DIAGNOSTIC ACCURACY OF ULTRASONOGRAPHY IN DIAGNOSING MAXILLARY SINUSITIS

Yasar Shakeel, Muhammad Asad Khan*, Rashid Mehmood**

Combined Military Hospital Bannu Pakistan, *Combined Military Hospital/National University of Medical Sciences (NUMS) Rawalpindi Pakistan, **Combined Military Hospital Peshawar Pakistan

ABSTRACT

Objective: To determine the diagnostic accuracy of ultrasonography in diagnosing maxillary sinusitis while keeping magnetic resonance imaging as gold standard.

Study Design: Cross sectional, validation study.

Place and Duration of Study: Radiology Department Combined Military Hospital Rawalpindi, from Mar 2014 to Sep 2014.

Material and Methods: Consenting three hundred and ninety one patients diagnosed clinically as a case of maxillary sinusitis at Combined Military Hospital Rawalpindi during the study period fitting the inclusion criteria were selected. Ultrasonography of maxillary sinuses focusing on mucosal thickening, fluid level and cyst or polyp was done for all patients. After ultrasonography all patients underwent MRI at our department to look for mucosal thickening, fluid levels and total opacity appearing hyperintense on T2 weighted sequence. Diagnostic accuracy of ultrasonography was evaluated in diagnosis of maxillary sinusitis.

Results: The sensitivity of Ultrasonography in diagnosis of maxillary sinusitis keeping MRI as Gold Standard was quite low at 40.15%. The ability (specificity) of Ultrasonography in diagnosis of maxillary sinusitis taking MRI as Gold Standard was good i.e. 84.67%. The diagnostic accuracy was encouraging at 55.75%.

Conclusion: Ultrasonography had low sensitivity but high specificity in diagnosis of maxillary sinusitis.

Keywords: Diagnostic accuracy, Maxillary sinusitis, Magnetic resonance imaging, Ultrasonography.

INTRODUCTION

Maxillary sinusitis is one of the most frequently encountered conditions in the primary health care units[1] with a prevalence of 16% in Pakistan[2]. The diagnosis of maxillary sinusitis is difficult on the basis of clinical examination alone because of the nonspecific symptoms it presents, which are very similar to those of common cold[3].

First line investigation most commonly used in the diagnosis of maxillary sinusitis is plain film radiography which exposes the patient to radiation[4]. An alternative to plain film radiography is B-Mode ultrasonography of the maxillary sinus which is usually readily available in primary health care units, spares ionizing radiation exposure to vital organs such as lens of

eyes and gonads and is safe to use especially in pregnant women and children[5]. Other investigations used in the diagnosis of maxillary sinusitis are Computed Tomography scan and Magnetic Resonance Imaging[6] of which MRI is considered superior because of its better soft tissue contrast and is considered investigation of choice at present in detecting the changes on the mucosal surface of maxillary sinuses[7].

A lot of work has been done on the subject locally[8] (Sensitivity 35.89% specificity 80.95%) and internationally[9] (Sensitivity 64% specificity 95%) but the results have been extremely variable due to methodological variation and absence of exact criterion for diagnosing maxillary sinusitis on ultrasound, hence the status of ultrasonography in diagnosing maxillary sinusitis remains unestablished to date. Secondly no study has been done locally which compares the accuracy of ultrasonography with MRI. The presence of mucosal thickening and fluid

Correspondence: Dr Yasar Shakeel, Radiology Department, Combined Military Hospital Bannu Pakistan

Email: yasirshakeel@hotmail.com

collection on ultrasound examination will signify maxillary sinusitis.

Ultrasonography equipment is widely available in primary and tertiary care setups of Pakistan but physicians are reluctant to use this as a tool in diagnosing maxillary sinusitis, so the potential of this modality is not adequately exploited in Pakistan. Secondly it is difficult to differentiate between common cold and maxillary sinusitis clinically, which exposes a lot of patients to unnecessary anti biotic treatment for common viral infections. Considering the ever increasing rate of anti-microbial resistance if maxillary sinusitis can be diagnosed using a simple tool like ultrasonography, unjudicial use of antibiotics can be greatly reduced. Given the evident advantages of ultrasonography in terms of cost and availability and keeping in view the safety issues especially the cumulative effect of ionizing radiation on the lens of the eye and subsequent development of cataract in plain film radiography of paranasal sinuses, it seemed prudent to look for the accuracy of ultrasonography for the diagnosis of maxillary sinusitis.

PATIENTS AND METHODS

It was a cross sectional, validation study. The study was carried out at Combined Military Hospital, Rawalpindi between 15th March 2014 to 15th September 2014 in collaboration with ENT department, CMH Rawalpindi. 391 patients were included in the study after calculating the sample size using WHO calculator for sample size keeping a prevalence of maxillary sinusitis at 16%. Non Probable, purposive sampling was done.

All patients above the age of 6 years and clinical symptoms suggesting maxillary sinusitis including headache, rhinorrhea, post nasal drip with or without fever (Temp>38°) were included in the study. Patents having deformities of maxillary sinuses secondary to congenital conditions and trauma were excluded. Inability to perform ultrasound and MRI on the same day and contraindications to MRI e.g. claustrophobia,

metallic implants were also a part of exclusion criterion.

Patients who presented with clinical features of maxillary sinusitis in Department of E.N.T and met the inclusion criteria of this study were identified and after obtaining written informed consent, ultrasound and MRI of the maxillary sinuses were performed in Radiology Department CMH Rawalpindi by two radiologists simultaneously in order to exclude the inter operator bias. Each patient was explained the procedure and protocol of the ultrasound of the maxillary sinus and was delivered all relevant instructions as regards the preparation for the examination. During the examination, the patient was made to sit on the couch with the head in slightly flexed position so that an imaginary line passing from external auditory canal and lower margin of the orbit is horizontal to the ground plane. A linear array transducer of 7.5 MHz of Toshiba Aplio was placed on the maxillary sinus lateral to the nose in a transverse position. Starting from the bottom of the sinus the entire maxillary sinus was carefully examined by obtaining readings after every 0.5 cm horizontal or vertical move.

Readings were documented and the patients were shifted to MRI on the same day. T1 and T2 weighted coronal, sagittal and axial images were taken using PhilipsIngenia 1.5 Tesla MRI scanner. Sonographic findings were correlated with the findings of MRI.

The data was analyzed in SPSS version 17.0. Mean and standard deviation for age and frequency percentages for gender and clinical symptoms and signs were calculated. A 2x2 table was used to determine the diagnostic accuracy in terms of Sensitivity, Specificity, Positive predictive value and Negative predictive value keeping MRI as gold standard.

RESULTS

The present validation study consisted of patients of Maxillary Sinusitis diagnosed on clinical findings and were further tested for confirmation by ultrasonography and Magnetic

resonance imaging to find out sensitivity, specificity, positive predictive value and negative predictive value of Ultrasonography for the detection of Maxillary Sinusitis keeping Magnetic resonance imaging as gold standard. These patients had a mean age of 31.68 with standard deviation of 6.24 years. The minimum age in the sample was 15 years and maximum was 50 years. There were 310 (79.49%) males and 81 (20.51%)

fluid and 13 patients (10.56%) having cyst or polyp in right, left or both maxillary sinuses respectively (fig-1). MRI showed 137 (35.03%) patients as having normal maxillary sinuses. 254 (64.96%) patients had positive findings of which 174 (68.50%) had mucosal thickening, 55 (21.65%) had total opacity and 25 (9.84%) had air fluid level (fig-2). Fig-3 shows that 21 (5.37%) patients who were negative on MRI (gold standard)
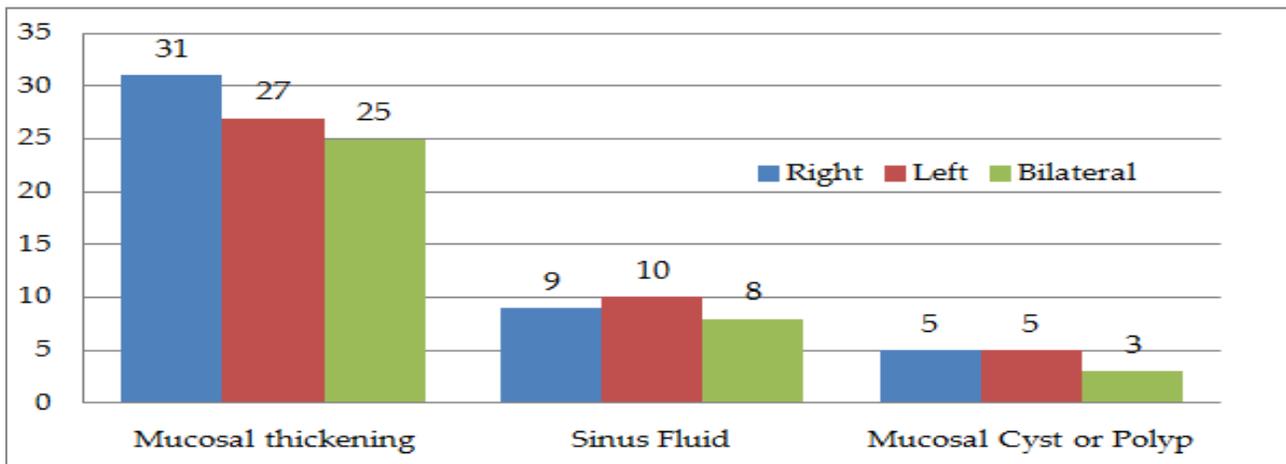

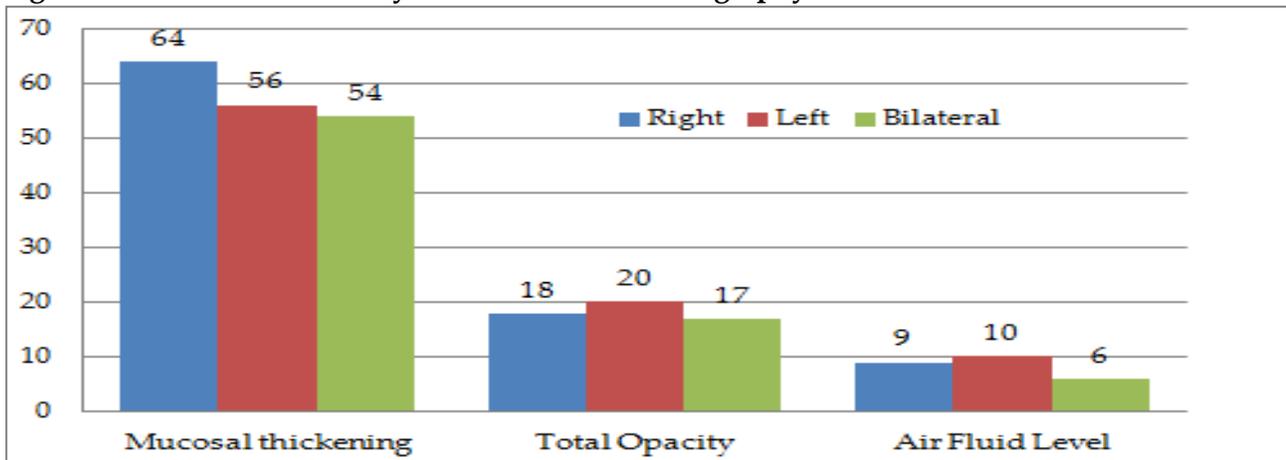Figure-1: Patterns of Maxillary Sinusitis on Ultrasonography.

Figure-2: Patterns of Maxillary Sinusitis on MRI.

females in the study. On Ultrasonography 268 (68.54%) patients didn't reveal any positive findings. About 123 (31.45%) patients had positive findings of which 83 (70.73%) patients were having right, left or bilateral mucosal thickening alone making it the most common finding in ultrasound positive cases. It was followed by 27 (21.95%) patients having sinus

were positive on Ultrasound findings (false positive) and 152 (32.87%) patients who were positive on MRI were negatively diagnosed by ultrasonography (false negative).

Fig-4 shows the results in terms of true positive, false positive, false negative and true negative. The distribution shows that the highest frequency was of false negative 152 (32.87%)

results i.e. the patients who were positive on gold standard (MRI) our test (Ultrasonography) diagnosed them as negative. Similarly, 2nd frequent result was true negative 116 (29.66%) i.e. the patients who diagnosed as negative by the test were also found negative on gold standard.

The Calculation of Sensitivity of Ultrasonography in diagnosis of Maxillary

The overall accuracy of the Ultrasonography in diagnosis of Maxillary Sinusitis taking MRI as Gold Standard is 55.75%.

DISCUSSION

Maxillary sinusitis is one of the most frequently encountered conditions in the primary health care units[2] with a prevalence of 16% in Pakistan[1] and leading cause of outpatient
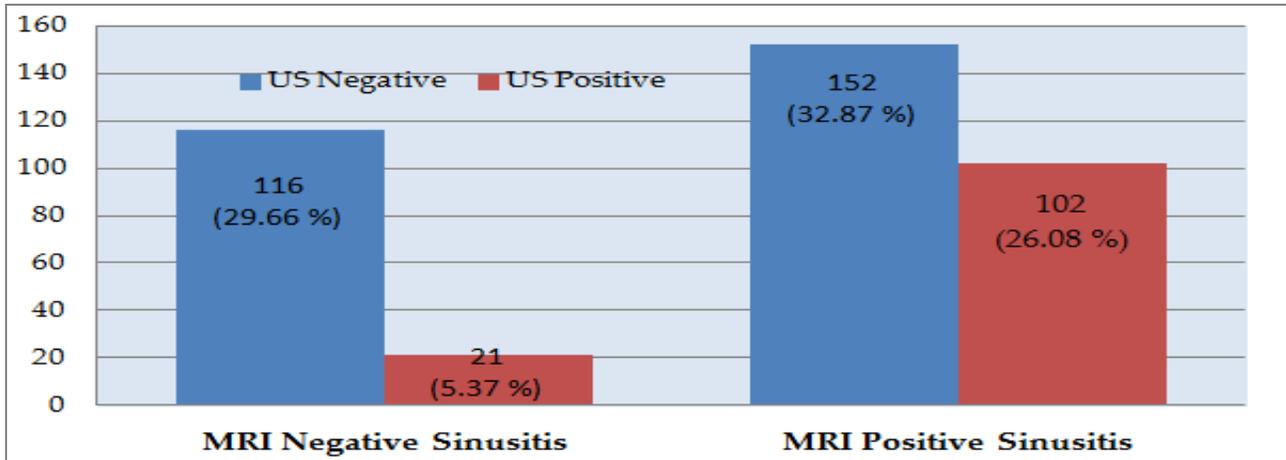

Figure-3: Comparison of results of Ultrasound with MRI.
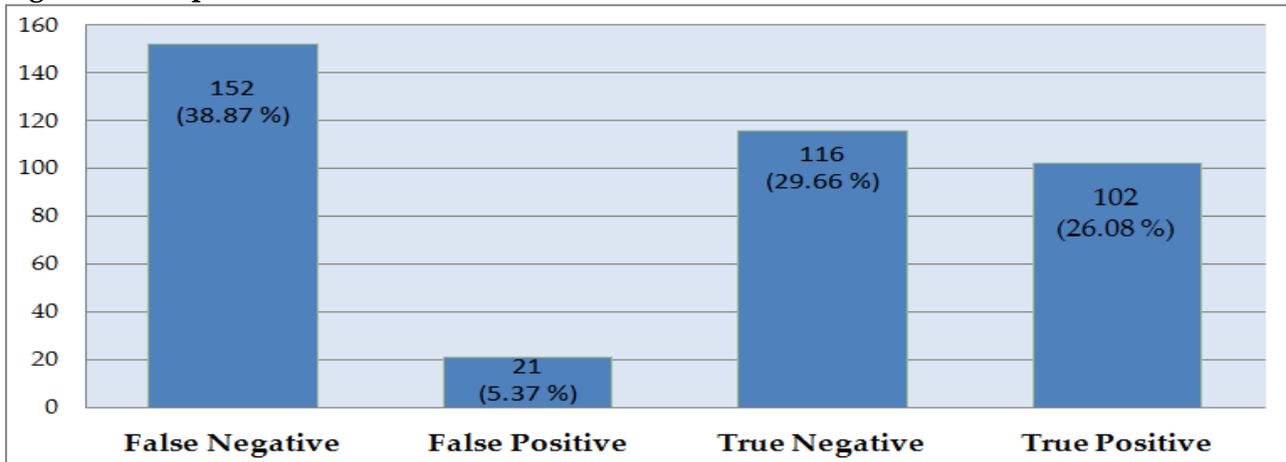

Figure-4: Distribution of Results.

Sinusitis taking MRI as Gold Standard shows that the sensitivity is low at 40.15%. Specificity of ultrasonography in diagnosis of Maxillary Sinusitis taking MRI as Gold Standard was good enoughthough i.e. 84.67%. Positive predictive value and Negative predictive value of Ultrasonography in diagnosis of Maxillary Sinusitis taking MRI as Gold Standard were 82.92% and 43.28% respectively (table).

workload and disposal. Despite the diversity of the problem, the exact pathophysiology of this disease still eludes the scientific world. Three factors, however, appear vital for the normal physiologic functioning of the sinuses: patency of the osteo meatal complex, normal mucociliary transport and normal quantity and quality of secretions. Interference in one or more of these factors can predispose to sinus infection.

In every day practice sinusitis is usually diagnosed on the basis of symptoms and signs, resulting in an incidence of 21 to 25 episodes per 1000 listed patients per year[10]. Radiography is used in 14% of episodes and referrals occur in 7%. Fever, a preceding upper respiratory tract infection, (unilateral) purulent rhinorrhea and unilateral maxillary pain are considered to be essential for diagnosis. Cacosmia and purulent secretions from the antral ostium have a strong predictive value.

Five methods are available to us for diagnosing maxillary sinusitis objectively: radiography, computed tomography, magnetic resonance imaging, ultrasonography, and invasive procedures. Of these methods, only

more sensitive than plain radiographs in discriminating of fluid from thickened mucosa. Recent studies which compare ultrasonography and CT suggest possible applications of ultrasonography in emergency patients, children, and pregnant women. However, ultrasonography generally limits itself to "accessible" sinus regions. The representation of disease in the maxillary sinuses is limited, and displays of the other sinuses are of limited value. Although one reason for the difference in trial results could be the differences in equipment and/or technique used, the widely varying data as well as the display provided by ultrasonography preclude this technique as a preferred method for sinus imaging. Recently, therapeutic ultrasound was

Table: Calculation of Sensitivity of Ultrasonography in diagnosis of Maxillary Sinusitis taking MRIas Gold Standard.

Test result		Sinusitis on MRI		
		Positive	Negative	Total
Sinusitis on ultrasound	Positive	TP= 102	FP=21	123
	Negative	FN = 152	TN = 116	268
	Total	254	137	391

ultrasonography is suitable for repeated use in general practice as part of a study. It does not affect the course of sinusitis and is considered ethical in healthy patients as it does not expose to ionizing radiations.

From a theoretical perspective, A-mode (amplitude) and, more recently, B-mode (brightness) ultrasonography has potential value in the evaluation of the nasal and paranasal sinuses. Ultrasonography is based on the principle that ultrasound waves are reflected at the boundary of two media with differing acoustic characteristics. If the sinus contains fluid, an echo will be reflected from the posterior wall of the sinus. If the sinus is normally aerated, the sound will totally be reflected at the anterior sinus wall. Some studies have shown that the diagnostic value of ultrasonography closes to that of plain film evaluation, although a wide range of sensitivities (from 29-100%) and specificities (27–98%) have been published by several authors. Other studies describe ultrasonography as being

reported as a possible treatment for chronic sinusitis[11].

In this study I determined the diagnostic accuracy of ultrasonography in diagnosis of maxillary sinusitis as compared to MRI. The age and gender distribution of sinusitis patients has been studied.

In a study done by Hansen et al[12] to predict acute maxillary sinusitis in a general practice population they found that the median age was 35 years and 70% were females. Main symptoms and signs of sinusitis were nasal congestion 73%, cough 62%, maxillary pain 87% and purulent nasal discharge in 29%.

My study also validates some of these statistics. Mean age in my study was 31.68 years but there was a male predominance i.e. 79.48%. Male predominance is seen because majority of my patients were serving military persons.

Raza et al estimated the sensitivity and specificity of ultrasonography compared to that

of antral lavage at our set up. The sensitivity and specificity came out to be 35.89% and 80.95% respectively[8]. My results are slightly encouraging when compared with a sensitivity of 40.15% and specificity 84.67% probably owing to latest equipment and continuing expertise in diagnosing maxillary sinusitis.

Haapaniemi et al[13] compared the sensitivity and specificity of ultrasonography in diagnosis of maxillary sinusitis as compared to antral lavage. The sensitivity of USG examination to find maxillary sinus secretion was 77% and the specificity 49%.

Risavi et al[14] found that Ultrasonography can be used as a diagnostic method in the early diagnosis of sinus diseases. Compared to radiographic and sinusoscopic findings, it shows a high agreement in negative and positive findings, i.e. a high sensitivity and specificity. In comparison to sinusoscopic examination, sensitivity of ultrasonography was 93% and specificity 74%. In my study the sensitivity was quite low i.e. 40 in comparison with this study.

Savolainen et al[15] found that USG and radiology were similarly reliable in diagnosing fluid retention and sinusitis, when the results are compared with the findings of the sinus puncture.

Lichtenstein et al[16] found that Ultrasound may be proposed as first-line investigation in diagnosis of radiological maxillary sinusitis.

Peng et al[17] found that the diagnostic A mode ultrasound of sinus has higher accuracy; the control is easy, the cost is relatively lower, it can be used repeatedly and do no harm to the patient's health. It is a good method and assistant technique in the diagnosis of frontal and maxillary sinus disease.

Savolainen et al[18] found that both USG and radiology were similarly reliable in diagnosing fluid retention and sinusitis, when the results are compared with the findings of the sinus puncture. USG and radiology gave false positive findings almost equally (*p*>0.05). On the other

hand, when the volume of secretion was less (<1 ml), US gave a fluid echo finding more often than radiology showed fluid retention.

Varonen et al[19] found that antibiotics hasten symptom relief in AMS. Yet many patients recover in 2 weeks without antimicrobial treatment. Only half of patients with a clinical diagnosis of AMS have sinusitis on ultrasound examination. Furthermore it was found that symptoms and clinical examination were not reliable in AMS diagnosis. If the criterion for AMS diagnosis is to be fluid in maxillary sinuses in ultrasound instead of clinical impression, the number of antibiotic prescriptions would be reduced by half in primary care[21].

Puhakka et al[9] found that the high specificity of ultrasonography shows that a positive ultrasound finding can be considered as evidence of maxillary sinusitis. The addition of plain-film radiography in cases of negative ultrasound findings increases the diagnostic sensitivity to clinically acceptable levels without loss in specificity. Active use of ultrasonography would substantially decrease the need for radiological imaging of the sinuses and also help reduce unnecessary antibiotic treatment in primary care. The sensitivity of ultrasonography for detection of maxillary sinusitis was 64% (specificity, 95%).

Kaups et al[21] found that sinus ultrasound is a simple, efficient method for determining the presence of maxillary sinus fluid in setting of a surgical intensive care unit.

In my study sensitivity of USG is found to be quite low, while specificity is relatively high. Low sensitivity is mainly due to the fact that USG is an operator dependent procedure. As USG is not commonly used for the detection of sinusitis in our setup, so the radiologists are not fully confident in making the diagnosis. If employed regularly USG can become a very useful tool for the diagnosis of maxillary sinusitis.

CONCLUSION

Sinusitis is quite a common disease. With a variety of investigations available for detection

of sinusitis, this study demonstrated that USG has low sensitivity but has high specificity. While my study has shown that USG has quite a low sensitivity, further research is warrant to evaluate the sensitivity of USG in the hands of expert radiologists.

CONFLICT OF INTEREST

This study has no conflict of interest to declare by any author.

REFERENCES

1. Iseh KR, Makusidi M. Rhinosinusitis: A retrospective analysis of clinical pattern and outcome in north western Nigeria. Ann Afr Med 2010; 9(1): 20-6.
2. Khan S, Hannan A, Usmanghani K, Uddin S, Nazar H, Mohiuddin E, et al. Sinusitis Review. J Med Plants Res 2011; 5(24): 5649-57.
3. Fufezan O, Asavoaie C, Panta PC, Mihuț G, Bursaşiu E, Anca I, et al. The role of ultrasonography in the evaluation of maxillary sinusitis in pediatrics. Med Ultrason 2010; 12(1): 4-11.
4. Maestre FL, Galán GS, Carrillo GC, Peñarrocha DM. Radiographic findings in the maxillary sinus: comparison of panoramic radiography with computed tomography. Int J Oral Maxillofac Implants 2011; 26(2): 341-6.
5. Teppo H, Revonta M. Ultrasound device helps in ruling out maxillary sinus fluid in acute rhinosinusitis: How we do it. Clin Otolaryngol 2011; 36(5): 491-4.
6. Olwoch IP. Microbiology of acute complicated bacterial sinusitis at the University of the Witwatersrand. S Afr Med J 2010; 100(8): 529-33.
7. Adil R, Qayyum A, Qayyum A. Correlation of X-rays and computed tomography in paranasal sinus diseases. Pak Armed Forces Med J 2011; 61(3): 413-7.
8. Raza M, Tahir M, Zubair M, Kundi NA. Sensitivity and specificity of ultrasonography in diagnosis of maxillary sinusitis as compared to antral lavage. Pak Armed Forces Med J 2012; 62(3): 423-7.
9. Puhakka T, Heikkinen T, Mäkelä MJ, Alanen A, Kallio T, Korsoff L, et al. Validity of ultrasonography in diagnosis of acute maxillary sinusitis. Arch Otolaryngol Head Neck Surg 2000; 126(12): 1482-6.
10. N P van Duijn, H J Brouwer, H Lamberts. Use of symptoms and signs to diagnose maxillary sinusitis in general practice: comparison with ultrasonigraphy. BMJ 1992; 305: 684-7.
11. Ansari NN, Naghdi S, Farhadi M, Jalaie S. A preliminary study into the effect of low-intensity pulsed ultrasound on chronic maxillary and frontal sinusitis. Physiother Theory Pract 2007; 23(4): 211-8.
12. Jens GH, Henrik S, Join R, Elisabeth L. Predicting acute maxillary sinusitis in a general practice population. BMJ 1995; 311: 233-5.
13. Haapaniemi J, Laurikainen E. Ultrasound and antral lavage in the examination of maxillary sinuses. Rhinology 2001; 39(1): 39-42.
14. Risavi R,Klapan I, Barcan T,Simović S. Effectiveness of ultrasonography in diagnosis of maxillary sinus disease: A prospective comparison with radiographic and sinusoscopic examination. Croat Med J 1998; 39(1): 45-8.
15. Savolainen S, Pietola M, Kiukaanniemi H, Lappalainen E, Salminen M, Mikkonen P. An ultrasound device in the diagnosis of acute maxillary sinusitis. Acta Otolaryngol Suppl 1997; 529: 148-52.
16. Lichtenstein D, Biderman P, Mezière G, Gepner A. The "sinusogram", a real-time ultrasound sign of maxillary sinusitis. Intensive Care Med 1998; 24(10): 1057-61.
17. Peng J, Cai X, Gong J, Zou H, Chen Q. Use of diagnostic ultrasound of sinus in the paranasal sinus disease. Lin Chuang Er Bi Yan HouKeZaZhi 1999; 13(2): 81-2.
18. Savolainen S, Pietola M, Kiukaanniemi H, Lappalainen E, Salminen M, Mikkonen P. An ultrasound device in the diagnosis of acute maxillary sinusitis. Acta Otolaryngol Suppl 1997; 529: 148-52.
19. Varonen H, Kunnamo I, Savolainen S, Mäkelä M, Revonta M, Ruotsalainen J. Treatment of acute rhinosinusitis diagnosed by clinical criteria or ultrasound in primary care. A placebo-controlled randomised trial. Scand J Prim Health Care 2003; 21(2): 121-6.
20. Varonen H, Savolainen S, Kunnamo I, Heikkinen R, Revonta M. Acute rhinosinusitis in primary care: a comparison of symptoms, signs, ultrasound, and radiography. Rhinology 2003; 41(1): 37-43.
21. Kaups KL, Cohn SM, Nageris B, Lavelle WG. Maxillary sinusitis in the surgical intensive care unit: A study using bedside sinus ultrasound. Am J Otolaryngol 1995; 16(1): 24-8.

....