Accuracy of ultrasound versus computed tomography in diagnosis of maxillary sinusitis

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Summary:
Background: ultrasound offers non-invasive, rapid and simple method for confirming the clinical diagnosis of maxillary sinus pathologies.
Objective: to evaluate the accuracy of real time ultrasound compared with the computed tomography in evaluation of maxillary sinusitis.
Patients and materials: This comparative cross-sectional study was done on 42 patients referred for computed tomography examination of paranasal sinuses in Al-Yarmook Teaching Hospital-Baghdad, from October 2012 to February 2013 with patients clinically suggesting an underlying maxillary sinusitis. Ultrasound and computed tomography examinations were carried out on the same day, the ultrasound being the first investigation. The sample of this study consisted of 26 men and 16 women. The age of patients ranged between 20-60 years, mean age equal to 38 years. Our patients were randomly selected.
Results: The results are based on the data analysis of total forty two [84 sinuses] patients with symptoms and/or signs of maxillary sinus diseases. In this study, real time B-mode ultrasonography of maxillary compared with computed tomography had a 81.8% sensitivity, 100 % specificity and 90.4% accuracy. The present study showed that total opacity of the maxillary sinus on computed tomography frequently gave a positive full sinus scan [77.7%] while the rest shows partial sinus scan [22.3%]. All patients with positive full sinus scan on ultrasound of maxillary sinuses have total opacity on computed tomography.
Conclusion: Ultrasound can help as one of primary investigations of maxillary sinusitis. A positive full sinus scan appeared specific for total opacity of the maxillary sinus on computed tomography. A postural adjustment of the patient slightly bent foreword reduces the false negative results.
Key words: ultrasound, computed tomography, maxillary sinus.

Introduction:

Diagnosis of maxillary sinus abnormality is not always simple and various opinions on the accuracy of the current diagnostic methods have been presented.[1] Ultrasound as a diagnostic aid in the evaluation of the sinuses has been a controversial issue; however, the sonographic diagnosis of sinus abnormalities has been studied, and a wide range of sensitivities and specificities for the diagnosis of sinus disorders by ultrasound has been reported. Sensitivities have been reported from 29% to 100% and specificities from 55% to 99%. [2, 3] In general, the ultrasound of maxillary sinus is based on physical characteristics of ultrasound waves, which penetrate easily through fluid, but not through the air. Hence, fluid or mass in maxillary sinus enables ultrasound waves to travel through it, create an echo at bony posterior wall and travel back to the source of ultrasound device. In air-filled cavity, no back wall echoes are created.[4] Computed tomography considers as "gold standard" in imaging recurrent and chronic rhinosinusitis. CT is perfect for demonstrating the complex bony paranasal sinus anatomy with its variants as well as the localization and extent of soft the tissue masses. Further, during functional endoscopic sinus surgery (FESS), the coronal or multiplanar CT is used as a bony map. Imaging rhinosinusitis without suspected complications, no intravenous contrast medium is needed.[5]The goal of the present study was to investigate the usefulness and efficacy of diagnostic ultrasound in the diagnosis of maxillary sinusitis in comparison with computed tomography findings.

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Patients and Methods:

This comparative cross-sectional study enrolled 42 patients referred for computed tomography examination of paranasal sinuses in Al-Yarmook Teaching Hospital-Baghdad, from October 2012 to February 2013 with patients clinically suggesting an underlying sinus disease. The sample of this study consisted of 26 men and 16 women. The age of patients ranged between 20-60 years, mean age equal to 38 years and our patients were randomly selected.The including criteria were represented by symptoms and signs suggesting sinonasal pathology (pain in sinuses/forehead, nasal obstruction, rhinorrhea, cough, fever, nasal speech, headache, facial tenderness and postnasal drip). The excluding criteria were anomalies of the maxillary sinuses

(such as a previously diagnosed as sinus hypoplasia), facial trauma, post-operative sinus and pregnant woman.Initially the patient's history, symptoms and signs are recorded then the ultrasound examination was performed and interpreted by two board-certified radiologist who was unaware of the computed tomography results after that the computed tomography examination was interpreted by another observer (senior on call). Both imaging methods were carried out on the same day, the ultrasound being the first examination.The ultrasound examination was performed by Philips HD 11 ultrasound machine with curvilinear transducer of 3.5 MHz. The examination carried out with the patient in a sitting position with his head slightly bent forward. The transducer was placed in a transverse view, under the orbit and lateral to the nose. The time allocated for ultrasound examination was not more than one minute for each sinus. Ultrasound findings are classified into two categories:

Normal study (negative sinus scan); where, the sonographic appearance of a normal maxillary sinus is given by the reverberation of the sound waves due to the presence of air in the sinuses. ***Abnormal study (positive sinus scan)***; where, the visualization of the hypoechoic sinus cavity delineated by hyperechoic lateral and/or posterior walls. Which is further subdivided into two patterns: *Full sinus scan*; defined as complete visualization of the internal, external and posterior walls of the maxillary sinus. *Partial sinus scan*; defined as incomplete visualization of whole maxillary sinus walls. Computed tomography was performed using a Siemens multidetector - 64 slices machine (Somatom Definition) on the day of ultrasound examination, in the supine position. Consecutive 1 mm slices including the paranasal sinuses from the hard palate to the orbit parallel to the orbitomeatal plane were performed. Abnormal maxillary sinus findings are recorded like mucosal thickening, partial and complete opacification, fluid level, cysts and polyps or soft tissue masses. All patients were examined in our study without the administration of intravenous contrast medium. After the data collection, the statistical analysis was performed; the sensitivity, specificity and accuracy of ultrasound compared to the computed tomography were calculated.

Results:

The results presented in this section are based on the data analysis of total forty two [84 sinuses] patients with symptoms and/or signs of maxillary sinus diseases. From the 42 patients included in this study who were referred to ultrasound and computed tomography examinations of maxillary sinuses, 16 were females and 26 were males. The age of patients ranged between 20-60 years, mean age equal to 38 years.

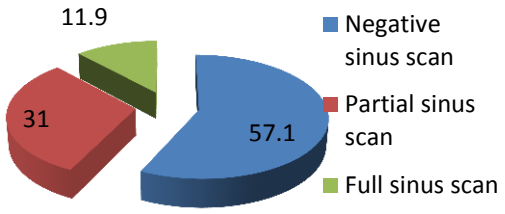

Figure (1) shows ultrasound findings of maxillary sinus examination.

Table (1) shows computed tomography findings of maxillary sinus examination.

Computed tomography findings	Number (n=84)	%
Normal	40	47.6
Mucosal thickening	14	16.7
Fluid level	14	16.7
Total opacity	9	10.7
Cyst	4	4.8
Soft tissue mass	3	3.5
Total	84	100

Table (2) shows comparison between computed tomography and ultrasound findings.

Computed tomography findings	Ultrasound findings			
	Negative sinus scan	Partial sinus scan	Complete sinus scan	Total (n=84)
Normal	40	0	0	40
Mucosal thickening	4	10	0	14
Fluid level	2	12	0	14
Cyst	2	2	0	4
Soft tissue mass	0	0	3	3
Total opacity	0	2	7	9
Total (n=84)	48	26	10	84

Table (3) Value of a full sinus scan for the diagnosis of total opacity of the maxillary sinus

Computed tomography/ Ultrasound	Absence of total opacity of the maxillary sinus on CT	Total opacity of the maxillary sinus on CT	Total
Full sinus scan	3	7	10
Partial sinus scan	24	2	26
Total	27	9	36

Table (4) shows value of ultrasound in diagnosis of maxillary sinusitis.

Computed tomography/ Ultrasound	Positive computed tomography findings	Negative computed tomography findings	Total
Positive ultrasound findings	36	0	36
Negative ultrasound findings	8	40	48
Total	44	40	84

Sensitivity of ultrasound= **81.8%**, Specificity of ultrasound= **100%,** Accuracy of ultrasound= **90.4%**

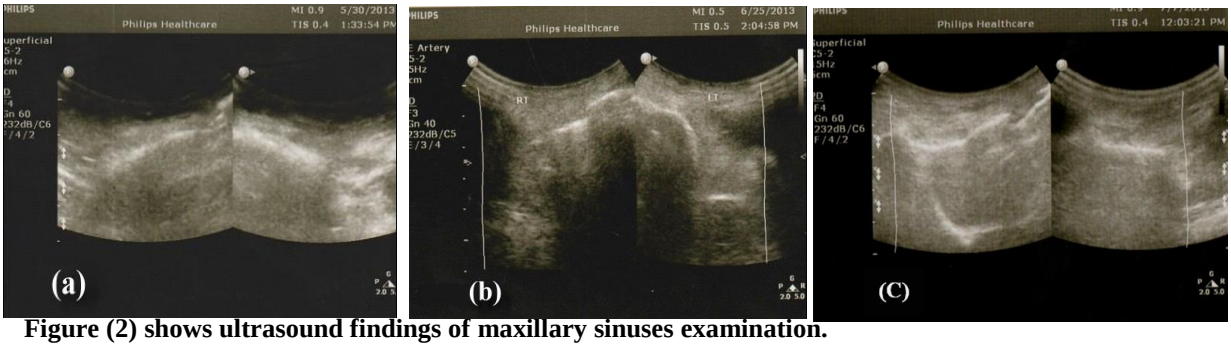

Figure (2) shows ultrasound findings of maxillary sinuses examination.

(a) A 27 years old man presented with headache, suspected having maxillary sinusitis, ultrasound examination reveals negative sinus scan, which is proved by computed tomography. **(b)** A 31 years old woman presented with nasal obstruction, suspected having maxillary sinusitis, ultrasound examination reveals positive partial sinus scan on the left side, proved as polyp on computed tomography. Right sinus reveals negative sinus scan. **(c)** A 47 years old man presented with nasal obstruction and post nasal drip, suspected having maxillary sinus pathology. Ultrasound examination reveals negative sinus scan on the left and positive full sinus scan on the right, proved as total opacity on computed tomography [antrocoanal polyp].

Figure (3). Shows a patient in sitting position and slightly bent forward and ultrasound transducer is in transverse position.

Discussions:

Computed tomography considered the gold standard in the diagnosis of sinusitis but there are authors who regard as that this radiation exposing imaging technique should be considered only in certain situations: recurrent sinusitis, chronic sinusitis and no response to therapy. [6]Accurate diagnosis of maxillary Sinus disease is difficult on the basis of clinical examination only because the signs and symptoms are non-specific, so we need a simple ,non-invasive, rapid, safe inexpensive and readily available , method for diagnosing maxillary sinus diseases therefore the ultrasonography could be used as a first-line investigation for the diagnosis of maxillary sinus pathology.There are relatively few studies in literature evaluating the role of ultrasonography in the diagnosis of maxillary sinus diseases. One dimension A-mode or two dimensions B-mode were used to evaluate maxillary sinuses.In this study real time B-mode ultrasonography compared with computed tomography had a 81.8% sensitivity, 100 % specificity and 90.4% accuracy while in other study performed on 56 adult patients, with a clinical and/or radiological diagnosis of acute maxillary sinusitis, a sensitivity of 66.7% and a specificity of 94.9 % of the ultrasound compared with computed tomography was detected.[7] Happaviemi et al detected a 77 % sensitivity and a 49% specificity of the ultrasound in study published in 2001 that evaluated 209 maxillary sinuses, the authors compared ultrasonography with maxillary antral lavage.[8] Abd Alameer et al show the sensitivity, specificity and accuracy of ultrasound of maxillary sinuses in comparison to plain radiography and diagnostic antral washout were 92.5%, 55.4% and 73.4% respectively.[9] There is wide variation in sensitivities, specificities and accuracy of ultrasound mostly resulting from using different types of ultrasound modes, these previous studies generally used A-mode type while in our study we used B-mode real time ultrasonography because of real-time offers basic advantages over A-mode; the A-mode may appear complicated, whereas real time allows solid visualization of the opacified sinus.We defined the term "sinus scan" (sinus ultrasound) this way: a "sinus scan" is ***full*** when the internal, external and posterior walls of the sinus are visualized and ***partial*** when these walls are just partially visible. The "sinus scan" was correlated with the computed tomography's findings. Therefore, the positive sinus scan was present in 36 of the 44 computed tomography positive maxillary sinuses findings.The present study showed that total opacity of the maxillary sinus on computed tomography frequently gave a positive full sinus scan [77.7%] while the rest shows partial sinus scan [22.3%]; in contrast to results obtained from Lichtenstein D et al study that reveals 100% correlation between full sinus on real time sonography scan and total opacity on computed tomography.[3] This is may be explained by difference of effectiveness of ultrasound device with sector transducer that used by mentioned author from that with curvilinear transducer as in our work as well as the experience limitations; therefore, for all new procedures it is usual to consider the level of expertise necessary to perform the procedure. In

partial sinus scan, could not distinguish total opacity from substantial mucosal thickening in routine supine position until further improvements of the technique in this study based on sitting position with slight bending foreword maneuver, a partial sinus scan should logically lead to confirmation of maxillary sinusitis by means of CT. This study shows that, in the case of partial sinus scan, an immediate postural change compared with CT could improve the diagnosis of maxillary sinus pathologies; however, we obtained eight false-negative results. The screening of these eighth false-negative results showed that there were both a small air-fluid level and posteriorly located mucosal thickening which are cannot be detected even after sitting position maneuver . Our study shows 81.8% sensitivity for detection of total opacity by ultrasound examination in comparison with computed tomography while in Lichtenstein D et al study the sensitivity was only 70%.[3]In this study about 22.2 % of the cases of total opacity gave a partial sinus scan whereas the 52% of the cases gave a partial sinus scan in Lichtenstein D (ed).[10] This is explained by the position of the patient in the former was sitting while in the latter was supine; however, In these cases, small air bubbles visible at the front wall on CT may explain the degradation of the ultrasound signal. The ultrasound acoustic barrier could not distinguish air-fluid level from normal sinus. This may appear logical in a protocol performed on supine patients. The aim of the present study was adjust the previous supine position technique to sitting technique to overcome this dilemma. Therefore, during ultrasound examination, the position of the patient is of extreme importance. Hilbert G et al was in agreement with our concept in patients positioning during examination, which showed that ultrasound accuracy for all lesions (complete or partial sinusogram) is improved in the semi-erect patient.[2] Frederic V et al also confirmed that a postural change test improves the prediction of radiological maxillary sinusitis by ultrasonography in mechanically ventilated patients.[11] The information obtained from this postural change maneuver could minimize referral of critically ill patient for computed tomography in situations where CT scans require time-consuming transfer of complex patients.

Conclusions:

Ultrasound can help as one of primary investigations in evaluation of maxillary sinusitis. Diagnostic ultrasound represents a rapid, painless, harmless and easily reproducible means of assessment of maxillary sinuses. Ultrasound, while operator dependent, can be a useful tool to reduce the number of unnecessary computed tomography ordered and thus aid in a rapid diagnosis of maxillary sinus abnormalities. A positive full sinus scan on ultrasound examination appeared specific for total opacity of the maxillary sinus on computed tomography.

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Author Contributions:

Mustafa AA, Hassan SF:

Authors make substantial contributions to conception and design, and/or acquisition of data, and/or analysis and interpretation of data.

Al-Mosawi AA, Kammona WK:

Authors participate in drafting the article or revising it critically for important intellectual content; authors give final approval of the version to be submitt

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