

COMPUTED TOMOGRAPHIC EVALUATION OF INFERIOR TURBINATE HYPERTROPHY IN ADULT INDO-DRAVIDIAN PATIENTS WITH DEVIATED NASAL SEPTUMNIRANJAN SAHU¹, SATYA SUNDAR G MOHAPATRA¹, SIBA NARAYAN RATH^{2*}, RABINDRA NATH PADHY²¹Department of Radiodiagnosis, Institute of Medical Sciences and Sum Hospital, Siksha 'O' Anusandhan University, Kalinga Nagar, Bhubaneswar - 751 003, Odisha, India. ²Department of Radiodiagnosis, Central Research Laboratory, Institute of Medical Sciences and Sum Hospital, Siksha 'O' Anusandhan University, Kalinga Nagar, Bhubaneswar - 751 003, Odisha, India. Email: snrath19@gmail.com

Received: 22 February 2017, Revised and Accepted: 24 April 2017

ABSTRACT**Objective:** Aim of the study was to evaluate the prevalence and significance of inferior turbinate hypertrophy (ITH) in adult indo-dravidian patients with deviated nasal septum (DNS).**Methods:** Analysis of sinonasal computerized tomography (CT) images of 86 patients having DNS was done during October 2015-December 2016 for evaluation of severity of the associated ITH. Values of maximum width of medial mucosa, bone and total width of the turbinate were measured. Patients with inflammatory or expansile sinonasal masses were excluded.**Results:** Total 86 patients with varying degrees of septal deviation with ages ranging from 18 to 72 years (mean age of 42.8 years) were distributed as: Group I, mild cases and Group II, moderate and severe DNS cases. Patients having ITH on the contralateral side of deviation were included in the study group. The dimensions of the ITH were evaluated. The medial mucosal component of the ITH underwent maximum hypertrophy as compared to bone and lateral mucosa components. The average medial mucosa, bone and total turbinate widths of the inferior nasal concha as well as lateral offset in Group II DNS cases were 5.21 mm, 1.76 mm, 9.96 mm and 8.74 mm, respectively. Total width and width of medial mucosa of ITH in relation to the severity of septal deviation was statistically significant ($p=0.0001$ and 0.0098).**Conclusion:** Present study evaluated the relationship between DNS and compensatory ITH. The findings support the decision to excise the inferior turbinate at the time of septoplasty, because of the significant mucosal expansion.**Keywords:** Computed tomography, Deviated nasal septum, Inferior turbinate hypertrophy.© 2017 The Authors. Published by Innovare Academic Sciences Pvt Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>) DOI: <http://dx.doi.org/10.22159/ajpcr.2017.v10i7.18083>**INTRODUCTION**

Nasal airway obstructions are often present in patients with deviated nasal septum (DNS) associated with varying degrees of concomitant inferior nasal turbinate hypertrophy (ITH) on the side contralateral to the direction of septal convexity [1-7]. Because of this association, it has been speculated that ITH is compensatory to create a physiologically favorable pathway for nasal airflow; the nasal mucosa could be protected from excessive drying and crusting due to increased air flow. In other words, the inferior turbinate becomes progressively enlarged to fill the void in the nasal cavity created by the midline shifting of the DNS. However in presence of inflammation, both DNS and ITH could cause decrease in airflow resulting in total obstruction of nasal airways with consequent sinus blockage leading to chronic nasal congestion and recurrent episodes of acute rhinosinusitis.

Nasal turbinates are bony projections from lateral nasal walls covered with mucosa assisting in warming, filtering and moisturizing the inhaled air. In many instances, people would have prolonged nasal congestion and could not breathe through one or both sides of nose, indicating turbinate hypertrophy. Nasal obstruction is typically worse at night, due to the increase in nasal blood flow secondary to gravity, when lying down. Causes of turbinate hypertrophy are allergy related diseases, upper respiratory infections, vasomotor rhinitis and changes in temperature. Prolonged nasal obstruction leads to chronic mouth breathing causing dry mouth, snoring and/or sore throat. In the literature, the mucosal layer of the inferior turbinate is frequently implicated as the structure responsible for turbinate enlargement [8,9].

Though the term "hypertrophy" implies as the enlargement of an organ or tissue due to an increase in the size of its cells; herein the term

"turbinate hypertrophy" is widely accepted as increased thickness of soft-tissue and/or bone components [10-12]. Hyperplasia and hypertrophy of the mucosal or osseous layers of the inferior turbinate also provide potential explanation for the mechanism of inferior turbinate enlargement [13]. Turbinate enlargement can be bilateral or unilateral. The bilateral turbinate enlargement is caused by allergic and non-allergic conditions including environmental triggers, such as dust and tobacco [14]. The unilateral turbinate enlargement usually occurs in association with a DNS in the nasal cavity contralateral to the direction of septal deviation. ITH always remained a clinical diagnosis, though limited computed tomography (CT) analytic data had published regarding its size [15]. As ITH commonly develops along the concave side of a DNS, logically an interaction may coexist between these structures.

Turbinoplasty is the common surgical technique used for the reduction of the size of enlarged turbinates which can be broadly divided into two main categories: Turbinate soft tissue reduction (sub-mucosal diathermy and surface diathermy) and turbinate bone resection/reduction (trimming of the turbinate bone or total turbinectomy). Contribution of either bony/soft tissue components or both towards the enlargement of the inferior concha are to be decided before the selection of the type of surgical intervention. The aim of this study was to assess whether the presence of DNS influences to contralateral ITH concomitant to evaluation of the cause of this compensatory ITH.

MATERIALS AND METHODS

In this retrospective study, sinonasal CT scan images of 86 patients with DNS were analyzed for evaluation of dimensions, structural composition and possible radiological changes of the associated ITH during October

2015-December 2016. The study group was having DNS with clean unilateral pattern of septal deviations and was found associated with ITH on the contralateral side of the deviation. DNS cases were classified as per degrees of septal deviation into mild, moderate and severe varieties. The total 86 patients were further divided into two groups as per severity of septal deviation. Group I included mild degree DNS cases whereas Group II comprised of both moderate and severe degree DNS cases. Four measurements were acquired to document the width of the ITH: A, total turbinate width was determined by maximum transverse width of the pendulous portion of inferior turbinate inclusive of soft tissue and bone (Fig. 1a); B, medial mucosa width was measured as transverse thickness at the point of maximal soft-tissue thickness along the medial aspect of the inferior turbinate (Fig. 1a); C, bone width was represented by maximum transverse width of the inferior conchal bone (Fig. 1b); and D, lateral offset was determined by the maximum transverse distance from the medial end of the inferior turbinate bone to the lateral bony nasal wall (Fig. 1b). These measurements were taken separately at the maximum hypertrophied portion of inferior turbinate at a place perpendicular to the mucosal surface with the aid of a cursor on the screen of CT console (Fig. 1). Measurements were analyzed by Chi-square statistical methods.

CT scans were performed by 128 multi-slice CT scanner of GE Optima CT660 multi-slice scanner (GE Healthcare Japan Corporation, Tokyo). Patients were positioned in supine position and scanning was done with contiguous thin slices from superior margin of frontal sinuses to inferior margin of maxillary sinuses. Reformatted coronal images obtained from the axial data are mostly preferred to direct coronal images obtained with patients in less comfort prone position due to good quality resolution of the high end multi-slice scanner. Scanning parameters were 3 mm table incrementation, 3 mm slice thickness, 2 seconds scanning time, 120 kVp and 180 mAs tube current. The field of view was confined to the sinonasal area for optimal visualization. Bone and soft tissues were best visualized at a window width of 1500-2000 HU and window level of 200-300 HU.



Fig. 1: Non-contrast coronal sinonasal computed tomography (CT) scan images demonstrate the measurements of the right inferior nasal turbinate (IT), (a) Measurement of the width of medial mucosa of the right IT (upper white line) and total width inclusive of soft tissue and bone of the right IT (lower white line), also note bilateral prominent ethmoid bulla and pneumatized superior nasal turbinates (b) Measurement of bone width of the right IT (upper white line) and Lateral bony offset measured as the maximum transverse distance from the most medial end of the right inferior concha bone to the bony lateral nasal wall (lower white line). Note bilateral pneumatized middle turbinates

RESULTS

Total 86 cases with DNS were divided into two groups as per severity of the septal deviation; Group I comprised of 33 cases of mild degree DNS cases whereas, Group II comprised of the rest 53 cases, with 31 cases having moderate and 22 cases with severe DNS (Table 1). Total width of the pendulous portion of the hypertrophied inferior turbinate, medial mucosa width, turbinate bone width and the lateral offset were measured in both cited groups. The average width values of medial mucosa, bone and total turbinate as well as of the lateral offset in Group II cases were 5.21, 1.76, 9.96 and 8.74 mm, respectively. Moreover, the average width values of medial mucosa, bone and total turbinate as well as, of the lateral offset in Group I cases were 3.38, 0.98, 5.56 and 4.86 mm, respectively. With Chi-square test, average measurement of both moderate and severe variety DNS cases of Group II were compared with those of Group I cases and were found statistically highly significant ($p=0.0001$, Table 1).

In this study on basis of sinonasal CT images, it was seen that the anterior and middle part of inferior nasal concha underwent the maximum hypertrophy followed by the posterior part, which had least hypertrophy. The average mean value of the anterior and middle part of the ITH was 10.41 and 9.86 mm, respectively as compared to 6.12 mm in the posterior part. Out of three components of the inferior nasal concha it was the medial mucosa which has undergone maximum hypertrophy as compared to bone and lateral mucosa. Total turbinate width and width of medial mucosa of ITH in relation to severity of DNS was statistically significant ($p=0.0001$ and 0.0098) indicated definite difference between both groups having different degree of septal deviation. Mean bone widths of IHT in the anterior and middle parts were measuring 1.98 mm and 1.84 mm, as compared to 1.67 mm in the posterior part of the inferior nasal concha, which indicated that bone had underwent relatively more hypertrophy along the anterior aspect.

DISCUSSION

Among all three nasal concha, inferior concha is mostly susceptible for enlargement. Two-thirds of upper airway resistance is produced by the anterior tip of the inferior nasal concha at the time of inspiration. In patients with nasal obstruction, the most common association was found between DNS and contralateral ITH. DNS may be from nasal trauma or may be present since birth in the form of an anatomical variant. Sometimes, bony spur from DNS projects into the nasal cavity further complicating the situation. In many cases, a DNS or turbinate enlargement causes no problem and needs no treatment. Moreover, allergic and non-allergic inflammatory conditions cause swelling of the nasal mucosa that often makes an anatomic obstruction more noticeable. Though ITH is common in day to day practice, little evidence is present to explain about the component of the turbinate responsible for the enlargement. With available resources, it is suggested that either bony/mucosal or both components with underlying differences in their pathology contribute to the enlargement of the turbinate.

In this study, medial mucosa undergoes maximum hypertrophy as compared to bone and lateral mucosa. The anterior and the middle parts of the inferior turbinate were found hypertrophied more than the posterior part; and no significant relationship was identified on the basis of age or sex. Values for the total turbinate width, medial mucosa width and the lateral offset width were greater in the Group II cases, as

Table 1: Measurements of contralateral ITH in relation to severity of septal deviation

Measurements of contralateral ITH (mm)	Group I cases (n=33)		Group II cases (n=53)		p value
	Mild DNS (n=33)	Moderate DNS (n=31)	Severe DNS (n=22)	Average	
Total turbinate width	5.56	9.74	10.18	9.96	0.0001
Medial mucosa width	3.38	5.05	5.37	5.21	0.0098
Bone width	0.98	1.68	1.84	1.76	0.2152
Lateral bony offset	4.86	8.50	8.98	8.74	0.0004

DNS: Deviated nasal septum, ITH: Inferior turbinate hypertrophy

compared with Group I cases (Table 1). The relative increase in inferior turbinate size in this study group could be explained as greater projection of the turbinate bone more medially into the nasal cavity in the form of increased lateral offset, and an increase in the width of the pendulous portion of the inferior turbinate in the form of increased turbinate width causative to the thickening of mucosa more than the bone.

As generally assumed that unilateral turbinate enlargement in the presence of contralateral septal deviation, usually occurs to protect the more patent nasal cavity from the drying and crusting caused by an excess airflow. With cases of acute rhinitis it appears that the main cause of turbinate enlargement is filling of venous sinuses, since the size of the turbinate can be reduced by application of a topical decongestant [16]. Combination of factors responsible for mucosal enlargement includes cellular hyperplasia, vascular congestion and intercellular edema. As there is no evidence for cellular hypertrophy, use of the term "turbinate hypertrophy" cannot be substantiated, rather the term "turbinate enlargement" would be a more accurate description of this condition. Surgical anatomy of the more anterior nasal concha bone is important as it is relatively thicker. It was reported that the enlargement of the bony component is also common in ITH; thus, the mucosal swelling is not solely responsible for nasal obstruction. Few studies recorded an increased size of bony component in ITH that may be merely due to an increase in the overall size of the turbinate [8,11]. However in contralateral ITH, mucosal enlargement was the major contributing factor as evidenced from CT scan studies.

Inferior turbinate widths (total and mucosa) and the distance that the inferior turbinate projects into the nasal cavity (lateral offset) were selected as appropriate representations of ITH. Because the medial mucosal layer of the inferior turbinate tends to be the widest, as it contains the thickest lamina propria, it was chosen for the recorded measurements. As reality, symptomatic nasal obstruction from ITH and nominal standard dose is best determined clinically. The CT-based measurement performed in this study was a tool to identify anatomic features that contribute to the development of ITH, though not a recommended form of clinical assessment. Simultaneous turbinateplasty is advised in patients undergoing septoplasty for better post-surgical benefits, as post op midline relocation of septum usually occurs further reducing the nasal airway on the ITH side [4,14]. While opting for the septoplasty as a corrective surgical measure of DNS, addressal of the ITH is usually done to avoid the unintended consequences of worsened nasal obstruction symptoms and related post-surgical nosocomial infections; as surgical site infections are found to be the second most common type of nosocomial infection. Due to gratuitous infectious agents, the process of regaining normal health found deteriorating nowadays and the control of infection and infectious agents remains a great challenge in these advanced era of medicines [17]. The present study can help the surgeon to determine whether to add turbinateplasty to the standard septoplasty procedure. Present scenario demands more debate regarding the significance of the contralateral ITH in presence of DNS.

CONCLUSION

The present study concludes that the degree of compensatory hypertrophy of inferior turbinate is increased in direct proportion

with the severity of the DNS. The medial mucosa undergoes maximum hypertrophy as compared to the bone and the lateral mucosa components of ITH. CT is the best imaging modality for assessment of the structural composition of the inferior nasal turbinate, which helps in evaluation of the type of turbinateplasty. Addition of turbinateplasty to septoplasty is suggested for better relief of the nasal obstruction.

REFERENCES

- Egeli E, Demirci L, Yazıcı B, Harputluoglu U. Evaluation of the inferior turbinate in patients with deviated nasal septum by using computed tomography. *Laryngoscope* 2004;114(1):113-7.
- Akoglu E, Karazincir S, Balci A, Okuyucu S, Sumbas H, Dagli AS. Evaluation of the turbinate hypertrophy by computed tomography in patients with deviated nasal septum. *Otolaryngol Head Neck Surg* 2007;136(3):380-4.
- Kim DH, Park HY, Kim HS, Kang SO, Park JS, Han NS, et al. Effect of septoplasty on inferior turbinate hypertrophy. *Arch Otolaryngol Head Neck Surg* 2008;134(4):419-23.
- Jun BC, Kim SW, Kim SW, Cho JH, Park YJ, Yoon HR. Is turbinate surgery necessary when performing a septoplasty? *Eur Arch Otorhinolaryngol* 2009;266(7):975-80.
- Aslan G, Uzun L, Ugur MB, Uckurt YS, Sagun OF, Yazıcılar O. Unilateral inferior turbinate bone hypertrophy: Is it compensatory or congenital? *Am J Rhinol Allergy* 2013;27(4):255-9.
- Orhan I, Aydin S, Ormeci T, Yilmaz F. A radiological analysis of inferior turbinate in patients with deviated nasal septum by using computed tomography. *Am J Rhinol Allergy* 2014;28(1):e68-72.
- Korkut AY, Islim F, Gulseven Ciftci S, Dogan R, Gedikli O, Kahya V, et al. Evaluation of inferior turbinate hypertrophy in patients with congenital and traumatic nasal septum deviation. *J Laryngol Otol* 2012;126(8):784-8.
- Berger G, Hammel I, Berger R, Avraham S, Ophir D. Histopathology of the inferior turbinate with compensatory hypertrophy in patients with deviated nasal septum. *Laryngoscope* 2000;110(12):2100-5.
- Uzun L, Savranlar A, Beder LB, Ugur MB, Cinar F, Ozdemir H, et al. Enlargement of the bone component in different parts of compensatorily hypertrophied inferior turbinate. *Am J Rhinol* 2004;18(6):405-10.
- Pearsall J, editor. *The Concise Oxford Dictionary*. 10th ed. Oxford: Oxford University Press; 2001.
- Berger G, Gass S, Ophir D. The histopathology of the hypertrophic inferior turbinate. *Arch Otolaryngol Head Neck Surg* 2006;132(6):588-94.
- Eccles R. Query, concerning mechanism of inferior turbinate enlargement. *Arch Otolaryngol Head Neck Surg* 2007;133(6):624.
- Farmer SE, Eccles R. Chronic inferior turbinate enlargement and the implications for surgical intervention. *Rhinology* 2006;44(4):234-8.
- Rohrich RJ, Krueger JK, Adams WP Jr, Marple BF. Rationale for submucous resection of hypertrophied inferior turbinates in rhinoplasty: An evolution. *Plast Reconstr Surg* 2001;108(2):536-44.
- Balbach L, Trinkel V, Guldner C, Bien S, Teymoortash A, Werner JA, et al. Radiological examinations of the anatomy of the inferior turbinate using digital volume tomography (DVT). *Rhinology* 2011;49(2):248-52.
- Eccles R. Nasal airflow in health and disease. *Acta Otolaryngol* 2000;120(5):580-95.
- Amutha B, Viswanathan T. Incidences of *Staphylococcus* species in surgical site infections - Prospective study from tertiary care center, Coimbatore, Tamil Nadu. *Int J Pharm Pharm Sci* 2015;7:225-8.