ANATOMIC VARIATIONS IN SINONASAL REGION IN CASES OF SINUS HEADACHE - CT SCAN - PNS STUDY
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ABSTRACT: BACKGROUND: Sinus headache secondary to Chronic Rhinosinusitis refers to episode of pain over the sinus area of the face and is often associated with nasal congestion, rhinorrhea, facial pressure, lacrimation, nausea and sensory sensitivity. Any small lesions or anatomical variations over lateral wall of nose may give rise to sinus headache. CT scan play a vital role in accurate assessment of osteomeatal complex area and anatomical variations at this site. AIM: To study anatomical variations of osteomeatal complex area and deviated septum in cases of chronic sinus headache secondary to Chronic Rhinosinusitis. MATERIALS AND METHODS: This study was conducted in Jhalawar Medical College, ENT Department between Sept. 2012 to Dec. 2014. In this study 75 patients with chronic sinus headache was selected who had chronic headache for more than 3 months duration not responding to medical line of treatment and who were willing to undergo function endoscopic sinus surgery. All patients underwent for CT scan para nasal sinus. RESULT: In this study deviated nasal septum was found in 77.33% patients, apart from that it was observed that 54.66% of the sinus headache cases had two or more anatomical variations and 28% had single anatomical variations, out of them commonest finding is concha bullosa followed by enlarge bulla ethmoid, paradoxical middle turbinate, medialiseduncinate process, lateraliseduncinate process, prominent aggar nasi cells, haller cells and onodi cells in decreasing order. CONCLUSION: The study of CT scan PNS conclude that Deviated Nasal Septum and anatomical variations at lateral wall of nose causes narrowing of osteomeatal complex area which predisposed patients to sino nasal disease and sinus headache.

KEYWORDS: Sinus headache, Chronic Rhinosinusitis, Osteomeatal Complex, Para Nasal Sinus, Deviated Nasal Septum, CT Scan.

INTRODUCTION: Headache is itself not a disease it is merely a symptom of disease. The quality, location, duration and time course of headache and the condition that produce, exacerbate or relieve should be carefully reviewed may provide close to the underlying cause. Sinus headache secondary to sinusitis refers to episodes of pain over the sinus area of the face, around the eyes. Sinus headache is often associated with nasal congestion, rhinorrhea, facial pressure, lacrimation, nausea and sensory sensitivity. The onset of headache is often related to change in weather.

"The International Headache Society and The American Academy of Otorhinolaryngology-Head and Neck Surgery” have attempted to define condition that leads to headache of sino nasal origin.

International headache society diagnostic criteria.¹ for headache attributed to rhinosinusitis.
| Category | Criterion |
|----------|-----------|
| A        | Frontal headache accompanied by pain in 1 or more regions of the face, ears or teeth and fulfilling criteria C&D. |
| B        | Clinical (evidence may include purulence in the nasal cavity, nasal obstruction, hyposmia, anosmia and / or fever), nasal endoscopic, computed tomography and/or magnetic resonance imaging and / or laboratory evidence of acute or acute-on-chronic rhinosinusitis. |
| C        | Headache and facial pain develop simultaneously with onset of acute exacerbation of rhinosinusitis. |
| D        | Headache and / or facial pain resolves within 7 days after remission or successful treatment of acute or acute-on-chronic rhinosinusitis. |

Negative pressure creation in the sinuses due to obstruction of natural Ostia is first proposed in 1891 by McBRID.2

Wolf HG.3 in 1948 found that pain could be elicited from much lower pressure applied over ostium or osteomeatal complex area.

Pain and tenderness in the frontal regions is often a symptom of frontal sinusitis, pain and tenderness relating to the maxilla on either side may be symptom of acute Maxillary sinusitis, pain between eyes a symptom of ethmoiditis, headache referred to the vertex or other part of cranium a symptom of sphenoid sinusitis. Small lesions or anatomical variations over lateral wall of nose may give rise to headache especially when located in key area of ethmoidal infundibulum and frontal recess. Many anatomical variations like concha bullosa, paradoxical middle turbinate, medially bent uncinate process, ethmoidal bulla etc., compromise the osteomeatal complex and middle meatus area. Stamberger and wolf postulated that variations in the anatomy of the nasal cavity results in mucous stasis, infection and ultimately headache and facial pain.

CT scan plays a vital role in accurate assessment of osteomeatal complex and anatomical variations at this area. CT scan has the ability to delineate mucosal disease of sinuses to detect primary obstructive pathology and to image the ethmoid and sphenoid sinuses which cannot be visualised by endoscopy. CT scan is important to assess the possible pathogenicity, its evaluation and treatment modalities in cases of sinus headache.

**MATERIAL AND METHODS:** After taking approval from institutional ethical committee this study was conducted at tertiary hospital, Jhalawar (Rajasthan) during Sept. 2012 to Dec. 2014.

90 patients were selected for this study has chronic headache and associated symptoms of rhinosinusitis. International Headache Society diagnostic criteria for headache attributed to rhinosinusitis were used for inclusion criteria. 15 patients were excluded from this study who was suffering from any other associated cause of headache, post traumatic nasal injury, facial neoplasm and those who underwent nasal surgery previously. 75 patients underwent CT Scan PNS. CT scan was done in radiology department of Jhalawar Medical College. Plane CT scan nose and PNS was done in both coronal and axial section.
Thickness of slice was 3mm CT scan done for both bony and soft tissue windows. The presence of anatomical variations and mucosal changes has been found out in CT scan PNS. The presence of anatomical variations was also documented along with radiological features of chronic rhinosinusitis.

**RESULTS:** Total 75 patients of chronic sinus headache were enrolled in the study. The age of the patients ranged between 15 years to 60 years with female to male ratio was 1.32:1 (Table -1) 72% of the patients were relatively younger as they were either equal to or less than 40 years of age.

| Age          | Sex |
|--------------|-----|
|              | M   | F   |   |
| 15 - 25 Yrs. | 8   | 15  | 23|
| 25 - 40 Yrs. | 14  | 17  | 31|
| 41- 60 Yrs.  | 10  | 11  | 21|
|              | 32  | 43  | 75|

Table 1: Age and Sex Distribution

In this study prevalence of sinuses opacities in CT scan study shown in Table-2.

| Sinusitis          | Unilateral N (%) | Bilateral N (%) | Total N (%) |
|--------------------|------------------|-----------------|-------------|
|                    | Right N (%)      | Left N (%)      | Total N (%) | Bilateral N (%) | Total N (%) |
| Maxillary          | 17 (22.66)       | 10 (13.33)      | 27 (36)     | 24 (32)         | 51 (68)     |
| Anterior Ethmoid   | 10 (13.33)       | 5 (6.66)        | 15 (20)     | 30 (40)         | 45 (60)     |
| Frontal            | 10 (13.33)       | 6 (8)           | 16 (21.33)  | 9 (12)          | 25 (33.33)  |
| Posterior Ethmoid  | 6 (8)            | 5 (6.66)        | 11 (14.66)  | 12 (16)         | 23 (30.66)  |
| Sphenoid           | 4 (5.33)         | 6 (8)           | 10 (13.33)  | 4 (5.33)        | 14 (18.66)  |

Table 2: CT Scan prevalence of sinus opacities in patients of chronic sinus headache (n=75)
In 51(68%) patients had maxillary sinusitis, 45(60%) patients had anteriorethmoid sinusitis, 25(33.33%) patients had frontal sinusitis. Posteriorethmoid sinusitis 23(30.66%) or sphenoid sinusitis 14(18.66%) was not seen individually but was seen in association with maxillary and or anterior ethmoid sinusitis.

In this study findings of CT scan PNS in relation to anatomical variants shown in Table No. 3

| Anatomical Variations       | Computed tomography findings N (%)       |
|-----------------------------|-----------------------------------------|
|                            | DNS 58 (77.33%)                         |
|                            | U/L  | B/L  | Total |
| Concha bullosa             | 25 (33.33) | 6 (8) | 31 (41.33) |
| Large Ethmoid Bulla        | 10 (13.33) | 18 (24) | 28 (37.33) |
| Paradoxical Middle Trubinate | 12 (16) | 8 (10.66) | 20 (26.66) |
| MedialisedUncinate Process | 10 (13.33) | 8 (10.66) | 18 (24) |
| LateralisedUncinate Process | 10 (13.33) | 7 (9.33) | 17 (22.66) |
| AggarNassi Cells           | 6 (8) | 10 (13.33) | 16 (21.33) |
| Haller Cells               | 5 (6.66) | 5 (6.66) | 10 (13.33) |
| Onodi Cells                | 3 (4) | 3 (4) | 6 (8) |

Table 3: CT scan finding of Anatomical Variations in Sinonasal Region in cases of Sinus Headache (n=75)

In this CT scan study DNS was found in 58(77.33%) patients, apart from DNS various anatomical variations of nose and PNS in case of chronic sinus headache were diagnosed on CT scan. They were either unilateral or bilateral. In our study it was observed that 41(54.66%) patients of the chronic sinus headache had 2 or more anatomical variations and 21(28%) of the cases had single anatomical variations.

In the present study most common anatomical findings was DNS in 58(77.33%) patients followed by concha bullosa in 31(41.33%), large ethmoid bulla in 28(37.33%), paradoxical middle turbinate in 20(26.66%), medialiseduncinate process in 18(24%), lateriseduncinate process in 17(22.66%), aggar nasi cells in 16(21.33%), haller cells in 10(13.33%) and onodi cells in 6(8%) patients (as shown in Table No. 3).

DISCUSSION: Anatomical variations in the sinonasal region in cases of sinus headache are very common. In 1965 Naumann.\(^4\) described the OMC area is a set of anatomical structure (ant ethmoid, uncinate process & middle meatus complex) located in the anterolateral nasal wall and middle meatus (Fig. 1).
Fig. 1: Showing the osteomeatal complex (OMC).

The OMC small compartment located in the region between the middle turbinate and the lateral nasal wall in the middle meatus-represents the key region for the drainage for the maxillary, anterior ethmoid and frontal sinuses.

Messerklinger.\textsuperscript{5} (1967) observed that any mini scale pathology in OMC area lead to sinusitis or to substantial varied symptomatology headache being one of them. Stammberger.\textsuperscript{6} (1986) described the ant ethmoids as ‘Prechamber’ for larger sinuses (maxillary and frontal) any mucosal changes or anatomical variations at that site leads to stasis of secretions in sinus and infection of sinus. Mafee MF.\textsuperscript{7} et al (1989) advocate the use of coronal plane CT scans PNS to evaluate the topographic relations of anatomical structures at osteomeatal complex area in cases of sinus disease. CT scan PNS defining with utmost precision the three main components of the osteomeatal complex area i.e. air, soft tissue and thin bony wall.

Messerklinger.\textsuperscript{8} (1978) identified plethora of anatomical variations like nasal septum deviation, spur, concha bullosa, aggarnasi cells, paradoxical middle turbinate, uncinate process and bulla ethmoidalis are responsible for hampered sinus ventilation and pathogenesis of sinus disease.

In our study we found anatomical variations in osteomeatal complex of 82.66% sinus headache patients, out of which 54.66% had two or more anatomical variations and the remaining 28% had single anatomical variation. Similar finding were reported by Liu X et al,\textsuperscript{9} who observed prevalence of about 81% anatomical variations in chronic rhinosinusitis.

Anita Aramaniet al.\textsuperscript{10} reported relatively high anatomical variations 87% in the osteomeatal complex area of CRS cases. Severino Aires de Araugo Neto et al.\textsuperscript{11} reported relatively less anatomical variations 65% in the osteomeatal complex of chronic rhinosinusitis cases.
In the present study most common sinus effected due to infection / inflammation was maxillary sinus about 68% (Fig -4).

The findings corresponds with the studies done by Clement et al.\textsuperscript{12} and Lloyd et al,\textsuperscript{13} whereas anterior ethmoid sinus was most commonly affected sinus in the studies done by Bolger et al,\textsuperscript{14} Calhoun et al.\textsuperscript{15} (84.3%) and Kennedy et al.\textsuperscript{16} (78%).

**Fig. 2:** Bilateral concha bullosa (Arrow) Rt. > Lt. with deviated septum to left.

**Fig. 3:** Left concha bullosa (broad arrow) with deviated septum (narrow arrow) to right.

**Fig. 4:** Paradoxical middle turbinate (dotted arrow) with medialised uncinate process (broad arrow) with bilateral enlarge bulla ethmoid (narrow arrow) with right maxillary sinus opacity.

**Nasal Septal Deviation:** Nasal spetal is fundamental in the development of the nose and PNS. In present study of 75 patients, 58(77.33%) patients had septal deviation. It was the most common anatomical variation seen in study (Fig. -2, 3 & 4). Similar finding were observed by Perez et al,\textsuperscript{17} who reported the prevalence of deviated nasal septum to be about 80%. Anita Armani et al,\textsuperscript{10} reported the prevalence of DNS to be about 74%. Stallmannet al,\textsuperscript{18} and Mamtha et al,\textsuperscript{19} also reported lesser prevalence of 60% and 65% deviated nasal septum in sinus disease respectively. Sever septal deviation has been noted as a contributing factor for sinusitis and sinus headache.

**Concha Bullosa:** Concha bullosa (Pneumatised Middle Turbinate) has been implicated as a possible aetiological factor in the causation of sinus headache (Fig.-2 &3). In the present study concha bullosa was observed in 31 (41.33%) patients (Unilateral 33.33%, bilateral 8%) of sinus headache. The reported prevalence of concha bullosa varies widely among investigators ranging from 4% to 80% (LAINE F. J.\textsuperscript{20} 1992). In patients having CT for evaluation of symptomatic sinus disease the incidence of concha bullosa was found to be 34% (Zinreich, Kennedy et al,\textsuperscript{21} 1988), Joe et al.\textsuperscript{22} (2000) noted concha bullosa in 37% cases of headache.

**Prominent Ethmoid Bulla:** This is largest and most consistent cell of anterior ethmoid sinus. The ethmoid bulla can be so extensively pneumatised that it can obstruct infundibulum/ middle meatus completely (Fig.-3 & 4). In present study prominent ethmoid bulla was observed in 28 (37.33%) patients (unilateral 13.33% and bilateral 24%). Patel AK et al.\textsuperscript{23}
Reported prevalence of large ethmoid bulla in 32.66% patients. Fadda GL et al.,24 Krzeski A et al.25 reported large ethmoid bulla in 32.8% and 26.75% patients respectively.

**Paradoxically Curved Middle Turbinate:** The middle turbinate may be paradoxically curved i.e. bent in the reverse direction, this may lead to impingement of the middle meatus and thus to sinus disease (Fig.-4). In the present study paradoxical middle turbinate was observed in 20 (26.66%) patients (Unilateral 16%, Bilateral 10.66%). Bolger et al.14 (1991) found it in 26% cases and Lloyd GA.13 (1991) found it in 17% of patients of sinusitis. S.K. Kaluskar,26 (1990) encountered paradoxical middle turbinate in 14% of cases.

**Uncinate Process:** Uncinate process may be deviated or pneumatised. Uncinate deviation can impair sinus ventilation and responsible for sinus headache (Fig.-4).

In the present study medialiseduncinate process was observed in 24% patients and lateralised uncinate process was observed in 22.66% patients of sinus headache. Study conducted by Saxena R et al.27 medialiseduncinate process was seen in 33 (55%) patients. Study conducted by Fadda GL et al.24 medialiseduncinate process was detected in 22.08% patients and lateraliseduncinate process in 21.4% on CT scan.

**AggerNasi Cells:** AggerNasi cells are the most anterior extramural ethmoid cells, located anterosuperior to the insertion of middle turbinate along the lateral nasal wall.

In the present study aggernasia cell was found in 16 (21.33%) patients.

In anatomic dissection the prevalence varies from 10% (Messerklinger,8 1978; Schaefer SD et al.28 1989) to 89% (Van Alyea OE,29 1939).

In anatomical dissection Krzeskiet al.25 reported it in 59%, Van Alyea,29 reported in 89% and Bolger et al,14 observed in 98.5% of cases, Fadda et al.24 detected aggernasi cells on CT scan in 24.3% cases.

**Haller Cells:** It is an ethmoidal air cell located beneath the floor of orbit, which formed part of the lateral wall of infundibulum. It is thought that haller cells causes sinusitis by impinging on the ostium of the maxillary sinus and infundibulum by inhibiting the ciliary function, leading obstruction of ostium. In this study haller cell was found in 13.33% patients. Anatomical studies by Grunwald L.30 (1925) and Van Alyea.29 (1939) have assessed their incidence to range from 4% to 11%. Kennedy and Zinreich.16 (1988) reported this anomaly in 10% of patients evaluated by coronal CT scan. The prevalence of haller cells in other study was, 15% Lloyd et al,13 20% Perez - Pinas et al,17 36% Tonai and Baba,31 38% Bolger et al,14 36% Maru et al.32

**CONCLUSION:** The results of this study highlights that CT scan are important investigation tool to detect the anatomical variations of nose and para nasal sinuses. Some anatomical variations like DNS, concha bullosa, aggernasi cells, and medialised uncinate process play an important role in pathogenesis of sinus headache.
Prevalence of multiple anatomical variations was more in our study in comparison to single anatomical variation. DNS was the most common anatomical variation found in our study followed by concha bullosa and enlarged bulla ethmoid.

Careful evaluation of anatomical variations by CT scan is necessary in patients of sinus headache secondary to chronic rhinosinusitis especially those undergoing endoscopic sinus surgery.

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