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Evaluation of Ultrasound Efficiency in the Diagnosis of Acute Maxillary Sinusitis in Comparison with CT Scan Findings in Children Aged 5 to 15 Years

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ABSTRACT

Acute maxillary sinusitis in children is diagnosed often based on the patient's clinical findings. However, imaging is required in many cases due to overlap of signs and symptoms. CT scan is nowadays used as a radiologic Gold Standard. Ultrasound, as a diagnostic method, has been less studied and the results of studies have also been different. This study evaluates the diagnostic accuracy of ultrasound compared to that of CT scan in diagnosing acute maxillary sinusitis in children. This is a cross-sectional study. The inclusion criterion of study was 5 to 15 years of old children, underwent paranasal sinuses CT scans with suspected acute rhinosinusitis clinically, to confirm the diagnosis. Exclusion criteria included presence of other sinus pathologies such as polyp and retention cyst. All patients underwent maxillary sinus ultrasound within 24 hours of CT scan. The findings of ultrasound and CT scan were classified as opacification (Op), mucosal thickening (MT) and normal. The DTComPair package under the R software was used for analysis and calculations. In addition, level of agreement between the two modalities was determined using CAPA statistical index. Results: given the exclusion criteria, 50 patients, including 22 female and 28 male patients with mean age of 7.14 ± 2.98 *were included into study. Subjects with 100% maxillary sinus underwent ultrasound. The sensitivity, specificity, positive predictive value, and negative predictive value of ultrasound were determined 92%, 88%, 92%, and 88%, respectively. The level of ultrasound error was low in diagnosing normal and opacification cases but high in diagnosing mucosal thinning (41.7%). Ultrasound is a reliable method for diagnosis of acute maxillary sinusitis, while this modality shows a high level of error in diagnosing mucosal thickening.*

Key words: Acute Maxillary Sinusitis, Ultrasound, CT Scan, Children

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INTRODUCTION

Sinusitis is considered as one of the infections around the nose and paranasal sinuses. Nowadays, it is considered as one of the most common human diseases, and despite its high prevalence, its diagnosis is difficult, since clinical criteria and simple radiographs are not so diagnostic in this case [1]. Clinical diagnosis of sinusitis is based on clinical symptoms such as nasal congestion, facial pain and discomfort, post-nasal and pharyngeal secretions, as well as olfactory disorder, which each of them is non-specific and might appear with other diseases [2]. Various pathogens are also involved in the development of sinusitis, including bacteria (haemophilus influenzae, bacteroides), viruses (rhinovirus, adenovirus), as well as fungi (aspergillus, etc.) [3]. Sinus puncture is considered as a gold standard for diagnosis of sinusitis, but this method is highly invasive and is not easily accepted by patients [4]. Simple sinus radiographies (including waters, Caldwell and skull profile) are still used as a convenient and available method in many centers as the primary diagnostic method for sinusitis. CT scan is another standard method in this regard [5]. One of the limitations of this method is the time consuming and high cost of doing CT scan [6].

Ultrasound is one of the methods, proposed by researchers nowadays as an effective method to examine the facial problems. This method, unlike CT scan, does not involve x-rays and it is cost-effective. Moreover, it is safe and non-invasive method, compared to sinus puncture method and it is easily accepted by patients [7]. Other advantages of ultrasound are availability and using it in various clinical settings. Limited research has reported ultrasound efficiency in evaluating nasal and orbital fractures [8]. However, there is not enough information on the efficiency of this method in the diagnosis of paranasal sinusitis compared to conventional methods, such as simple radiography and CT scan. Thus, the objective of our study is to evaluate the sensitivity and specificity of ultrasound in comparison with CT scan method in diagnosing maxillary sinusitis. In a study conducted by Hilbert G et al. to examine the efficiency of ultrasound in the diagnosis of maxillary sinusitis in intubated patients in ICU, the results showed that the sensitivity, specificity, and positive predictive value, and negative predictive value of this method in the diagnosis of maxillary sinusitis were 100%, 96.5%, 98.4 % and 100%, respectively. This study concluded that ultrasound can be considered as the first line for examining various types of sinusitis, especially in intubated patients [8].

In a study conducted by Fufzun et al to examine the efficiency of ultrasound in the diagnosis of maxillary sinusitis in children, the results of the study revealed that ultrasound was simple based on simple radiographic findings and its sensitivity and specificity were reported 94.5% and 98.4%, respectively, for diagnosis of maxillary sinusitis. It was also found that the ultrasound error was high in diagnosis of Mucosal Thickening in the sinusitis. This study concludes that ultrasound is a valuable tool in examining paranasal sinusitis [9]. In the study conducted by KU Tiedjen et al to examine the efficiency of ultrasound in diagnosing the paranasal sinuses compared with CT scan, results showed that ultrasound diagnostic potential, compared with CT scan, was 97.4.4, 31.5%, and 18%, respectively, for maxillary sinuses, frontal sinuses, and ethmoidal sinuses. This study concludes that ultrasound is appropriate for diagnosing maxillary sinusitis. As a radiation-free method, it can be also used as valuable tool in screening the children, pregnant women, and young women [10].

MATERIALS AND METHODS

This cross-sectional study was conducted on children aged 5 to 15 years. Sinus CT scan and maxillary sinus ultrasound were performed on all patients. The inclusion criteria of study were children aged 5 to 15 years, who had symptoms of rhinosinusitis (rhinorrhea, cough, fever, headache, and post-nasal secretions) which underwent the paranasal sinus CT scan to confirm the diagnosis of acute sinusitis. The exclusion criteria included the presence of other sinus pathologies such as polyp and retention cyst in the CT scan. CT scan findings included, Mucosal Thickening, Opacification, and normal cases. Ultrasound was performed for patients within 24 hours after CT scan. Sinus ultrasound was performed by a linear probe with frequency of 7.5-10 MHZ. In ultrasound, patients are placed in sitting position and head is slightly flexed forward. The probe is placed transversally on the anterior wall of sinus in the vicinity of nose and below the lower wall of orbit, and the sinus is scanned slowly in the direction of craniocaudal and by giving angle to probe. The first observed layer is skin and subcutaneous tissue, and then, continuous linear echogenic layer, which is the anterior wall of sinus. (First Echo) since a normal sinus containing air, its ultrasound view due to sound reflections is seens as parallel echogenic lines(A-Line Artifact), and has view similar to normal lung (Figure 1). Sinusitis causes inflammation of the mucosa and accumulation of fluid within the sinus. Ultrasound findings are created based on these changes. The accumulation of fluid within the sinus causes creation of hypoechoic or anechoic triangular area within the sinus, which is called sinusgram. If all posterior, external, and internal walls of the maxillary sinus are clearly visible, the sinusgram would be called complete, and if a part of them is specified, sinusgram would be called incomplete (Figures 2and3). Complete sinusgram is considered opacification sinus and incomplete sinusgram is considered mucosal thickening. Back Wall Echo is a clear hyper echo line formed by the posterior wall of the sinus and its appearance indicates pathology in the sinus .If the distance of BWE line from the anterior wall of sinus(First Echo) is more than 20 mm, it is considered as opacification, and if it is less than 20 mm, it is considered as mucosal thickening [11, 12, 13]. The results of ultrasound and CT scan were compared in these patients.

RESULTS

In this study, 55 children were included into study based on the inclusion criteria of study (symptoms of rhinosinusitis and doing paranasal sinus CT scan to confirm the diagnosis). Based on exclusion criteria (the presence of concomitant pathologies such as retention CYST or polyp), 50 patients including 22 females and 28 males with mean age of 7.14 ± 2.98 were selected. Sinus ultrasound was performed on 100 maxillary sinuses. The results of CT scan showed 48 cases of normal, 24 cases of mucosal thickening, and 28 cases of opacification. In ultrasound, 45 cases were diagnosed normal, 14 cases were diagnosed mucosal thickening, and 25 cases were diagnosed opacification (Table 1). Out of 100 cases, results of CT scan and ultrasound were not similar in 16 cases. The highest non-similarity was seen in mucosal thickening, which it was reported normal in ultrasound. Non-similarity in normal cases was 3 cases and it was 3 in mucosal thickening cases and opacification cases, which were reported as mucosal thickening in ultrasound. Comparison between two methods of imaging showed that high agreement between two modalities with Kappa coefficient of 74% (P <0.05). In addition, sensitivity, specificity, negative predictive value, and positive predictive value were also determined 94%, 81%, 88%, and 92% (Table 2). Error rate of ultrasound in comparison to CT scan was as follows: the error rate was 6.3, 10.7, and 41.7 in diagnosing the normal cases, opacification, and mucosal thickening, respectively. As seen, the error rate in diagnosis of mucosal thickening is higher than that of normal and opacification findings, indicating ultrasound weakness in diagnosis of mucosal thickening.

Table 1

	Estimate value	Standard error	Confidence interval 95%	
			Upper bound	Lower bound
Sensitivity	0/94	0/03	1	0/86
Specificity	0/81	0/05	0/91	0/70
PPV	0/81	0/05	0/92	0/71
NPV	0/93	0/03	1	0/86

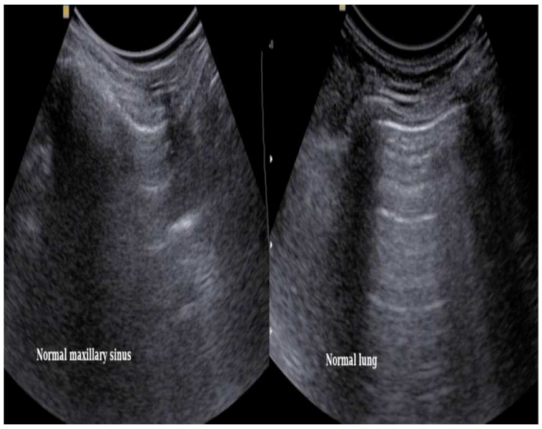

Figure 1: Normal sinus view compared to normal lung

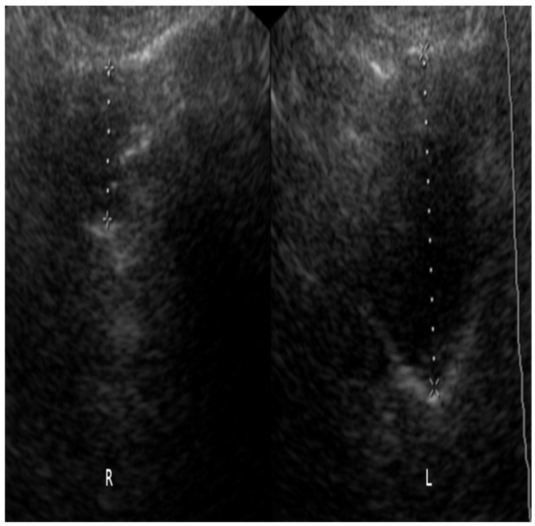

Figure 2: bilateral incomplete sinusgram

Figure 3: complete sinusgram

Table

			Ultrasound result			Total
			Normal	Mu	opacification	
CT scan result	Normal	Count	45	3	0	48
		% within CT_type	93.8	6.3	0.0	100.0
	Mu	Count	10	14	0	24
		% within CT_type	41.7	58.3	0.0	100.0
	opacification	Count	0	3	25	28
		% within CT_type	0.0	10.7	89.3	100.0
Total		Count	55	20	25	100
		% within CTtype	55.0	20.0	25.0	100.0
X2 value= 116.94			p-value< 0.05		CAPA value=0.74	p-value< 0.05

DISCUSSION

Inflammation of the sinus mucosa, leading to fluid accumulation in the sinus is called as sinusitis. Diagnosis of acute sinusitis, including maxillary sinusitis, is often based on clinical findings according to Guideline of Pediatric American Academy [14]. Imaging is used in certain cases, such as chronic or recurrent sinusitis, lack of response to treatment or suspected complications . However, in many cases, such as patients hospitalized in ICU or in cases where clinical symptoms overlap with other upper respiratory tract infections, imagings are needed to confirm the diagnosis. These radiological methods are simple radiology, CT, and MRI. CT scan is nowadays used in many centers as a radiologic gold standard for diagnosis of sinusitis. However, the presence of ionizing radiation, high cost and the need for sedation are the disadvantages of this imaging method [15-17]. Ultrasound was first used by Mann for diagnosing the sinusitis, which was recorded in a study conducted in 1975 [18]. Quantitative studies have been conducted on the role of ultrasound in the diagnosis of maxillary sinusitis in children and adolescents, and the results of these studies have been different [19-21]. In a study conducted on efficiency of ultrasound in diagnosis of maxillary sinusitis in intubated patients in ICU, results showed that sensitivity, specificity, positive predictive value, and negative predictive value of this method were reported 100%, 96.5%, 98.4%, and 100% in the diagnosis of maxillary sinusitis, compared with CT scan [8]. In another study conducted to examine efficiency of ultrasound in the diagnosis of maxillary sinusitis in children, the results showed that ultrasound compared with simple radiographic findings had sensitivity of 94.5% and specificity of 98.4% for the diagnosis of maxillary sinusitis .It was also found that the ultrasound error in mucosal thickening diagnosis was high 59.3 [9]. In a study conducted by Tiedjen KU *et al* to examine the efficiency of ultrasound in the diagnosis of paranasal sinuses, compared with CT scan, the results showed that the diagnostic accuracy of ultrasound is 97.4% for maxillary sinuses [10]. In our study, the sensitivity, specificity, positive predictive value, and negative predictive value were reported 94%, 81%, 88%, and 92%, respectively. The agreement between the two modalities was determined 75%. The error rate was reported low in diagnosing normal and opacification cases, but high in diagnosing mucosal thickening, indicating the weakness of ultrasound in diagnosing mucosal thickening. This weakness has been also reported in other studies [22-24].

CONCLUSION

Ultrasonography is a non-invasive, cost-effective and non-radiation method, and its performing portably in ICU patients is feasible, and based on results of this study, it can be used as a reliable method for the diagnosis of acute maxillary sinusitis, in cases where there is no suspected complication in children. However, ultrasound depends on operator and requires experience and equipment. This study also showed that ultrasound is weak in diagnosing mucosal thickening in maxillary sinusitis.

REFERENCES

1. Rosenfeld RM, Andes D, Bhattacharyya N et al. Clinical practice guideline: adult sinusitis. Otolaryngol Head Neck Surg 2007; 137: S1-31.
2. Varonen H, Mäkelä M, Savolainen S, Läärä E, Hilden J. Comparison of ultrasound, radiography, and clinical examination in the diagnosis of acute maxillary sinusitis: a systematic review. J Clin Epidemiol 2000; 53: 940-8.

3. Osguthorpe JD. Adult rhinosinusitis: diagnosis and man-agement. Am Fam Physician 2001; 63: 69-76.
4. Okuyemi KS, Tsue TT. Radiologic imaging in the management of sinusitis. Am Fam Physician 2002; 66: 1882-6.
5. Calhoun KH, Waggenspack GA, Simpson GA, Hokanson JA, Bailey BJ. CT evaluation of the paranasal sinuses in symptomatic and asymp-tomatic populations. Otolaryngol Head Neck Surg 1991; 104:477–81.
6. Gwaltney JM, Jr., Phillips CD, Miller RD, Riker DK. Computed tomographic study of the common cold. N Engl J Med 1994; 330 :25–30.
7. Puhakka T, Heikkinen T, Mäkelä MJ et al. Validity of ultra-sonography in diagnosis of acute maxillary sinusitis. Arch Otolaryngol Head Neck Surg 2000; 126: 1482-1486.
8. Hilbert G, Vargas F, Valentino R, Gruson D, Chene G, Bébéar C, Gbikpi-Benissan G, Cardinaud JP. Comparison of B-mode ultrasound and computed tomography in the diagnosis of maxillary sinusitis in mechanically ventilated patients. Crit Care Med. 2001 Jul;29(7):1337-42.
9. Fufezan O, Asavoaie C, Cherecheş Panta P, Mihuţ G, Bursaşiu E, Anca I, Iacob D, Gocan H, Valean C.The role of ultrasonography in the evaluation of maxillary sinusitis in pediatrics. Med Ultrason. 2010; 12(1):4-11.
10. Fufezan O1, Asavoaie C, Cherecheş Panta P, Mihuţ G, Bursaşiu E, Anca I, Iacob D, Gocan H, Valean C. The role of ultrasonography in the evaluation of maxillary sinusitis in pediatrics. Med Ultrason. 2010 Mar;12(1):4-11.
11. Varonen, Helena. 2003. Ultrasound in the management of acute rhinosinusitis patients in primary care. Academic dissertation. Medical faculty of the University of Helsinki, Helsinki, Finland. 105p
12. Puhakka t et al, Validity of ultrasonography in diagnosis of acute maxillary sinusitis, Arch Otolaryngol Head Neck Surg. 2000 Dec; 126(12):1482-6.
13. Lichtenstein D, The "sinusogram", a real-time ultrasound sign of maxillary sinusitis, Intensive Care Med. 1998 Oct;24(10):1057-61
14. American Academy of Pediatrics. Subcommittee on Management of Sinusitis and Committee on Quality Improvement. Clinical practice guideline: management of sinusitis.Pediatrics 2001; 108: 798-808.
15. Osguthorpe JD. Adult rhinosinusitis: diagnosis and management. Am Fam Physician 2001; 63: 69-76.
16. McAlister WH, Kronemer K. Imaging of sinusitis in children. Pediatric Infectious Disease Journal 1999; 18: 1019-1020.
17. Okuyemi KS, Tsue TT. Radiologic imaging in the management of sinusitis. Am Fam Physician 2002; 66: 1882-6
18. Mann W. [Echography of the paranasal sinuses] Arch Otorhinolaryngol 1975; 211: 145-147 [Article in German].
19. Reilly JS, Hotaling AJ, Chiponis D, Wald ER. Use of ultrasound in detection of sinus disease in children. Int J Pediatr Otorhinolaryngol 1989; 17: 225-230.
20. Shapiro GG, Furukawa CT, Pierson WE, Gilbertson E, Bierman CW. Blinded comparison of maxillary sinus radiography and ultrasound for diagnosis of sinusitis. J Allergy Clin Immunol 1986; 77: 59-64.
21. Revonta M, Kuuliala I. The diagnosis and follow-up of pediatric sinusitis: Water's view radiography versus ultrasonography. Laryngoscope 1989; 99: 321-324
22. Berg O, Carenfelt C. Etiological diagnosis in sinusitis: ultrasonography as clinical complement. Laryngoscope 1985; 95: 851-3.
23. Jensen C, von Sydow C.Radiography and ultrasonography in paranasal sinusitis. Acta Radiol 1987; 28: 31-4.
24. Vento SI, Ertama LO, Hytönen ML, Malmberg CH. Amode ultrasound in the diagnosis of chronic polypous sinusitis. Acta Otolaryngol 1999; 119: 916-20