attachment of middle turbinate & anterior attachment of superior turbinate

Table 2: Frequency distribution table for M1

M1 (mm)	Freq.	%
5-9.99	7	7
10-14.99	75	75
>15	18	18
Total	100	100

M1=Height of middle turbinate at its intersection with the anterior attachment of superior turbinate

Table 3: Frequency distribution table for M2

M2 (mm)	Freq.	%
0-4.99	1	1
5-9.99	65	65
10-14.99	31	31
>15	3	3
Total	100	100

M2=Height of middle turbinate at its intersection with middle portion of superior turbinat

Table 4: Frequency distribution table for M3

M3 (mm)	Freq.	%
0-4.99	23	23
5-9.99	75	75
10-14.99	2	2
Total	100	100

M3=Height of middle turbinate at the posterior end of superior turbinate

performed simultaneously, because the remaining portion of the middle turbinate following resection can fall into the nasopharynx as a result of gravity.

Furthermore, in Type 3, partial anterior middle turbinectomy helps ensuring wide view and maintaining patency of the middle meatus postoperatively.[4]

The means of MS, M1, M2, and M3 according to Lee *et al*.:[4]

1. The mean distance between the anterior attachment of the middle turbinate and the anterior attachment of the superior turbinate (MS) to be 18.5 ± 4.1 mm [Table 8]
2. The mean height of the middle turbinate at its intersection with the anterior attachment of the superior turbinate (M1) to be 10.9 ± 2.4 mm [Table 8]
3. The mean height of the middle turbinate posterior to the anterior attachment of the superior turbinate at the middle (M2) portion to be 10.6 ± 3.3 mm [Table 8]
4. The mean height of the middle turbinate at the posterior end of the superior turbinate (M3) to be 7.7 ± 2.3 mm [Table 8].

Table 5: Variance values of M1 in Type 1, Type 2, Type 3

Groups	Count	Sum	Average	Variance
Type 1	38	464.14	12.21	4.80
Type 2	42	541.74	12.90	4.19
Type 3	20	277.3	13.87	12.54

Table 6: ANOVA in M1

Source of variation	SS	df	M1	*F*	*P*	*F* crit
Between Groups	36.03	2	18.02	2.98	0.05	3.09
Within Groups	587.38	97	6.06			
Total	623.42	99				

Table 7: Comparision of the types of middle turbinate between studies

	Present study	Lee *et al*. study
Type 1	38%	45.30%
Type 2	42%	44.20%
Type 3	20%	10.50%

Table 8: Comparision of MS, M1, M2, M3 values of middle turbinate between studies

	Distances in mm	
	Present study	Lee *et al*. study
MS	19.22+4.01	18.5+4.1
M1	12.83+2.51	10.9+2.4
M2	9.14+2.34	10.6+3.3
M3	5.61+1.24	7.7+2.3

Regarding the mean height of the middle turbinate at its intersection with the anterior attachment of the superior turbinate (M1)

1. The mean value for M1 in Type 1 cases was 12.21 ± 2.19 mm (range: 8.24–16.2 mm)
2. The mean value for M1 in Type 2 cases was 12.90 ± 2.05 mm (range: 10.04–16.54 mm)
3. The mean value for M1 in Type 3 cases was 13.87 ± 3.54 mm (range: 5.05–20.04 mm)
4. Analysis of variance was done for these values. Fisher's test was applied and the *P* value was found to be 0.05, which is statistically significant. The above values suggest that M1 is more in Type 3 cases followed by Type 2 cases.

Variations

Alatus *et al*.[14] have described a case of the secondary middle turbinate (SMT). SMT is a rare anatomical variation of the nasal cavity. It is a bony prominence

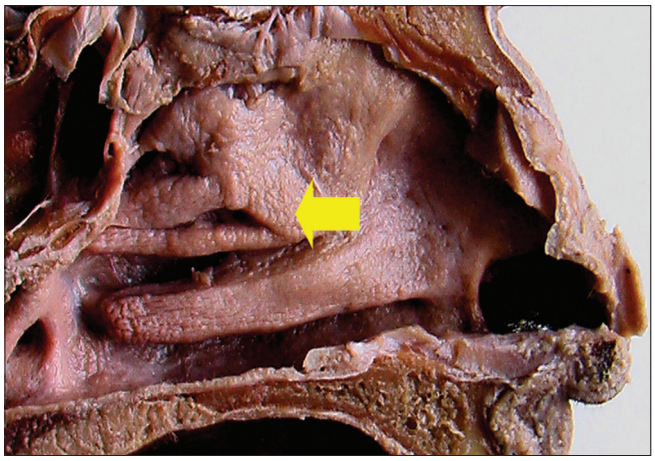


Figure 10: Grooved middle turbinate

covered with soft tissue that originates from the lateral wall and projects inferolaterally. This variation is important for ESS and inflammatory sinus diseases. A similar structure, however, present anterosuperior to the middle turbinate, was observed in the right lateral nasal wall. This structure was referred to as accessory middle turbinate. No sinus was found opening underneath it. There was no underlying bony support.[15] Improper partitioning of the mesodermal lateral nasal elevations during development or formation of extra elevations could be the probable cause of development of accessory middle turbinate.[16,17]

Grooved middle turbinate – Figure 10 shows a complete horizontal groove on the surface of the middle turbinate. This gives the appearance of very small middle turbinate being overlapped by a larger superior turbinate. As per discussions with various otorhinologists, this groove may be a normal variation or might be caused postoperatively due to instrumentation. It also shows the presence of supreme turbinate. Hence, in all, apparently five turbinates are visible. This could again be quite confusing when performing endoscopy. An endoscopist should, therefore, be aware of such a variation.

Conclusion

It is observed that M1 is more in Type 3 cases followed by Type 2 cases. $P = 0.05$ is statistically significant. Appropriate care should be taken during endoscopy and partial turbinectomies. The documentation of these variations and their frequencies would be useful for the otorhinologists while performing endoscopy and be ready with optional interventions as and when required.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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