Original Article / Çalışma - Araştırma

Preoperative evaluation of chronic rhinosinusitis patients by conventional radiographies, computed tomography and nasal endoscopy

Kronik rinosinüzitli hastaların konvansiyonel radyografi, bilgisayarlı tomografi ve nazal endoskopi ile ameliyat öncesi değerlendirilmesi

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Objectives: The aim of this study was to compare the efficacy of conventional radiography (CR), computed tomography (CT) and nasal endoscopy for the preoperative evaluation of chronic rhinosinusitis in patients with persistent complaints despite appropriate medical therapy.

Patients and Methods: Forty-three patients (26 males, 17 females; mean age 43 years; range 15 to 73 years) were prospectively evaluated. All patients underwent detailed physical examination, CR and coronal high resolution CT of paranasal sinuses. Thirty of them were evaluated with detailed nasal rigid and/or flexible endoscopy as well. The anatomic variations and mucosal changes in paranasal sinuses were noted. The specificity and sensitivity of CR was calculated using CT findings as a reference point. Surgery was performed on two of the other three patients because of obstructive symptoms of middle turbinate. Paradoxal middle turbinate surgery was performed on one patient due to a headache of rhinogenic origin.

Results: In our study 40 (93%) of all patients showed mucosal abnormalities on CT. Computed tomography scanning of the patients revealed anatomic variations in 74.4% of the cases. Mucosal pathology was most frequently observed in the anterior ethmoid region (middle meatus). While we found mucosal anomalies in 47.4% of all sinuses using CR, 42.2% of these cases were confirmed with CT. Also, 19.5% of all sinuses evaluated as normal with CR presented pathologic findings on CT. An overall correlation of 75.3% was observed between CR and CT, while diagnostic nasal endoscopy and CT findings were correlated at a rate of 87%.

Conclusion: *(i)* While no ipsilateral maxillary or frontal sinus disease was detected when no abnormality in the anterior ethmoid region and infundibulum was observed endoscopically in the presence of mucosal abnormalities similar abnormalities were seen at the same side for maxillary or frontal sinuses. *(ii)* Anatomic variations of nasal and paranasal sinuses may be considered as etiologic and predisposing factors of chronic rhinosinusitis. *(iii)* Conventional radiography should not be used as a single diagnostic tool in pre-operative evaluation; however, due to its high sensitivity, CR technique may be used alone in the diagnosis and follow-up of maxillary sinus disease. *(iv)* Nasal endoscopy may reduce unnecessary diagnostic CT scanning procedures.

Key Words: Conventional radiography; endoscopic sinus surgery; paranasal computed tomography.

Amaç: Bu çalışmada uygun medikal tedaviye rağmen semptomları devam eden, kronik rinosinüzitli hastaların ameliyat öncesi değerlendirilmesinde düz radyografiler, paranazal sinüs bilgisayarlı tomografisi (BT) kullanıldı ve nazal endoskopinin etkinliği karşılaştırıldı.

Hastalar ve Yöntemler: Kırk üç hasta (26 erkek, 17 kadın; ort. yaş 43 yıl; dağılım 15-73 yıl) ileriye dönük olarak değerlendirildi. Bütün hastalara ayrıntılı fizik muayene, konvansiyonel radyografi ve koronal planda yüksek çözünürlüklü paranazal sinüs BT uygulandı. Otuz hasta ayrıca rijit ve/veya fleksibl nazal endoskopi ile değerlendirildi. Paranazal sinüslerdeki anatomik varyasyonlar ve mukozal değişiklikler kaydedildi. Bilgisayarlı tomografi referans alınarak düz radyografilerin duyarlılık ve özgüllükleri araştırıldı. Diğer üç hastadan ikisine obstrüktif semptomlar nedeniyle konka bulloza cerrahisi, bir hastaya da rinojenik kaynaklı baş ağrısı nedeniyle paradoksal orta konka cerrahisi uygulandı.

Bulgular: Olguların 40'ında (%93) BT'de mukozal anormallikler bulundu. Bilgisayarlı tomografi görüntülemelerinde hastaların %74.4'ünde anatomik varyasyonlar saptandı. Patolojinin en sık görüldüğü alan anterior etmoid bölge (orta mea) idi. Konvansiyonel radyografilerde bütün sinüslerin %47.4'ünde mukozal değişiklik bulunurken, BT'de bunların %42.2'si doğrulandı. Aynı zamanda konvansiyonel radyografilerle tamamen normal olarak değerlendirilen sinüslerin BT incelemesinde %19.5'inde patolojik bulgu saptandı. Toplamda konvansiyonel radyografiler ile BT uyumu %75.3 bulundu. Tanısal nazal endoskopi ve BT bulguları arasında %87 ilişki bulundu.

Sonuç: *(i)* Anterior etmoid bölge veya infundibulumda endoskopik bir anomali olmadığında aynı tarafta maksiller ya da frontal sinüs hastalığı görülmedi; anomali varlığında ise aynı taraf maksiller veya frontal sinüste benzer anormallikler bulundu. *(ii)* Nazal ve paranazal sinüslerin anatomik varyasyonları kronik rinosinüzitli hastalarda etyolojik ve predispozan faktör olarak kabul edilebilir. *(iii)* Düz radyografiler cerrahi öncesi değerlendirmede yalnız başlarına kullanılmamalıdır. ancak yüksek duyarlılıkları nedeniyle düz radyografiler sadece maksiller sinüs hastalığının tanı ve takibinde tek başlarına kullanılabilir. *(iv)* Nazal endoskopi, gereksiz tanısal BT çekimlerini azaltabilir.

Anahtar Sözcükler: Konvansiyonel radyografi; endoskopik sinüs cerrahisi; paranazal bilgisayarlı tomografi.

Received / *Geliş tarihi:* May 29, 2006 Accepted / *Kabul tarihi:* November 24, 2006

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New horizons have been opened by endoscopic approach in diagnosis and treatment of chronic sinusitis. In early researchs ethmoid sinus constituted the key point in sinus infections. Later on, shown that obstruction of ostium was a precursor of sinusitis.[1-4] Aim of this surgery is to construct the normal physiology by achieving sinus ventilation and normal mucociliary drainage.[1-4] The primary objective here is to clear out the local disease, which filled out ethmoid cells. So, regression of the mucosal disease in frontal and maxillary sinuses is expected as a result of normal mucociliary clearance and the ventilation achieved.

Conventional radiography, (CR) nasal endoscopy and high-resolution computed tomograpy (CT) are used for diagnostic purposes.[2,5-12] Nasal endoscopy and scanning methods performed before the operation are complementary methods.[2,6,8,10,13,14] Anatomical structures like septal deviation, presence of paradoxical medial concha and appearance of infundibulum may be evaluated by nasal endoscopic examination, without any need for scanning methods. Therefore, endoscopic examination performed prior to CT is thought to be very useful.[9,10,15,16]

An increased rate of coincidental mucosal changes in paranasal sinuses were reported from clinical studies.[8,11,12] It is known that unnecessary CTs were performed at a high rate due to insufficient clinical assessment and negligence of conventional X-ray methods.[8,10] A more cautious attitude is required considering our country's economical status and the cost of unnecessary CT scans.

Anatomic and diagnostic details relative to osteomeatal complex (OMC) in patients with chronic sinusitis are crucial and advised to be checked for functional endoscopic sinus surgery.[4,9] It is also critical to avoid unnecessary interventions by identifying regions without any pathology as well as to determine the extension of the disease prior to operation, and to determine anatomic abnormalities. All these data are necessary to perform an effective surgical intervention, and to avoid intracranial and intraorbital complications.[4,10]

The aim of this study is to compare the efficiency of nasal endoscopy, high-resolution coronal CT of paranasal sinuses and conventional X-rays in preoperative evaluation of chronic sinusitis patients with persistent complaints despite appropriate medical treatment.

PATIENTS AND METHODS

Forty-three patients (26 males, 17 females; mean age 43 years; range 15 to 73 years) admitted to the Department of Otorhinolaryngology of Uludağ University Medical School because of symptoms of recurrent acute rhinosinusitis or chronic rhinosinusitis who were evaluated prospectively between April 2001 and March 2003 are included in this study. Patients were presented with an uncontrolled clinical status after a maximal medical treatment (amoxicillin-clavulanic acid, second generation cephalosporins or macrolides for three weeks with systemic and local decongestant) and their anamnesis were complying with chronic rhinosinusitis.

Following an examination of conventional X-ray, detailed physical examination and anamnesis of 43 patients who met the criteria of chronic rhinosinusitis[17-19] and who had inflammatory nasal and/or sinus disease with specific symptoms and signs lasting more than three months were accepted for this study. All patients were evaluated using high resolution CT in coronal plan; 30 of them also underwent rigid and/or flexible nasal endoscopy. Allergy anamnesis was carried out. Radiologic evaluation of patients were performed at Radiology Department of Uludağ University Medical School. Of the conventional methods, Waters CR was used for maxillary and ethmoid sinus evaluation, Caldwell CR for frontal sinus evaluation and lateral radiograms of paranasal sinuses for sphenoid sinus evaluation.

As all patients included in the study have undergone a surgery, coronal CT scans of paranasal sinus were performed in all patients as a routine procedure.

Siemens Somatom HIQ (Siemens Somatom HiQ, Erlangen, Almanya) device was used. The width of the slice sections was 3 mm. However, a thickness of 5 mm was used in areas where no mucosal pathology was detected. The bandwidth at scanning was set to 1500 HU (Haunsfield Unit) and -500 HU was considered central at the band.

Rigid and flexible telescopes were used for the assessment of patients. Although nasal endoscopy did not allow conventional examination of all sinuses, mucosal or structural abnormalities in the nasal cavity as well as changes at

sphenoethmoid recesses, the osteomeatal complexes were evaluated. As a component of routine ENT examination carried out for diagnostic purposes and for preoperative evaluation, nasal endoscopy was performed to observe mucosal changes occurring after medical therapy. Thirty patients with access to medical records were included in the evaluation since records of all endoscopic examinations performed were not accessible or not sufficient.

Possible anatomic abnormalities and variations of paranasal sinuses were evaluated on the coronal plane CT images. For each maxillary, ethmoid, frontal, and sphenoid sinuses CR and CT images were assessed separately. Mucosal thickness, opacification, air-fluid level, and localization of disease were recorded for each sinus, while considering CR and CT. In general, for staging of rhinosinusitis using CT, Lund-Mackay staging system is being used.[20] Advantage of the system is to determine a numerical value. We decided to use the way used in this system, but to find the sensitivity and the specifity values for each sinus we gave separete numerical values for mucosal thickness, air-fluid level, opacification and retantion cyst.

Sensitivity and specificity of CR for paranasal sinuses were determined while taking CT results as references.

Datas were analyzed using Fisher's exact chi-square and Chi-square tests. Correlation between CR, CT, and diagnostic nasal endoscopy was investigated.

RESULTS

Patients were asked for allergy history, which is one of the most important underlying factor in chronic rhinosinusitis cases. Twenty patients (46.5%) were found to have allergy history.

Mucosal abnormalities were observed in 40 of the cases (93%) on CT scans. Surgery was performed in two of the other three patients because of obstructive symptoms of middle turbinate. Paradoxal middle turbinate surgery was performed in one patient due to a diagnosis of rhinogenic originated headache. Anterior ethmoid region was the most commonly affected area. Similar mucosal maxillary or frontal sinus abnormalities were observed at the right side in 29 patients (67.7%), and at the left side in 32 patients (74.4%) in the presence of a mucosal abnormality at the infundibulum or anterior ethmoid region. On the other hand, no patient presented with a same side maxillary and frontal sinus disease when no abnormality of anterior ethmoid region and infundibulum existed.

According to a generally accepted opinion, anatomic variations of paranasal sinuses make patients more susceptible to chronic recurrent rhinosinusitis. Anatomic variations were observed in 32 (74.4%) of 43 patients on CT scans in our study. Sixteen of the patients had one and the remaining sixteen had more than one anatomic variations. The most common anatomic variations included deviation of septum (n=17; 39.5%), paradoxal middle turbinate (n=7; 16.3%) and concha bullosa (n=6; 14%). Variations such as Haller cell, agger nasi cell, large ethmoid bulla and uncinate processus were more infrequent (Table 1).

Mucosal abnormalities were seen in 47.4% of all sinuses during evaluation using CR; 42.2% of these cases were confirmed with CT. However, 19.5% of all sinuses assessed as normal using CR were found to be abnormal on CT scans. As a result, the concordance between CT and CR results were found to be 75.3%. This value was 87.2% for maxillary sinuses, 73.3% for frontal sinuses, 69.8% for ethmoid sinuses, and 70.9% for sphenoid sinuses (Table 2). Sensitivity of CR in all sinuses was found to be 68.4% in our study when CT was considered as the reference point. The highest sensitivity was achieved for maxillary sinuses (86.9%). Sensitivity and specificity values of CR obtained for each of the sinuses when CT was considered as the reference point are shown in Fig. 1.

Anatomic variation and/or mucosal abnormality was detected at middle meatus in 25 (83%) of 30 patients who underwent diagnostic nasal

Tablo 1. Anatomic variations

Anatomic variation	n	%
Septum deviation	18	41.9
Concha bullosa	7	16.3
Paradoxical median concha	7	16.3
Large ethmoid bulla	5	11.6
Agger nasi cell	2	4.7
Haller cell	4	9.3
Pneumatized uncinate processus	2	4.7
Medialized uncinate processus	1	2.3
Lateralized uncinate processus	1	2.3

Table 2. Sensitivity and specificity values for conventional radiograms

Sinus	Number of examined sinuses	CT (+) CR (–)	CT (–) CR (+)	CT (+) CR (+)	CT (–) CR (–)	Sensitivity (%)	Specificity (%)
Maxillary sinus	86	8	3	53	22	86.9	88
Frontal sinus	86	20	3	27	36	57.4	92.3
Ethmoid sinus	86	24	2	47	13	66.2	86.7
Sphenoid sinus	86	15	10	18	43	54.5	81.1
Total sinus	344						
CT abnormal CR normal		19.5%					
Mucosal abnormality on CR			47.4%				
Mucosal abnormality with CT confirmation				42.2%			
Accordance with CT and CR				75.3%			

CR: Conventional radioghrapy; CT: Computed tomography.

endoscopy. Computed tomography results of 26 (87%) of these patients were abnormal. Both CT and endoscopy findings of the remaining four patients were normal. Mucosal changes occurred in paranasal sinuses were not assessed. A correlation of 87% was found between two examinations in patients for whom nasal endoscopy and coronal CT were used as diagnostic tools.

DISCUSSION

Rhinosinusitis is a serious health problem, which is very common. The correct diagnosis of a patient presented with symptoms of rhinosinusitis, and evaluation of etiological and predisposing factors play a key role in the treatment of this common disease. In the past, radiological scanning methods had been widely used as diagnostic tool and today, they are rarely being used. However, the acceptance that the rhinosinusitis diagnosis can be achieved through a correct clinical assessment and using endoscopy, dominates nowadays. Radiological imaging methods are only required in limited number of cases.

Endoscopic surgery of sinuses is a method developed as a result of better understanding of mucociliary clearance and ventilation processes of paranasal sinuses. The aim is to eliminate anatomic disorders and pathologies leading to sinus diseases congesting ostium and causing mucus stasis and local inflammation by inhibiting mucus drainage. Mucosa, which is normal or close to become normal, should be conserved and mucosal excision should be limited only to areas which were affected severely or irreversibly.[1,2]

Infections of the paranasal sinuses generally begin in middle meatus and spread out via frontal recessus.[1,2] The disease in maxillary and frontal sinuses has recovered following small surgery performed in this region.[1-4,19] Today, endoscopic sinus surgery is largely focused on the surgical

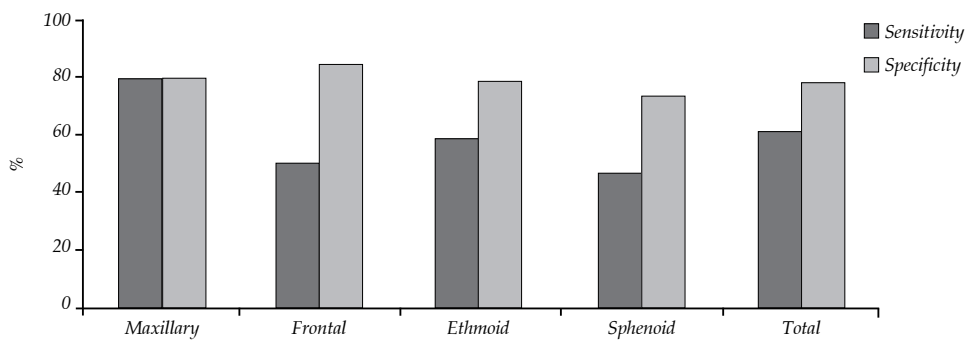

Fig. 1. *Sensitivity and specificity values of conventional radiograms for paranasal sinuses with reference to computed tomography.*

intervention performed in osteomeatal complex and anterior ethmoid region, which play a key role in the pathophysiology of sinusitis.

According to a generally accepted opinion, anatomic variations of the paranasal sinus structures predispose patients to recurrent rhinosinusitis. Therefore, anatomic variations of patients were recorded in our study group. However, no consensus is achieved on the clinical signs and prevalence of these pathologies among researchers in the literature.

The presence of agger nasi cell, median concha, variations of uncinate processus, Haller cell, or deviation of nasal septum were the possible etiologic factors contributing to headache and sinus diseases[5,8,21]

On the other hand Nadas et al.,[22] Lam et al.,[23] and Ünlü et al.[24] found that presence of concha bullosa did not cause mucosal disease in paranasal sinuses. Tonai and Baba[25] also suggested that presence of anatomic variations like agger nasi cell, Haller cells, pneumatisation of middle turbinate, paradoxal middle turbinate, and pneumatisation of uncinate did not show significant difference in patients with chronic sinusitis. In a controlled study, Bolger et al.[8] found no significant difference between the group without sinus disease and the one with chronic sinusitis in the presence of Haller cells, pneumatization of bulla, paradoxal middle turbinate, and pneumatization of middle turbinate.

Since evaluation process included the group of patients who had undergone endoscopic sinus surgery, we could not make a controlled comparison. However, we detected anatomic variations in 74.4% of the patients. In a similar study, this ratio was found to be 73%.[6] Therefore detection of high rates of anatomic variations in patients with chronic sinusitis suggests that it could be considered as an etiologic and predisposing factor but we think that anatomic variation and symptom specific, controlled studies are still required.

According to Lloyd,[11] CT is not necessary for routine examination of sinonasal diseases. Radiological assessment of these patients should begin with CR. However, CT should be used for the evaluation of patients who would undergo endoscopic sinus surgery (ESS).[8] According to Zinreich et al.,[4] Kennedy et al.[21] and Stamberger[26-29] CR was not crucial for the preoperative preparation of patients. In a study conducted by Garcia et al.[16] Waters CR was found to be an acceptable method for baseline evaluation of pediatric chronic sinusitis, but mini-CT appeared to be a better alternative. In confirming clinically significant chronic sinusitis with specifying sites and severity of the disease, mini-CT has closer specifity and sensitivity values to full CT, according to Waters CR. Also it's done with less radiation and more practical evaluation, according to full CT, in accesable centers. Konen et al.,[30] suggested that Waters' view has limited value in the diagnosis of maxillary sinusitis, from a comparative study with CT.

In this study, coronal plane CT of the paranasal sinuses was compared with CR. Sensitivity and specificity of CR were calculated according to the coronal plane paranasal sinus CT. The highest sensitivity was obtained for maxillary sinus as complying with the literature.[6,11,25] The results obtained for ethmoid, frontal and sphenoid sinuses were close to each other. Our values were extremely high when compared to other studies[6,11] However, Roberts et al.,[31] found a correlation of 87% between the CR and CT images of 21 patients with sinusitis. It is believed that correct diagnosis of sinusitis can be made using conventional X-rays, clinical evaluation and an effective endoscopy in 90% of the cases. Roberts et al.[31] recommend not to use CT scanning in patients with sinusitis as it is more expensive and also patients are exposed to high levels of radiation; they suggest keeping CT scanning for cases where no result is obtained from endoscopy or for cases where surgery is the sole choice of treatment.

In paranasal sinus CT scanning of 210 patients with a diagnosis of acute sinusitis, no fluid level, nor opacification in paranasal sinuses were observed in 49 of the patients.[32] Therefore, it is also important in which phase of the disease CT scan is performed. Based on this study we can conclude that CT should not be used if we have no suspect about our clinical diagnosis. However, symptoms of chronic sinusitis may interfere with findings of a systemic disease, so diagnosis of chronic sinusitis is not always as easy to be made as acute sinusitis. The necessity for a good endoscopy is getting more apparent at this stage. Coincidental mucosal changes of paranasal sinuses were also frequently seen in CT scanning[10,31,32] They are particularly more prevalent in pediatric

patients.[32,33] Conventional radioghrapy may be used in pediatric patients with chronic sinusitis and in doubtful acute sinusitis cases considering their easiness in application and the radiation dose to which children would be exposed. Garcia et al.,[16] reported similar findings in their study. In our study pediatric patients' values were not calculated. However, based on the results of similar studies, CR can be used for initial evaluation of chronic sinusitis cases and for acute sinusitis cases where the clinical diagnosis is doubtful.

Conventional radiography allows rapid and noninvasive evaluation of the nasal cavity and paranasal sinuses. It is possible to assess maxillary, frontal, sphenoid, posterior ethmoid sinuses and $^1/_3$ inferior part of the nasal cavity using these techniques. However, these CR are insufficient to evaluate anterior ethmoid cells, frontal recessus and $^2/_3$ superior part of nasal cavity according to our findings and similar studies.[33,34] Due to the superpositioning of the structures and problems experienced for ideal positioning, imaging is usually suboptimal and extension of soft tissue mass and bone destructions are not clearly visualized.[33,34]

Despite these disadvantages, CR should be taken into consideration because of low radiation dose, low cost, its easiness, and rapidity. It can be used as an easy diagnostic tool in doubtful circumstances and for the follow-up of maxillary sinus disease because of their high level of sensitivity. In a study conducted by Saito et al.,[35] postoperative maxillary sinus follow-ups of patients with antrochoanal polyps were performed using CR.

The highest sensitivity was obtained for maxillary sinuses in our study; this finding complied with the literature. However, CR was generally found to be more sensitive for all paranasal sinuses in our study when compared to literature.[6,11]

Anatomic variations such as medially deviated uncinate processus, concha bullosa, paradoxal middle turbinate located at the middle meatus can easily be identified with nasal endoscopy but information on their anatomic details and expansion of the sinus disease can not be obtained.[18,36] Computed tomography and nasal endoscopy are supplementary for each other in preoperative evaluation of patients with chronic sinusitis. Nasal endoscopy is a useful tool to detect the origin of the soft tissue pathology and to plan the surgery, on the other hand, CT scanning allows describing anatomic details and expansion of the sinus diseases. Detailed information about osteomeatal complex and anterior ethmoid cells, which plays a key role in the pathophysiology of chronic sinusitis, can be obtained by CT. Most reliable data on the orbital medial wall and anterior skull base to avoid complications of endoscopic sinus surgery of sinus can be achieved using CT.

In a study conducted with 100 patients, Vining et al.[37] reported that 9% of patients had abnormal endoscopic examination although they had negative CT findings. It was also specified that CT should be preferred to nasal endoscopy in patients with nasal polyposis and allergic rhinitis since its benefit in this group of patients is limited.[37] Researchers as Kennedy et al.[21] and Stammberger[26] emphasized that nasal endoscopy is an important tool in evaluating all the patients with sinonasal complaints. In a study conducted with 50 patients, Nass et al.[38] detected a correlation of 90% between the two methods when CT and endoscopy were used in combination. Our results revealed a correlation of 87% between CT and endoscopy.

Indispensability of nasal endoscopy in preoperative planning and diagnosis is clear. A good endoscopic examination will also reduce unnecessary scanning procedures. White et al.,[10] reported that nasal endoscopy performed prior to CT could reduce unnecessary CT demand.

In conclusions, *(i)* maxillary and frontal sinus diseases were not observed at the same side when no endoscopic abnormality at the anterior ethmoid region or at the infundibulum was detected. Same site abnormalities of the frontal or maxillary sinuses were detected at the left side in 74.4% of the patients and at the right side in 67.4% of the patients when a mucosal abnormality was observed at the anterior ethmoid region or at the infundibulum. *(ii)* Anatomic variations on CT evaluations are found in 74.4% of the patients with chronic decompensated rhinosinusitis showed anatomic variations on CT evaluations. Most common anatomic variations included deviation of septum (39.5%), paradoxal middle turbinate (16.3%), concha bullosa (14.0%), and large ethmoid bulla (11.6%). Anatomic variations of nasal and paranasal sinuses can be considered as an etiological and predisposing factor in patients with chronic sinusitis. *(iii)* The correlation between CR and CT was found to be 75.3%.

Highest correlation level of 87% was obtained for maxillary sinuses. In this context, CR should not be used alone in pre-operative assessment; they can only be used alone for the diagnosis and follow-ups of maxillary sinus diseases. *(iv)* A correlation of 87% was found between coronal CT and nasal endoscopy. Performing nasal endoscopy before CT may reduce unnecessary CT scanning. The use of CT for diagnostic purposes is unnecessary.

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