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Original Research Article

Radiological significance of the sinonasal anatomical variants in recurrent acute rhinosinusitis patients

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ABSTRACT

Background: Recurrent acute rhinosinusitis (RARS), a low form chronic rhinosinusitis is frequently under evaluated. The significance of sinonasal anatomical variants of osteomeatal complex (OMC) and spheno-ethmoidal (SE) recess regions in patients of RARS is assessed.
Methods: Retrospective analysis of coronal sinonasal computed tomography images of 120 RARS patients presented with sinonasal anatomical variants during November 2013 to October 2016 was carried out. Patients with acute and expansile sinonasal lesions are excluded.
Results: Sinonasal anatomical variants in the regions of OMC and SE recess are responsible for obstruction of normal mucociliary drainage of corresponding paranasal sinuses in presence of inflammation predisposing to RARS. Anatomical variants of nasal septum were, deviated nasal septum (DNS) in 86 (72%) and septal spur in 58 (48%) patients. Anatomical variants in OMC region were, pneumatized middle turbinate (concha bullosa) in 50 (48%), paradoxical middle turbinate in 38 (28%), giant ethmoid bulla in 35 (32%), agger nasi cell in 29 (38%), Haller cell in 23 (15%), pneumatised uncinate process in 20 (18%), medialized uncinate process in 18 (22%) and septated maxillary sinus in 5 (4%) patients. Anatomical variants in SE recess were superior concha bullosa in 14 (12%) and septal bullosa in 11 (9%) patients.
Conclusions: OMC pattern of recurrent rhinosinusitis is often prevalent in patients of RARS due to abundance of anatomical variants in the OMC region. DNS or ethmoid bulla when gets associated with concha bullosa increased the incidence of RARS. Present analysis would help surgeons to evaluate RARS patients for selective endoscopic sinus surgery.

Keywords: Anatomical variants, Concha bullosa, Computed tomography, Deviated nasal septum, Osteomeatal complex, Paranasal sinuses, Spheno-ethmoidal recess

INTRODUCTION

The rhinosinusitis disease spectrum defined as inflammatory processes of nasal and paranasal sinus mucosa is classified as, acute rhinosinusitis (ARS), which lasts for < 4 weeks and chronic rhinosinusitis (CRS) which lasts for > 12 weeks. Moreover, acute bacterial rhinosinusitis (ABRS) presents symptoms of purulent nasal drainage (anterior, posterior, or both) accompanied by nasal obstruction, or facial pain/pressure/fullness, or

both. ABRS is diagnosed when the above symptoms of acute rhinosinusitis fail to improve or worsen further within 10 days from the date of onset. When patients have four or more episodes of ABRS within a year and remain asymptomatic in between, the condition is termed as recurrent acute rhinosinusitis (RARS).[1] During the asymptomatic interval phase i.e., in between acute episodes of ABRS, a majority of RARS patients had demonstrated subtle findings of isolated ethmoid sinusitis, while they had undergone for computed tomography (CT) scan of brain for any reasons other than sinonasal symptoms. Nevertheless, this subtle isolated infection of ethmoid sinuses was reported as a potential nidus and is responsible for the recurrence nature of this disease.[2]

Based on CT appearance, patients having recurrent attacks of inflammatory sinusitis usually present 5 patterns of acute rhinosinusitis: osteomeatal complex (OMC), spheno-ethmoidal (SE) recess, sinonasal polyposis, isolated infundibular type and sporadic distribution patterns. Majority of RARS patients present OMC and/ or SE recess patterns of acute rhinosinusitis, when they are associated with anatomic variants in the corresponding region. Normal mucociliary drainage of anterior group of paranasal sinuses consisting of maxillary, frontal and anterior ethmoid sinuses occur into the middle meatus and a complex anatomic anterior drainage site, called as the osteomeatal complex (OMC).

The posterior group of paranasal sinuses consisting of sphenoid and posterior ethmoid sinuses drain into the superior meatus and the spheno-ethmoidal (SE) recess. Moreover, anatomic variants of OMC and SE recess regions are responsible for recurrent inflammation of corresponding draining paranasal sinuses. Narrowing of OMC occurs with anatomical variants of middle turbinate along with asymmetric nasal septum obstructing normal mucociliary drainage of adjoining maxillary, anterior ethmoid and frontal sinuses.[3] Herein, anatomic variants of nasal septum are included.

Functional endoscopic sinus surgery (FESS) is the coveted treatment for RARS as it helps to restore normal functions of paranasal sinuses including ventilation and mucociliary drainage.[4] Endoscopic surgeons need a detailed knowledge of structural anatomy of lateral nasal wall, paranasal sinuses and the surrounding vital structures. For this reason, CT scan is mandatory as a pre-operative work-up in patients undergoing FESS, as it provides a road map for endoscopic surgeons.[5]

Besides disturbing normal drainage pathways, sinonasal anatomical variants serve as a focus for an occult disease and concomitantly hinder endoscopic access with risks of surgical mishaps during FESS. The presence of variants, either singly or in combinations does/ do not constitute a disease state, but may predispose to a sinus disease in the presence of inflammation. Herein, the significance of sinonasal anatomic variant in RARS is assessed.

METHODS

The study-population included 158 patients with complaints related to RARS referred to the department of Radiology during November 2013 to October 2016, out of which 38 patients without any sinonasal anatomical variants were excluded from the study. Retrospective analysis of coronal sinonasal CT scan images of the rest of 120 RARS patients was done for assessing prevalence and significance of sinonasal anatomical variants. Patients having acute episodes of rhinosinusitis, tumors, polyps and other expansible lesions in the sinonasal region at the time of scan, diseases with altered ciliary motility including cystic fibrosis and with recent history of craniofacial surgery or trauma were excluded from this study.

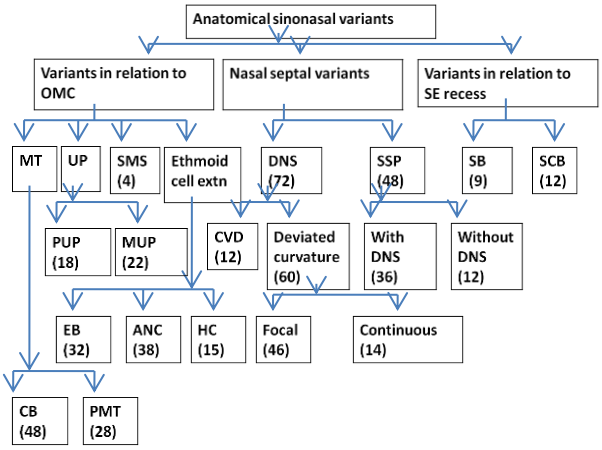

Figure 1: Anatomical sinonasal variants: DNS, deviated nasal septum; CVD, chondro-vomeral dislocation; SSP, septal spur; CB, concha bullosa; PMT, paradoxical middle turbinate; EB, ethmoid bulla; ANC, agger nasi cell; HC, Haller cell; PUP, pneumatized uncinate process; MUP, medialized uncinate process; SMS, septated maxillary sinus; SB, septal bullosa; SCB, superior concha bullosa; OMC, osteomeatal complex; SE recess, spheno-ethmoidal recess; MT, middle turbinate; UP; uncinate process. Numbers in parentheses are percent values of prevalence of the variants.

In the present study, sinonasal variants are classified under two major divisions; septal abnormalities and sinus air cell extension into the contiguous bony turbinates along the lateral nasal walls. The primary turbinates are three bulbous projections along the lateral nasal wall namely the superior, middle, and inferior turbinates, while the uncinate process acts as a secondary nasal turbinate. Anatomic variations of nasal septum are deviated nasal septum (DNS) and septal spur (SSP). Structural anatomic variations of OMC region evaluated in the study are giant ethmoid bulla (EB), agger nasi cell (ANC), middle turbinate concha bullosa (CB), Haller cell (HC), paradoxical middle turbinate (PMT), horizontal medialized uncinate process (MUP), pneumatized

uncinate process (PUP) and septated maxillary sinus (SMS) as well as variants of SE recess included superior turbinate concha bullosa (SCB) and septal bullosa (SB) (Figure 1).

CT scans were performed with the GE Optima CT 660 scanner (GE Healthcare Japan Corporation). 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 due to good quality resolution of the high end multi-slice CT 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.

RESULTS

A total of 120 (100%) RARS patients with anatomical sinonasal variants having different prevalence percentage values were evaluated (Figure 2). Total patients in the age group of 18 to 70 years (mean age 34.6 years) undergone coronal CT scan evaluations comprised of 62 (52%) males and 58 (48%) females. The key areas for drainage of all major sinus pathways, OMC (Figure 3A) and SE recess (Figure 3B) were specifically examined. DNS found in 72% of total cases, out of which 60% showed deviated curvatures either continuous (14%) (Figure 4A) or focal (46%) (Figure 4B), rest 12% DNS cases were due to dislocation of the chondro-vomeral junction (Figure 4C). SSP found in 48% of total cases out of which only 36% were associated with DNS (Figure 4D).

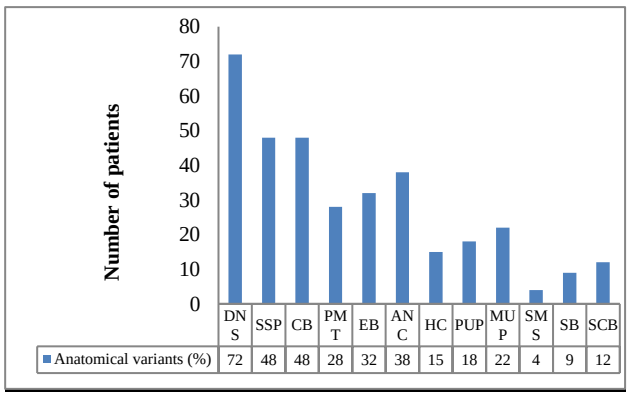

Figure 2: Prevalence of anatomical sinonasal variants.

'True CB' (Figure 5A) suggesting pneumatization of entire vertical length involving both bulbous and lamellar portions of middle turbinate, as well as 'lamellar CB' (Figure 5B), were noted in 48% cases. Other anatomical variants encountered were PMT (Figure 5C) in 28%, EB (Figure 5D) in 32%, ANC (Figure 4C) in 38%, SB (Figure 6A) in 9%, HC (Figure 6B) in 15%, unilateral or bilateral PUP (Figure 6B) in 18%, MUP (Figure 5D) in 22%, SCB (Figure 4D) in 12%, and SMS (Figure 5B) in 4% patients. Of total 120 patients, more than one anatomical variant was present in 106 patients. Of 106 patients, two anatomical variants were seen in almost 50% (54) cases, while three variants in 31 and four variants in 17 patients were seen. The most common pattern of rhinosinusitis in this study was the OMC pattern obstruction, recorded in 94 patients of RARS.

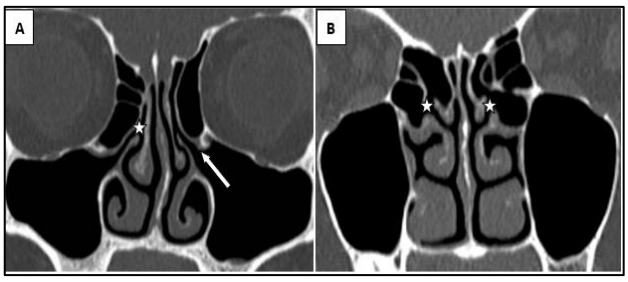

Figure 3: (A) Coronal CT scan of osteomeatal complex comprising of maxillary ostium (←), infundibulum, hiatus semilunaris (*), middle meatus and ethmoid bulla. (B) Sphenoethmoidal recess (*). The medial relationship of the recess is formed by the superior turbinate.

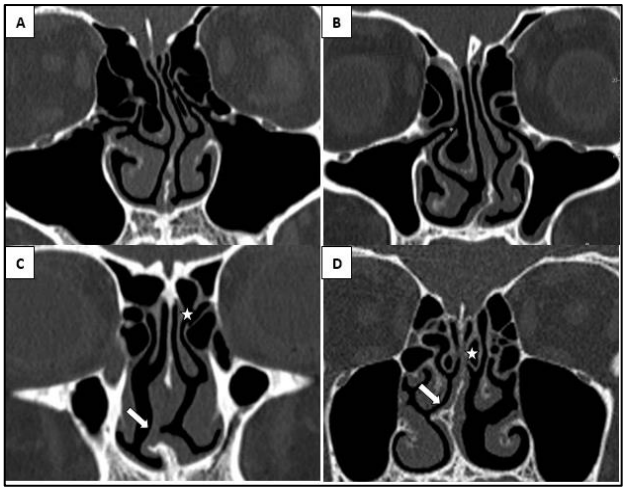

Figure 4: (A) Deviated nasal septum - CT scan shows single curvature involving the whole septum with convexity towards left. Associated asymmetry of the uncinate processes seen. (B) Focal septal deviation - focal curvature of lower third of the septum towards left. Both the above types of deviations are associated with right sided middle turbinate concha bullosa and hypertrophied inferior turbinate. (C) Deformed chondro-vomeral junction shows dislocation of septal cartilage towards right (←). Also note bilateral prominent agger nasi cells located inferior and lateral to the nasofrontal recess (*) and above the upper ends of nasolacrimal ducts. (D) Septal spur (←) on the right. Also note bilateral pneumatized superior turbinates (*).

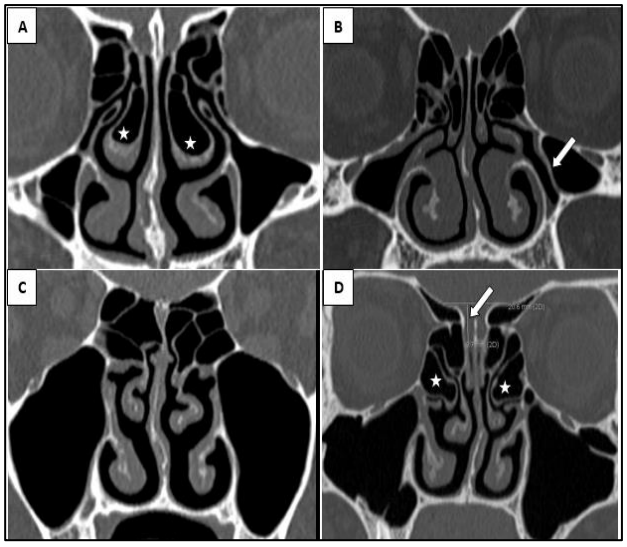

Figure 5: (A) Concha bullosa - Coronal CT scan shows pneumatization of bulbous as well as lamellar portions of bilateral middle turbinates, called as "True concha bullosa" (*). Also note pneumatization of bilateral uncinate processes. (B) Lamellar concha - Pneumatization of vertical lamellar portion of bilateral middle turbinates. Note the left septated maxillary sinus (←) showing intra-sinus bony septum extending from infra-orbital foramen to the lateral maxillary wall. (C) Paradoxical bilateral middle turbinates. (D) Bilateral large ethmoid bulla (*) seen above the infundibula, right one forcing its way between the uncinate process and the middle turbinate. Also note bilateral medialized uncinate processes and Keros type III (8-16mm) deep olfactory fossa (←) usually vulnerable to iatrogenic injury during surgery. Incomplete intra-sinus septations also noted in right maxillary sinus (Figure A) and in both maxillary sinuses (Figure D).

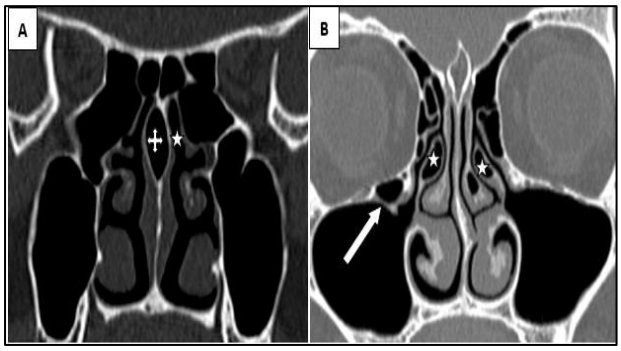

Figure 6: (A) Septal bullosa - Coronal CT shows pneumatization of postero-superior portion of the nasal septum (+) usually narrows the sphenoethmoidal recess (*). (B) Haller cell - right infra-orbital ethmoid air cell (←) usually compromise the maxillary ostium and narrows the adjacent infundibulum leading to maxillary sinusitis. Bilateral pneumatized uncinate processes (*).

DISCUSSION

Although clinical diagnosis is possible considering the history of the patients suggesting frequent attacks of ABRS, most of the RARS patients require imaging studies for further evaluation. RARS has been characterized recently as a mild form of CRS. The disease is often under diagnosed due to lack of awareness of the disease pattern of RARS, as a distinct form of CRS. Subtle isolated infections of anterior and posterior ethmoid sinuses usually occur in presence of anatomic variants of the OMC and SE recess respectively and this infection persist even in asymptomatic interval phase of RARS patients which usually go unnoticed. This potential nidus of infection in RARS patients contribute towards recurrent episodes of ABRS.[2] Narrowing of paranasal sinus ostia and/ or meati usually occurs due to presence of anatomical variations, which predisposes to recurrent mucosal diseases of the sinonasal region. The wide range of anatomical variants of sinonasal structures composing the OMC and the SE recess are common predisposing factors for corresponding inflammatory patterns of RARS, which need CT evaluation in the early stage for diagnosis and proper management. These anatomical variants are not pathological per se; nevertheless, their presence could result in RARS.[6]

Common anatomical variants of the nasal septum and the OMC region involving middle turbinate played the key role in the pathogenesis of RARS, corroborating this study.[7] In the current study, DNS was the most common anatomical variant with prevalence rate of 72%, while Aramani et al documented 74% cases in South India (Karnataka) and Patel et al recorded 77% cases in West Central India.[8,9] Prevalence of this particular anatomical variation ranging from 13% - 80% has been reported in different studies as different criteria were applied to diagnose and consider the septum to be deviated.[10,11] DNS and CB were associated with higher incidences of nasal obstruction. Herein, combination of CB either with DNS or prominent EB increased the incidence of RARS to many folds, recorded in the study. Bolger et al, classified the CB based on pneumatisation of different portions as follows: pneumatisation of the stem or vertical lamella as "lamellar CB", pneumatisation of the distal bulbous segment only as "bulbous CB", and "extensive or true CB" when pneumatisation involves both the lamellar and bulbous segments.[12] All the above three categories of CB having pneumatization of at least 50% of the vertical height of the middle turbinate were included in the study and a prevalence rate of 48% was recorded, while Aramani et al, documented 53%, Patel et al. recorded 41% cases and Bagul et al. recorded 43% cases.[8,9,13] Thus, it can be concluded that the presence of CB increased the prevalence and acts as a significant predisposing factor for OMC pattern RARS.

A comparative account of the rest of anatomical variations is presented herewith, for emphasizing the role of the total range of anatomical variants as causatives of

RARS. PMT, an anatomic variation having the convexity of middle turbinate paradoxically reversed towards the middle meatus, was found at a prevalence rate of 28% in this study, while Patel et al, recorded 27% and Lingaiah et al. recorded 14% cases of PMT.[9,14] SSP were found in 48% cases with or without associated with DNS. Herein, giant EB were seen in 32% cases corroborated with Patel et al. recording of 37%, while Dua et al, recorded 14% cases from Northern India.[6,9]

ANC was seen in 38% cases herein, while Patel et al, recorded 27% cases.[9] HC is defined as extramural infra-orbital extension of ethmoid air cell below the ethmoid bulla into the bony orbital floor, which constitutes the roof of the maxillary sinus. In this study, HC was seen in 15% cases, but was recorded comparatively high incidences of 52.3% patients in Iran.[15] PUP occurred in 18% patients herein, whereas in another study in Romania the prevalence of 3.4% was reported.[16] Incidences of MUP found in 22% in this study, corroborated findings of 24% cases in Sikkim of eastern India.[17] SCB was recorded in 12% cases in this work, while 15.5% prevalence was detected in another study.[18] SB was evident in 9% patients herein, but an excessively high incidence of 55.79% was reported.[19] SMS usually presented as unilateral and mostly anterior intra-sinus septum were seen in 4% patients in this study, but no bony septum within maxillary sinuses found in a study from Nigeria.[20] In this present era of FESS, a thorough and intimate knowledge of sinonasal anatomy and anatomical variants is a prerequisite for a successful and safe surgery so that complications can be prevented.[21]

CONCLUSION

RARS a mild form of CRS is frequently under-evaluated, thus remained a relatively uncommon disease as compared to CRS. CT analysis of the relation between anatomical variants and RARS depicts the conditions. Among common anatomical variants, DNS, CB and EB were found more prevalent in OMC region responsible for predisposing patients to OMC pattern RARS. The assessment and detailed description of the anatomical variants in the coronal sinonasal CT scan report is much crucial for proper management and/or surgical intervention of the RARS.

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