Journal of Cranio-Maxillo-Facial Surgery 44 (2016) 353–356

Contents lists available at ScienceDirect

Journal of Cranio-Maxillo-Facial Surgery

journal homepage: www.jcmfs.com

Comparison of ultrasonography with conventional radiography in the diagnosis of zygomatic complex fractures

Rahul P. Menon*, Sanjay Kumar Roy Chowdhury, Ravinder Singh Semi, Vishal Gupta, Serat Rahman, T. Balasundaram

Department of Oral and Maxillofacial Surgery, Army Dental Centre (Research and Referral), Delhi Cantt, New Delhi, 110010, India

ARTICLE INFO

Article history:
Paper received 21 October 2015
Accepted 26 January 2016
Available online 3 February 2016

Keywords:
Fracture
Zygomatic complex
USG
Radiography
Comparison

ABSTRACT

Purpose: Zygomatic complex fractures have changed in patterns of occurrence, severity, and, more importantly, in the mode of injury. Protection of the globe and maintaining the width of the face are the more important roles of the complex. Diagnosis and treatment planning of such fractures become imperative in the sequencing of repair if and where indicated, especially in the case of isolated zygomatic complex fractures. Exploring the versatility of ultrasonography (US), in diagnosing zygomatic complex fractures in comparison to conventional radiography in a double-blind study, the objective of this study was to evaluate the efficacy of US and to explore the possibility of making US examination a mainstay in the primary diagnosis of such fractures.

Material and method: The prospective, double-blind study design included 32 patients suspected of having sustained isolated zygomatic complex fractures. The patients underwent US examination and radiographic examination in the form of para-nasal sinus (PNS) and sub-mentovertex (SMV) views for comparison.

Results: A sensitivity of 100% was seen in favor of US in the areas of the fronto-zygomatic suture (FZ), arch, infra-orbital, and buttress areas. Statistically significant differences ($p < .01$) was seen in areas of the arch and buttress region and in the infra-orbital area.

Conclusion: Although US showed 100% sensitivity in detection of fracture lines at three articulations of the four that make up the zygomatic complex, it lacked in quantifying the amount and degree of displacement of the fractured segments, which hampered accurate treatment planning.

1. Introduction

Assessment of the extent of trauma to the zygomatic complex and fractures at other additional associated sites becomes difficult particularly when displacement exists around a vertical axis of rotation. Hence the assessment of the fracture(s) and its displacement (if any) becomes paramount in the treatment planning of such fractures (Adeyemo and Akadiri, 2011; Rowe and Williams, 1994).

Conventionally, the diagnosis of such fractures was done using radiographs such as those of the sub-mentovertex view (SMV) and the para-nasal sinus (PNS) view. Such modalities come with their own limitations, such as superimposition of adjacent anatomic structures and radiopaque implants in the vicinity of the area of interest, which may produce artifacts in the resultant image. The film-based modality also provided only a two-dimensional representation of the fractures, which became more relevant in cases of comminution. In addition, radiation exposure to the patient is an important factor that needs to be considered (White and Pharoah, 2009).

Ultrasonography (US) was first applied in the medical field in 1953 by Karl Theo Dussik (1954, 1958) for the detection and diagnosis of soft tissue swellings that arose from deeper cavities of the human body. The high degree of specificity and sensitivity spurred further studies into the extended application of US as a diagnostic/affirmative aid in modern medical and surgical practice (Danter et al., 1996; Akizuki et al., 1990).

* Corresponding author.
E-mail addresses: doc_rahulmenon@yahoo.co.in (R.P. Menon), skrchow@yahoo.co.in, skrchow@gmail.com (S.K.R. Chowdhury), ravindermds@yahoo.co.in (R.S. Semi), drvgupta16@gmail.com (V. Gupta), seratrahman@gmail.com (S. Rahman), drbalass@yahoo.co.in (T. Balasundaram).

http://dx.doi.org/10.1016/j.jcms.2016.01.016
1010-5182/

If US were to prove to be as useful in the diagnosis of fractures of larger bones such as the zygomatic complex, it could be a useful and noninvasive adjunct to conventional radiographs, possibly replacing them as a first-line modality in the diagnosis of such conditions.

This study aimed to explore the versatility of ultrasonography, which has thus far been a seldom-used modality for the diagnosis of fractures of the zygomatic complex in comparison to the time-tested modality of conventional radiography. The study design formulated was double-blind, in which neither the sonologist nor the radiologist was aware of the findings, thus providing an impartial diagnosis.

The main objective of this study was to evaluate the efficacy of US in comparison to conventional radiography in the diagnosis of zygomatic complex fractures with computed tomography (CT) scans serving as the established gold standard.

2. Material and methods

This study was conducted in an Armed Forces Tertiary care center from August 2013 to March 2015. Armed forces personnel (both serving and retired) and their dependents who were diagnosed with facial trauma were examined, and only those suspected of having sustained isolated zygomatic complex fractures were included in this study. Both sexes were part of this study, with an age group ranging from 18 to 62 years. Individuals with residual deformities and mal-united fractures were not included in this study. All patients satisfying the above criteria who were entitled to treatment at this facility were included in this study.

The protocol for this study included recommended imaging in the form of plain radiographs (PNS and SMV). All subjects also underwent US examination of the affected region by the same sonologist using HDI 500 SONO CT (Phillips Healthcare Services) with a 7.5-MHz transducer. Sonography was used in the region of the zygomaticofrontal process, zygomatico maxillary process, zygomaticotemporal process, and the body of the zygoma. Plain radiography (PNS and SMV) views were interpreted by the radiologist. Each patient also underwent CT examination of the head and neck as per the standard protocol to rule out associated concomitant intra-cranial and cervical spine injuries. The CT images also served as the established gold standard for comparison with regard to the sensitivity and specificity of US and conventional radiographs.

The observations were entered on a Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) spreadsheet with columns and rows for each modality. The presence of a fracture was denoted by the letter “Y” and the absence of a fracture by the letter “N”. The data obtained were then subjected to statistical analysis with the χ^2 test and Fisher exact test.

3. Results

A total of 32 patients were examined as described above, including 22 male and 10 female patients between the ages of 18 and 62 years.

Table 1
Region imaged and statistical significance.

Sl. No.	Region of zygomatic complex	p Value
1.	Fronto-zygomatic region	.206
2.	Zygomatic arch	.000
3.	Infra-orbital region	.115
4.	Zygomatic buttress region	.000

Sl No. stands for “Serial Number”

A comparison between US, radiography, and CT at the FZ process are shown in Table 1 and revealed a difference that was not statistically significant ($p = .206$). However, it was noted that the sensitivity of US was 100% comparable to that of CT and far greater than that of plain radiography (58%), with a specificity of 100%, which was the same as with CT.

The zygomatic arch revealed a great difference on comparison that was statistically significant ($p < .01$) (Table 1) in favor of US and sensitivity being 100% as compared to plain radiography, which showed a dismal sensitivity of 59%. Here again, the data collected showed results comparable to those of CT. The sensitivity of US in this area was found to be 100%, which was the same as seen with CT.

In the infra-orbital area, although there was a difference in significance noted with $p = .82$ (>.01) (Table 1), it was not deemed statistically significant; however, as with the previous anatomical locations, the sensitivity of US was comparable with that of CT at 92%, while that of plain radiography was 50%.

It is pertinent to note, however, that when it came to the zygomatic buttress region, the p value was >.01 and in favor of US (Table 1), which was also reflected in the comparison with CT. The sensitivity of radiography in detecting fractures at the buttress was far less than with US (48% and 86%, respectively).

4. Discussion

Zygomatic complex fractures, when displaced, regardless of the degree of displacement, are given special attention during the reduction and fixation procedures due to the protective and esthetic function served. However, the complexity in achieving the ideal result is compounded by the fragile architecture of the bone and also its complex articulations and muscle attachments. More often than not, it is these relations that lead to fair amount of displacement and comminution, rendering the reduction and fixation a challenge.

Ultrasound is cyclic sound pressure traveling at frequencies greater than the upper limit of human hearing (>20 kHz in healthy young adults). Most medical US equipment operates at frequencies in the range from 1 to 15 MHz, whereas therapeutic applications are usually restricted to the lower frequencies of this range (usually around 1 MHz).

All patients in this study underwent conventional radiographic examination for the affected region in the form of PNS and SMV views, followed by US examination as per the stipulations

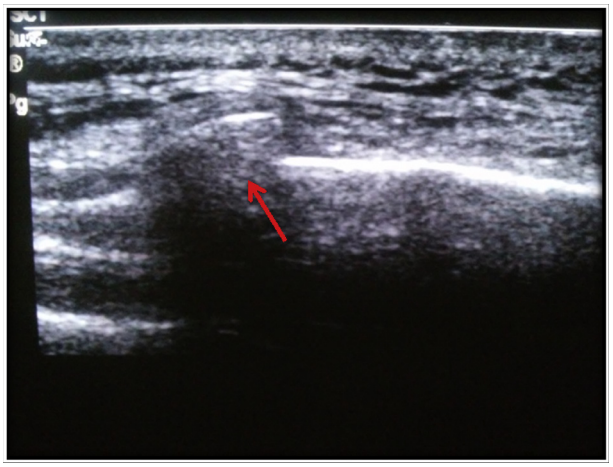

Fig. 1. USG scan at Lt FZ region demonstrating fracture.