

Morphometric Evaluation of the Middle Turbinate in Relation to Endoscopic Sinus Surgery

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ABSTRACT

Objective: Partial middle turbinectomy during endoscopic sinus surgery is done for better access and to avoid postoperative complications of lateralization of the middle turbinate. There are only few cadaveric studies available in literature describing the middle turbinate morphometry with surgical perspective. Therefore, the present study was planned to record morphometry and relevant surgical distances for the middle turbinate.

Materials and methods: Thirty-two midsagittal sections of cadaver heads from adult males were dissected. Middle turbinate measurements and shapes were taken. Reference distances and angles were measured.

Results: The average length of the middle turbinate was 20.4 ± 3.9 mm, while the height of the middle turbinate was taken at three specific points (13.1, 9.7, 6.1 mm). The most common shape found was the type 2. The mean value for the distance between limen nasi and the anterior and posterior attachments of the middle turbinate was found to be 32.1 ± 3.2 mm, with mean angle of 65° with the horizontal and 43.6 ± 4.2 mm, with mean angle of 39.4° with the horizontal respectively.

Conclusion: This baseline data may aid endoscopic surgeons in better planning and execution of the middle turbinate resection.

Keywords: Middle turbinate resection, Endoscopic sinus surgery, Limen nasi.

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INTRODUCTION

The anatomy of paranasal region and its variations have gained importance because of widespread practice of endoscopic sinus surgery (ESS). Significant advances have been made in endoscopic techniques; however frequent, miscellaneous anatomic variations in the paranasal region increase the risk for possible complications of ESS.¹ The middle turbinate (MT) is important for optimum physiologic functioning of the nasal cavity and is considered a useful landmark for guidance during ESS. Though it is desirable to preserve the MT during ESS, there are many a situation in which partial middle turbinectomy is warranted either to enhance surgical access to the middle meatus or for postoperative debridement. Most of the previous studies have reported MT variations like concha bullosa, accessory

concha, etc.²⁻⁵ but detail morphometry of the MT have been described by very few authors.^{5,6} Moreover, most of the available studies on sinonasal anatomy are radiological,^{2,4,7,8} with very few cadaver-based studies.⁹ Therefore, the present study was planned on midsagittal section of cadaveric heads with the aim to collect data related to shape, anatomical measurements and angles related to the MT. This anatomical knowledge can be useful for the surgeons performing ESS and middle turbinectomy.

MATERIALS AND METHODS

Thirty-two midsagittal sections of cadaver heads from adult males were used for dissection and measurement. The study was approved by institute ethical committee. Any specimen with known nasal pathology was not included in the study. The nasal septum was removed from each of the specimen. The three turbinates were identified. The following measurements were done with the help of digital vernier caliper (accurate up to 0.02 mm) and protractor.

A. Dimensions of the MT (Fig. 1)

1. *Length of the MT:* It was measured from the anterior attachment of the MT to the anterior end of the superior turbinate (posterior attachment of the MT).
2. *Height of the MT:* It was measured at three points.
 - a. H1: The height of the MT taken at the anteriormost point of the superior turbinate.
 - b. H2: The height of the MT taken at the middle portion of the MT.
 - c. H3: The height of the MT taken at the posterior portion of the MT.

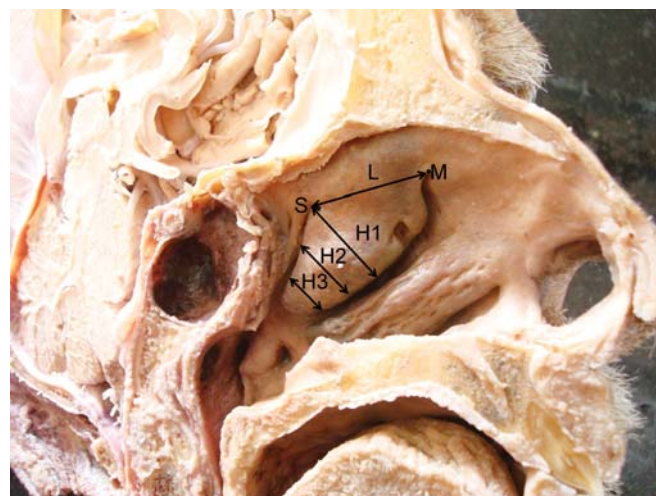


Fig. 1: Various dimensions of the MT

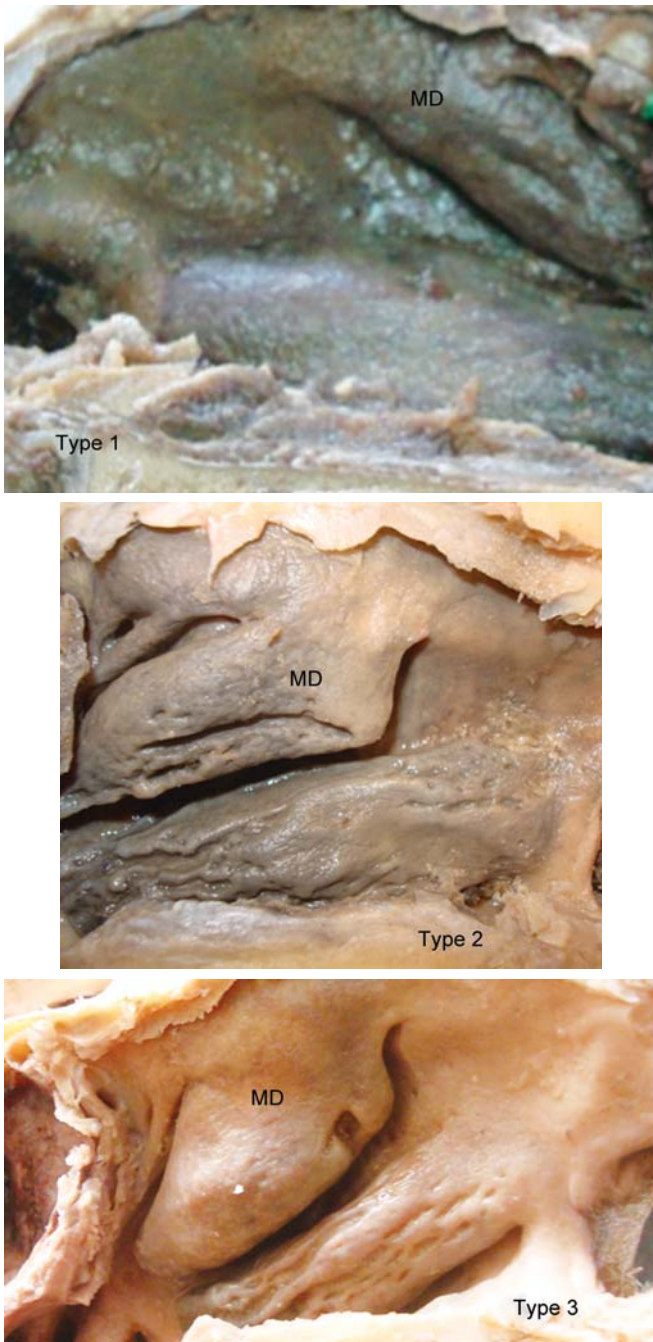


Fig. 2: The three different types of the MT shapes

B. Shape of the MT (Fig. 2): We have followed the classification extended by Lee et al.⁹

1. *Type 1:* The anterior border of the MT ran directly posteroinferiorly from its attachment to the conchal plate.
2. *Type 2:* The anterior border of the MT initially coursed inferiorly from the conchal plate then turned in a posteroinferior direction.
3. *Type 3:* The anterior border of the MT bulged anteriorly before coursing posteroinferiorly.

C. The distances and angles between the limen nasi, the MT and the superior turbinate (Fig. 3)

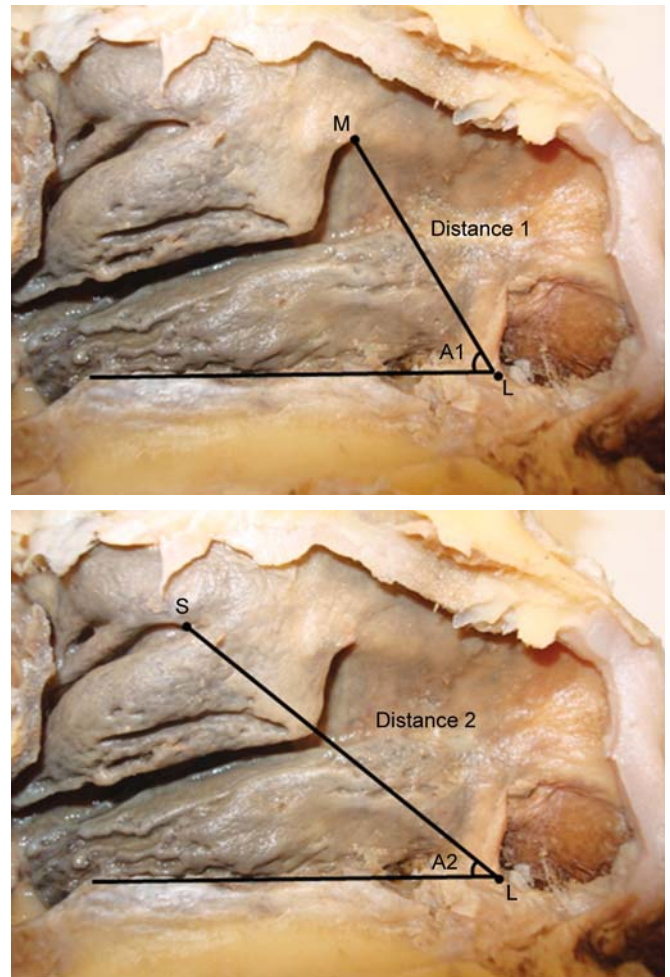


Fig. 3: The distances and angles between the limen nasi, the MT and the superior turbinate

1. *Distance 1:* The distance between the lower most point of the limen nasi (L) and the anteriormost attachment of the MT (M).
2. *Angle 1:* The angle between the line passing through the point L and point M and the horizontal line passing through the limen nasi.
3. *Distance 2:* The distance between the lower most point of the limen nasi (L) and the anteriormost attachment of the superior turbinate (S).
4. *Angle 2:* The angle between the line passing through the point L and point S and the horizontal line passing through the limen nasi.

RESULTS

Dimensions of the MT (Table 1)

The average length of the MT was 20.4 ± 3.9 mm, with the range of 10.7 to 28.5 mm. In 90% of the specimens length of the MT varied between 15 and 25 mm. The mean value for the H1 was found to be 13.1 ± 3.2 mm (range, 5.5-19.5 mm). In 77% of the specimens H1 was between 10 and 15 mm. H2 ranged from 2.3 to 15.9 mm with the

mean of 9.7 ± 2.8 mm. In huge majority (87%) of the specimens H2 was between 6 and 12 mm. The mean height at the posterior portion (H3) was found to be 6.1 ± 1.9 mm with the range of 1.5 to 9.5 mm.

Shape of the MT

The most common shape found was the type 2. It was present in 70% of the specimens examined. The MT in 23.3% of the specimens had the type 1 shape while the type 3 shape was found in only 6.7% of the specimens.

The Distances and Angles between the Limen Nasi, the MT and the Superior Turbinate (Table 1)

The mean value for the distance between limen nasi and the anterior attachment of the MT was found to be 32.1 ± 3.2 mm (range, 26.8-38.6 mm). The distance 1 varied between 30 and 35 mm in 73% of cases. The corresponding angle with the horizontal (angle 1) had mean value of $65.3^\circ \pm 5.5^\circ$, with the range of 50° to 70° . In 90% of the heads examined the angle 1 was constantly found to be between 60° and 70° . The mean value for the distance between limen nasi and the superior turbinate (the posterior attachment of the MT) was 43.6 ± 4.2 mm (range, 34.3-49.1 mm). In 87% of the specimens the distance 2 was between 40 and 50 mm. The angle 2 had mean value of $39.4^\circ \pm 3.1^\circ$ (range, 33° - 48°). In 83% of the specimens the angle 2 was between 38° and 42° .

DISCUSSION

The turbinates are physiologic structures that participate in the nasal cycle and are important for maintenance of a laminar airflow. The MT is the primary site for impaction of inhaled particles and serves to protect the maxillary and ethmoid sinuses from inhaled air and from the resultant

drying effects on sinus mucociliary clearance.¹⁰ Anterior/superior portion of the MT is considered to be an important surgical landmark.¹¹ Diversity of opinions continues to exist among otolaryngologists regarding potential benefits of preservation or resection of normal MT during endoscopic ethmoidectomy. MT resection can cause diminished humidification and filtration of inspired air, hyposmia and loss of important anatomical landmark. Conservative partial middle turbinectomy is a good alternative which preserve a portion of MT as a landmark, however MT remnant could become floppy and lateralize, causing frontal recess obstruction and frontal sinusitis.¹² Many surgical techniques of safe partial MT resection are described to avoid lateralization of MT remnant.¹²⁻¹⁴ According to the study by Giacchi et al,¹² anterior/inferior one-third to one-half of the turbinate should be removed while preserving superior and lateral attachments. Other authors^{13,14} prefer to preserve superior half of the MT. In our study the mean length of the MT was measured between the anterior attachments of the middle and superior turbinate, this length attaches the MT to the lateral nasal wall. The length of the MT was found to be about 2 cm, while in 90% of the specimens it varied from 1.5 to 2.5 cm. Lee et al in their study of 101 hemisected cadaveric heads have reported the similar value (18.5 mm) for the MT length. The surgeon should consider these values while deciding the resection line because extensive removal of anterior portion of the MT can decrease the stability of the MT remnant.⁹ Moreover, surgeon should be careful as not to remove the portion superior to the horizontal line connecting anterior attachments of the MT and the superior turbinate, where olfactory nerve filaments are distributed, as this could result in postoperative hyposmia.¹⁵

Baseline data regarding the height of the MT at various points may aid the surgeon in better planning of partial MT resection. We found the height of the MT at the anterior

Table 1: Morphometric parameters of the MT

	Length	Height			Distance 1	Angle 1	Distance 2	Angle 2
		H1	H2	H3				
Minimum	10.7	5.5	2.3	1.5	26.8	50°	34.3	33°
Maximum	28.5	19.5	15.9	9.5	38.6	70°	49.1	48°
Mean	20.4	13.1	9.7	6.1	32.1	65.3°	43.6	39.4°
SD	3.9	3.2	2.8	1.9	3.2	5.5°	4.2	3.1°

All the linear measurements are in millimeter.

- *Length of the MT:* It was measured from the anterior attachment of the MT to the anterior end of the superior turbinate.
- *Height of the MT:*
 - H1: The height of the MT taken at the anteriormost point of the superior turbinate.
 - H2: The height of the MT taken at the middle portion of the MT.
 - H3: The height of the MT taken at the posterior portion of the MT.
- *Distance 1:* The distance between the lower most point of the limen nasi (L) and the anteriormost attachment of the MT (M).
- *Angle 1:* The angle between the line passing through the points L and M and the horizontal line passing through the limen nasi.
- *Distance 2:* The distance between the lower most point of the limen nasi (L) and the anteriormost attachment of the superior turbinate (S).
- *Angle 2:* The angle between the line passing through the point L and point S and the horizontal line passing through the limen nasi.
- *SD:* Standard deviation.

end of the superior turbinate to be 13 mm which is comparable to the value (10.9 mm) reported by Lee et al.⁹ The mean values for the MT height taken at the middle and the posterior portion (10.6 and 7.7 mm) are also similar to those found in the previous study (9.7 and 6.1 mm).⁹

Morphologically, MT was classified into three types. In the present study the type 2 was the most common shape with the incidence of 70%. In a study of Koreans cadavers both type 1 (45.3%) and type 2 (44.2%) were reported to be equally prevalent in the population.⁹ In type 1 MT the posterior part of the MT is quite large. Therefore, liberal anterior resection can easily destabilize the MT especially when the partial middle turbinectomy and posterior ethmoidectomy is simultaneously performed, which means that the basal lamella is removed. The MT remnant can fall into the nasopharynx as a result of gravity.⁹ Type 3 morphology was present in only 6.7% of the specimens in the present study. These turbinates appear large and bulging anteriorly on endoscopy. Therefore, an anterior partial middle turbinectomy may be usually required to ensure wider view during surgery and to maintain the patency of the middle meatus postoperatively.⁹

The reference distances and angles were measured from the lower end of the limen nasi as this is the anteriormost landmark and an easily identifiable reference point while inserting the endoscope or other surgical instruments in ESS. The mean distance from limen nasi to the anterior attachment of the MT was about 32 mm with an angle of 65° to the horizontal. Other authors have reported this distance as varying from 38 to 50 mm^{9,16,17} with the mean value for the corresponding angle from 56° to 68°.^{9,18} The distance 2 from the limen nasi to the anterior attachment of the superior turbinate was found to be about 44 mm with an angle of about 40° with the horizontal. The values are comparable to those (49 mm, 45°) reported in previous study.

The MT is a key landmark in the nasal cavity. Therefore, baseline data regarding the shapes and dimensions of MT as well as reference distance and angles will be useful in accurate diagnostic and surgical management of the patients undergoing ESS.

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