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ORIGINAL RESEARCH

"A study to assess the use of ultrasonography in detecting maxillofacial fractures"

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ABSTRACT

Background:-Maxillofacial fractures occur most frequently as an after effect of trauma. Initially during first century, diagnosis of fracture was carried out using conventional radiographs but it has certain shortcomings which includes high radiation exposure, difficulty in detecting hair line & non dislocated fractures due to anatomical superimposition from the para-nasal air sinuses obscuring the visibility of underlying anatomical structures. At the time of this study the literature was focused more about isolated facial fracture and less about complete comprehensive evaluation of maxillofacial fractures using USG. A radiological confirmation is necessary because missed or incorrectly managed cases may encounter serious consequences. The most common causes of these fractures are road traffic accidents. The etiology and incidence of these fractures vary in different countries. The nasal bone being the most prominent bone is often prone to fracture (39% of maxillofacial fractures). The mandible and zygomatico-maxillary complex play an essential role in facial contour and mastication. A fracture in this area can affect facial appearance, function, and quality of life. To restore aesthetics, function, and quality of life, it is essential to completely diagnose these fractures for effective management. Thus we aim to add on more facts to the preexisting context which may further help to utilize ultrasonography as a first line diagnostic tool in detecting various maxillofacial fractures.

Materials & Methods:-Thirty four patients who presented with clinical signs & symptoms suggestive of maxillofacial fractures having computed tomography (GE Revolution 16 slice, 1.25mm slices) & conventional radiographs(GENORAY PAPAYA Plus DP-1S)done as a standard protocol for management of maxillofacial fractures were included in this study. These patients were subjected to ultrasonographic (VOLUSON 730 PRO)examination using 5-7 MHz frequency linear probe by an experienced sonologist who was blinded to the findings of computed tomography and conventional radiographs. Assessment was carried out in real time. The findings of conventional radiographs & ultrasonography were then correlated with findings on computed tomography. In this study computed tomography was taken as the gold standard & sample size estimation done with "two tailed test' in EPI INFO SOFTWEAR

Results:-The data analysis was performed by diagnostic & sensitivity test. Inferentional statistics was performed using EPI INFO 1.1.1.14. In this study ultrasonography shows sensitivity 86.20%, specificity 100%, positive predictive value (PPV) 100%, negative predictive value (NPV) 20.00%, accuracy of 86.66% in detecting maxillofacial fractures. When correlating the fracture detected by computed tomography & ultrasonography the results were highly significant with P = 0.001893.

Conventional radiographs shows sensitivity 50.57%, specificity 66.66%, PPV 97.77%, NPV 4.44%, accuracy of 51.11% in detecting maxillofacial fractures. When correlating fractures detected by USG & CR the results are significant with P = 0.00467.

Conclusion:-In the present study ultrasonography has shown better accuracy than conventional radiographs in diagnosing maxillofacial fractures. Though CT scan is the gold standard, we had observed that USG is equal to CT scan in diagnosing most of the superficial fractures. Hence with the availability of well experienced sonologist and high resolution transducer USG can be considered as the first line diagnostic procedure in suspected maxillofacial fractures.

Keywords:-Computed tomography, Ultrasonography, Conventional radiographs, Maxillofacial fractures

INTRODUCTION

Maxillofacial fractures occur most frequently as an after effect of trauma[1]. Initially during first century, diagnosis of fracture was carried out using conventional radiographs but it has certain shortcomings which includes high radiation exposure, difficulty in detecting hair line & non dislocated fractures due to anatomical superimposition from the paranasal air sinuses obscuring the visibility of underlying anatomical structures[2,3]. Real time visualization is impractical which requires digital technology for hard copy images[4]. After the advent of CT scan in 1970 & 1980 by Godfrey Hounsfield & Allan M Mc Cormack it was accepted as a gold standard imaging method in the diagnosis of maxillofacial fractures[1,5]. However it had limited access within the rural area, carries a high risk of developing cataract & thyroid carcinoma due to close proximity & high radiation exposure[6]. It is not advisory to be used in pregnant women, children & claustrophobic patients[7]. Conversely MRI gives information pertaining more about soft tissue than that of the underlying bony architecture[8]. Precedently USG was used to detect pathology in head & neck region but its use in detecting fractures of large bone like skull, clavicle & ribs had been reported[9,10]. After a remarkable progress made by Ord et al in 1891 where he used ultrasonography for detecting orbital fractures had made us more inquisitive for developing a less invasive & readily available method in detecting maxillofacial fractures[7,11]. Time needed for USG examination is shorter i.e. 10 min in contrast to CT & CR which is 25 min & 15 min respectively[5,12]. At the time of this study the literature was focused more about isolated facial fracture and less about complete comprehensive evaluation of maxillofacial fractures using USG. Thus we aim to add on more facts to the preexisting context which may further help to utilize ultrasonography as a first line diagnostic tool in detecting various maxillofacial fractures.

Aim:

The present study was designed to evaluate the diagnostic value of ultrasonography in maxillofacial fractures.

Objectives:

To observe and record the maxillofacial fracture using ultrasonography, conventional radiograph and correlated with computer tomography.

To assess the specificity, sensitivity, positive predictive value, negative predictive value of ultrasonography & conventional radiographs in determining maxillofacial fractures.

MATERIAL & METHODS

The present prospective study was conducted for over a period of 18 months including 34 patients (05 Female and 29 Male) at age range (14 to 40), mean age of the patients were 34.14% with maxillofacial fractures having CT scan & conventional radiographs done as a standard protocol for management of maxillofacial fractures. Intensive care patients, patients with penetrating globe injury, severe head injury & systemic illness were excluded from the study. CT scan was used as a reference method to evaluate the diagnostic value of USG in determining maxillofacial fracture. Informed consent was taken prior to examination. Ultrasonography was performed by an experienced radiologist who was blinded to the finding of CT scan & conventional radiograph using ultrasound machine (VOLUSON 730

PRO) & linear transducer with frequency of transducer was adjusted to 7MHz for examination of superficial structures whereas it was reduced to 5MHz for deeper structure. Close eye technique was used to detect orbital floor fractures. Images were best obtained from the lateral canthus, with the ultrasound beam in the coronal plane, angled caudally to intersect the orbital floor. To inspect infraorbital rim and anterior orbital floor fractures transducer was placed at the infraorbital rim, to investigate central & posterior orbital floor transducer was positioned on the supraorbital rim. To examine zygomatic arch fracture the transducer was positioned over, and longitudinal to the surface of the zygomatic arch. In case of nasal bone fractures, assessment of nasal dorsum was done by probing in sagittal & axial planes. To probe lateral wall of the nasal bone probe was positioned in an oblique manner. For condylar fracture the probe was placed along the imaginary line passing through the condyle, condylar neck & ramus. The findings of USG & CR were than correlated with the findings of CT scan. The results were analyzed by various statistical testing methods (for sensitivity, specificity, positive and negative predictive value, and accuracy).

RESULTS

The present study consists of 34 subjects out of which 29 were males & 5 were females. The mean age of the patients was 34.14%. The cause of injury in all cases was assault, road traffic accident or self fall. All cases were managed by open reduction internal fixation or by close reduction. None of the patients reported discomfort during examination using ultrasonography. In this study CT scan was taken as the reference method. The findings on USG & CR were correlated with the findings on CT scan. Data analysis was performed using diagnostic & sensitivity test. Inferential statistics was performed by using EPI INFO 1.1.1.14. There were total of 90 fractures of which CT scan was able to detect 87(96.66%) fractures with negative of 3(3.33%). USG was able to detect 75(83.33%) fractures with negative of 15(16.67%). Whereas CR was able to detect 45(50%) fractures with negative of 45(50%) (table 1). On correlating the fractures detected by CT & USG the results were highly significant with P = 0.001893. While taking CT scan as the diagnostic tool USG showed sensitivity of 86.20%, specificity of 100%, PPV of 100%, NPV of 20.00%, accuracy of 86.66% (table 2). When correlating fractures detected by USG & CR the results were significant with P = 0.00467. While taking CT scan as the diagnostic tool CR showed sensitivity of 50.57%, specificity of 66.66%, PPV of 97.77%, NPV of 4.44% & accuracy of 51.11% in detecting maxillofacial fractures (table 3).

Table 1: Depicting frequency of fractures detected by CR

Fractures Detected by CR	Frequency	Percent	Cum. Percent	Confidence limit
Yes	45	50.00%	50.00%	39.27% - 60.73%
No	45	50.00%	100.00%	39.27% - 60.73%
Total	**90**	**100.00%**		

Table 2: Taking CT scan as Diagnostic tool USG test variables are as follows

Sensitivity of USG	86.20%
Specificity of USG	100.00%
PPV of USG	100.00%
NPV of USG	20.00%
Accuracy of USG	86.66%

Table 3: Taking CT scan as Diagnostic tool CR test variables are as follows

Sensitivity of CR	50.57%
Specificity of CR	66.66%
PPV of CR	97.77%
NPV of CR	4.44%
Accuracy of CR	51.11%

DISCUSSION

Maxillofacial trauma contributes a highly significant health hazards across the globe, of which RTS heads the lists followed by assault, sports, occupational injury & fall[13]. Hence its accurate diagnosis is the major cause of concern for any maxillofacial surgeon. The newest trend in radiology is to give more ethical treatment with less radiation hazard to the patient based on ALARA (as low as reasonably achievable) is gaining popularity[14]. Ultrasonography is a least invasive procedure among other imaging modalities. It utilizes high frequency sound waves to produce images of internal structures. It can not only detect discrepancy within the bone but also soft tissue entrapments within the fracture line, edema, emphysema, callus formation can also be well appreciated which helps to differentiate between old & new fractures[9]. It can be used to assist the reduction of fractures intraoperatively[15]. In previous studies, linear transducer with frequency ranging from 5 MHz to 30 MHz was used in maxillofacial region. Curved array transducer of frequency 7.5 MHz was used for the diagnosis of orbital fractures. In our study we have used a linear transducer with frequency ranging from 5 to 7 MHz, where in most of the cases the frequency was adjusted to 7 MHz for examination of superficial structures and it was reduced to 5 MHz to visualize deeper structures.

In the present study we were able to detect 83.33% of fractures with negative of 16.67% using ultrasonography. Hence ultrasound prove to be a reliable first line imaging modalities for the investigation of suspected midface fracture in daily clinical practice[16]. Fractures not determined by ultrasonography mostly included fracture of postero-lateral wall of antrum, posterior wall of antrum, orbital floor and medial wall of orbit, all these anatomical structures are oriented at the deeper level in relation to that of the skin surface, whereas other fractures in proximity to the skin was detected without any difficulty. Many studies were conducted to evaluate the efficiency of ultrasonography in detecting nasal bone fracture, Afshin Mohammed reported sensitivity of 97%, specificity of 100% with high resolution ultrasonography (HRUS) in comparison with clinical examination. While sensitivity, specificity of HRUS when compared with CT scan was 100%, 91% in detecting nasal bone fractures[17]. Thiede et al reported that ultrasonography was statistically superior with P = .04 to radiograph in detecting lateral wall of nasal bone fracture. Whereas radiograph were statistically superior with P = .01 to ultrasonography in detecting nasal dorsum frature. There was no statistical difference between radiography and ultrasonography (P = .91) in the diagnosis of nasal pyramid fracture[18]. In this study there were 3 cases of nasal bone fracture out of which all 3 fractures were detected by using linear probe of frequency of 5-7 MHz. Advantages of using high resolution ultrasonography over conventional radiography is that, it can detect trauma to the nasal cartilage portion of nose. It is useful intraoperative in reduction of nasal bone fractures. The present study carries few limitations, inability to differentiate complex fractures like lefort, panfacial as we were not able to view extension & pattern of fracture, identification of intracapsular condylar fracture was difficult[17]. Hence experienced sonologist plays an important role in the diagnosis. We have discussed a few cases of different facial bone fracture detected on USG scan. Figure 1-AUSG showing left parasymphsis fracture, Figure 1-B: USG showing right angle of mandible fracture, Figure 1-C: USG showing left sub-condylar fracture, Figure 2-A: USG showing nasal bone fracture, Figure 2-B: USG showing right anterior maxillary antrum wall fracture, Figure 2-C: USG showing right frontal bone fracture, Figure 3-A: USG showing left zygomatic arch fracture, Figure3-B: USG showing right supraorbital rim fracture, Figure 3-C: USG showing right infraorbital rim fracture, Figure 3-D: USG showing right lateral wall of orbit fracture. Thus with this our views are in agreement with Adeyemo that to diagnose complex maxillofacial fractures or panfacial fractures, use of CT scan is obligatory[4]. In present study we had used a regular linear probe which was another drawback as it had poor adaptation to the facial topography and limits the diagnostic ability which could had been overcome by using curvilinear & small size probe specially designed to suit maxillofacial topography.

Figure 1A: USG showing left parasymphsis fracture

Figure 1B: USG showing right angle of mandible fracture

Figure 1C: USG showing left sub-condylar fracture

Figure 2A: USG showing nasal bone fracture

Figure 2B: USG showing right anterior maxillary antrum wall fracture

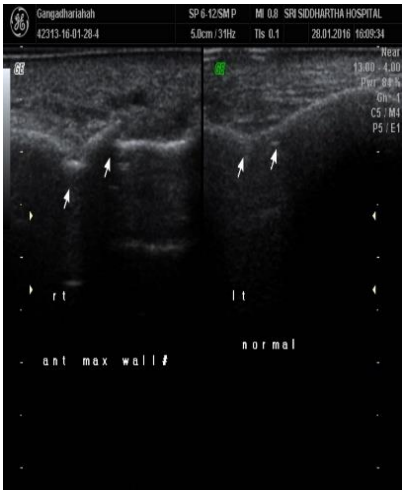

Figure 2C: USG showing right frontal bone fracture

Figure 3A: USG showing left zygomatic arch fracture

Figure 3B: USG showing right supraorbital rim fracture

Figure 3C: USG showing right infraorbital rim fracture

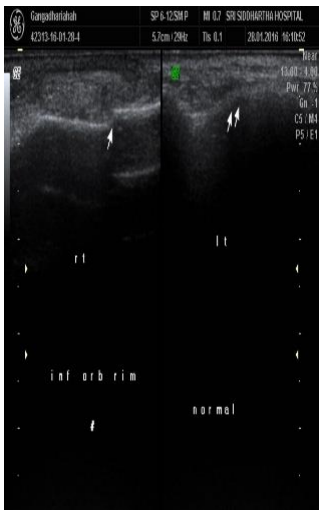

Figure 3D: USG showing right lateral wall of orbit fracture

CONCLUSION

Accurate assessment of facial fractures is very important as it aids the maxillofacial surgeon to shape the treatment plan prior to surgery. With this present study we would conclude that ultrasonography can be used as an adjunctive to the clinical examination in case of doubt where we can avoid use of other diagnostic aid with high ionizing radiation. It can also be used intraoperatively to assess the reduction of fractures which lessen the radiation exposure. But in complex cases with head injury where it is more preferable to take a CT scan as it may be give an overview of both a head injury as well as other maxillofacial fractures.

Conflict of Interest Statement:

The authors have no conflict of interests.

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References:

1. Jank S, Deibl M, Strobl H, Oberrauch A, Nicasi A, Missmann M, et al. Interrater reliability of sonographic examinations of orbital fractures. Eur J Radiol. 2005 Jun;54(3):344-51.

2. Zainab Mahmood Al- Bahrany, Lamia H. Al-Nakib. Comparison between high- resolution ultrasonography and conventional radiography in the diagnosis of nasal bone fractures. Tikrit Journal of Dental Science. 2011;1:6-13.

3. Ogunmuniya SA, Fatusi OA, Ugboko VI, Ayolla OO, Maaji SM. The validity of ultrasonography in the diagnosis of zygomaticomaxillary complex fractures. Inj J Oral Maxillofac Surg. 2012 Apr;41 (4):500-5.

4. Adeyemo WL, Akadiri OA. A systemic review of the diagnostic role of ultrasonography in maxillofacial fractures. Int J Oral Maxillofac Surg. 2011 Jul;40(7):655-61.

5. Maha Sallam, Ghada Khalifa, Fatma Ibrahim and Mohamed Taha. Ultrasonography vs. computed tomography in imaging of zygomatic complex fractures. Journal of American Science. 2010;6(9):524-33.

6. Javadrashid R, Khatoonbad M, Shams N, Esmaeili F, Jabbari Khamnei H. Comparision of ultrasonography with computed tomography in the diagnosis of nasal bone fractures. Dentomaxillofac Radiol. 2011 Dec;40(8):486-91.

7. S Jayachandra, Koijam Sashikumar Singh. A comparative study on the diagnostic utility of ultrasonography with conventional radiography and computed tomography scan in detection of zygomatic arch and mandibular fractures. Contemp Clin Dent. 2014 Apr-Jun;5(2):166-169.

8. McCann PJ, Brocklebank LM, Ayoub AF. Assessment of zygomatico-orbital complex fractures using ultrasonography. Br J Oral and Maxillofac Surg.2000 Oct;38(5):525-9.

9. Freiedrich RE, Plambeck K, Bartel-Friedrich S, Geese M, Schmelzle R. Limitations of B-scan ultrasound for diagnosing fractures of the mandibular condylar and ramus. Clin Oral Investig. 2001 March;5(1):11-16.

10. Ardeshirpour F, Ladner KM, Shores CG, Shockley WW. A preliminary study of the use of ultrasound in defining nasal fractures: criteria for a confident diagnosis .Ear Nose Throat J. 2013 Oct-Nov;92(10-11):508-12.

11. Jeremy N. Johnson, Daniel F. McBride, Steve Crandall, Christopher Kang. Ultrasound – confirmed frontal bone fracture. West J Emerg Med.2009;10(4):303.

12. S Nezafati, R Javadrashid, S Rad, S Akrami. Comparision of ultrasonography with submentovertex films and computed tomography scan in the diagnosis of zygomatic arch fractures. Dentomaxillofac Radiol. 2010 Jan;39(1):11-16.

13. Al-Hassani A, Ahmad K, El-Menyar A, et al. Prevalence and patterns of maxillofacial trauma: a retrospective descriptive study. Eur J Trauma Emerg Surg 2022;48:2513–2519.

14. Airan L, Baliga M, et al. Comparision of the efficacy of ultrasonography with computed tomography in thr diagnosis of maxillomandibular fractures. World J Dent 2019;10(3):181-185.

15. Gulicher D, Krimmel M, Reinert S. The role of intraoperative ultrasonography in zygomatic complex fracture repair. Int J Oral Maxillofac Surg. 2006 Mar;35(3):224-30.

16. Blessmann M, Pohlenz P, Blake FA, Lenard M, Schemelzle R, Heiland M. Validation of a new traning tool for ultrasound as a diagnostic modality in suspected midfacial fractures. Int J Oral Maxillofac Surg. 2007 June;36(6):501-6.

17. Gadicherla S, Pentapati KC, Rustaqi N, Singh A, Smriti K. Diagnostic accuracy of ultrasonography for the assessment of maxillofacial fractures: A Meta analysis. J Int Soc Prevent Communit Dent 2021;11:503-9.