

ORIGINAL RESEARCH ARTICLE

USE OF ULTRASONOGRAPHY IN REDUCTION OF ISOLATED ZYGOMATIC ARCH FRACTURE

Safal Dhungel^{1,*}, Ashutosh Kumar Singh¹

¹Department of oral and maxillofacial Surgery, College of medical sciences, Bharatpur, Nepal

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*Correspondence to: Safal Dhungel, Department of Oral and Maxillofacial Surgery, College of medical sciences, Bharatpur, Nepal.

Email: safaldhungel@gmail.com

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ABSTRACT

Background: Isolated zygomatic arch fractures, managed by closed methods, can be inadequate leading to facial asymmetry. Assessment of the reduction and ensuring correct alignment of fractured fragments in the operation table always avoids next surgery. This study aims to determine intraoperative, adequacy of reduction of by use of ultrasound in isolated zygomatic arch fracture.

Methods: During the closed reduction of isolated zygomatic arch linear probe of ultrasound was used to check the continuity of the echogenic line. The intraoperative ultrasound finding was compared with the gold standard CT scan.

Results: Ultrasound has 100% sensitivity and 80 % specificity. It also has high precision and accuracy to determine the reduction of the fractured bone.

Conclusions: Ultrasound is a handy tool in the reduction of zygomatic arch fracture. It not only shows but also guides to adequate reduction.

INTRODUCTION

Zygomatic arch is formed by fusion of temporal process of zygomatic bone and zygomatic process of temporal bone. Fracture of the arch can occur in ZMC (zygomatic complex) fracture or in isolated form.¹ Isolated arch fracture is caused by lateral force directly over the arch and result in facial asymmetry due to decreased facial width or restricted mouth opening.^{2,3} Apart from multiple fragments of arch, isolated fractures are not readily opened due to complex anatomy and threat to facial nerve.² Such fractures are treated by closed reduction either through extraoral (Gillies temporal)⁴ or through intraoral (Keens) approach. Irrespective of approach, the achievement of reduction depends on sensation (tactile or auditory) of the operator. This method though used invariably is subjective and cannot be readily relied upon.

Inadequate reduction, if occur, is only visible in post-operative X-rays one day later thus requiring re operation for correcting inadequate treatment. Various methods like Intraoperative radiographs,⁵ C arm² devices are used to confirm the adequate reduction but these procedure has radiation hazards. Portable Ultrasound (USG) machine are easily available and can be used

intraoperatively without any radiological hazard to operator and to patient. It is cheap and has high specificity to diagnose the facial bone fracture.

This study aimed to use of USG machine in determining adequate reduction intraoperatively as only few case series are published regarding its use.

METHODS

A cross sectional study was performed in cases of zygomatic arch fracture in department of Oral and Maxillofacial surgery, College of Medical Sciences (CMS), Bharatpur, Ethical clearance from institutional review committee of CMS was taken. Purposive sampling of 30 cases with isolated zygomatic arch fracture requiring closed reduction as per the Ozyazgan classification⁶ type I-B-V type (Figure 1) were included in the study from January to April 2020. Zygomatic arch with multiple fragments (Type I-B-D) and fractures associated with ZMC fracture type II were excluded.

The sample size was calculated by

$$n = z^2 \times pq / e^2$$

$$z = 1.96$$

Prevalence $p=91.66$ from previous study⁷
 $p=91.66$ $q=8.34$
 $=1.96^2 \times 91.66 \times 8.34 / 10^2$ $e=10\%$
 $=29.37$
 Correcting the sample size $n=30$

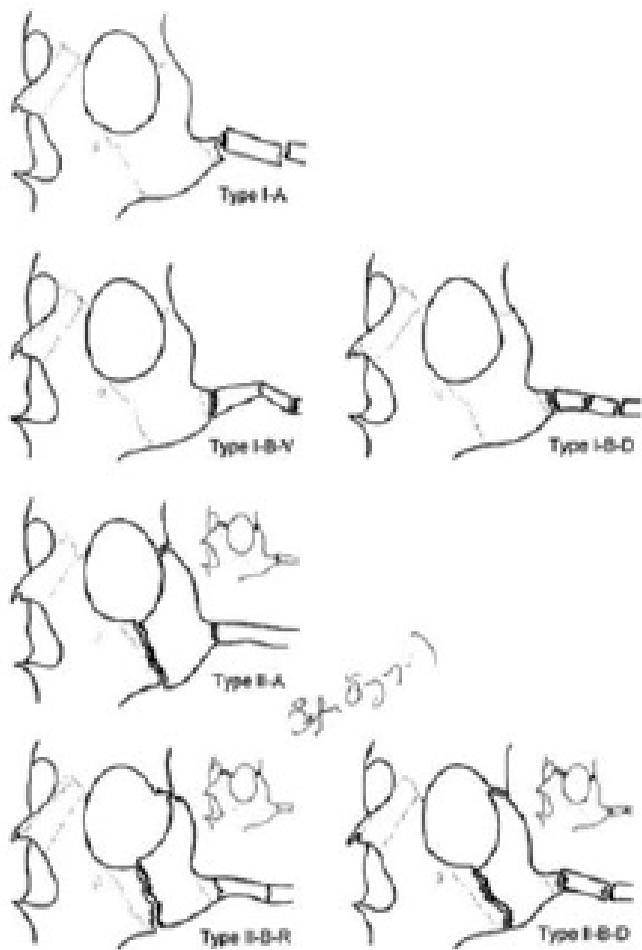


Figure 1: Schematic classification of zygomatic arch fractures⁶

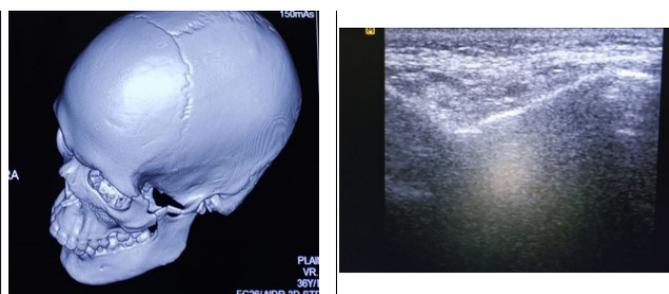


Figure 2: CT scan and intraoperative USG finding of isolated zygomatic arch fracture

Ultrasonography, with USG machine (Mysona U6 Samsung made in Japan), of the zygomatic arch was done at frequency of 10Hz. Ultrasound jelly was placed in a folded sterile surgical gloves. Linear transducer probe (LN 5-12) was kept and secured in the sterile folded glove. The entire unit (probe with covering glove) was dipped in betadine solution. Probe was placed over the malar prominence and ran along the arch visualizing the

echogenic shadow. Discontinuity in the echogenic shadow was used to determine the location of the fracture (Figure 2). Buccal vestibular incision was given and mucoperiosteal flap was raised. A flat handle of bayonet forceps was inserted below the depressed zygomatic arch.⁸ The depressed arch was elevated (reduced) by pulling the other handle of the forceps. Reduction was checked by conventional tactile sensation first, followed by running the probe and visualizing the continuity of the periosteal echogenicity. One or more attempts were made to mobilize the fracture fragments based on the tactile sensation and continuity of echogenic line up to the operator's satisfaction. Record of echogenicity was maintained in patient's proforma and the incision was closed. Postoperative radiograph (axial section of the CT scan) was taken next day (Figure 3). The mirror image of unfractured side was checked and recorded in the same proforma. All records were entered in MS excel and then transferred to SPSS version 20 for statistical calculation.

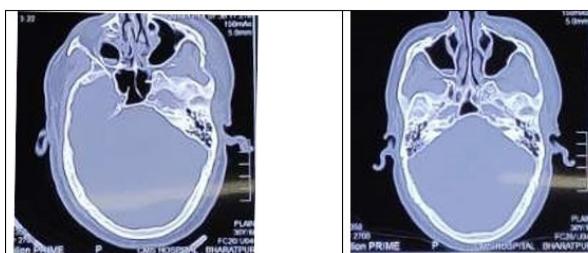


Figure 3: Pre and post CT scan of the isolated zygomatic arch fracture

RESULTS

In this study out of 30 patients, 24 (80.00%) were male. Age of patient ranged from 22 years to 50 years with mean of 33.73 ± 9.08 years. Left side zygomatic arch fracture was 17 (56.70%) (Table 1).

Table 1: Demographic distribution of the patient

	Gender		Side	
	Male	Female	Left	Right
Number (%)	24 (80)	6 (20)	17 (56.7)	13 (43.3)

Out of 30 patients, intraoperative USG showed continuity in echogenicity in 26 cases while 4 cases had discontinuity in USG. Out of 26 cases with echogenic continuity 25 cases showed mirror image to the contralateral unfractured side while 1 with echogenic line and 4 without continuity were not having the symmetry (Table 2).

Table 2: Distribution of USG and CT scan

		CT (adequate reduction)		Total
		Yes	No	
USG (continuity of echogenic line)	Yes	25	1	26
	No	0	4	4
Total		25	5	30

The sensitivity and specificity of the USG in diagnosis the adequacy of the reduction of zygomatic arch fracture was 100% and 80% respectively. Precision and accuracy of the use of USG in determining the reduction was calculated as follows.

$$\text{Sensitivity} = \frac{\text{true positive}}{\text{true positive} + \text{False negative}} \times 100\% \\ = \frac{25}{25+0} \times 100\% = 100\%$$

$$\text{Specificity} = \frac{\text{true negative}}{\text{true negative} + \text{false positive}} \times 100\% \\ = \frac{4}{4+1} \times 100\% = 80\%$$

$$\text{Precision} = \frac{\text{true positive}}{\text{true positive} + \text{false positive}} \times 100\% \\ = \frac{25}{25+1} \times 100\% = 96.15\%$$

$$\text{Accuracy} = \frac{\text{true positive} + \text{true negative}}{\text{true positive} + \text{false positive} + \text{true negative} + \text{false negative}} \times 100\% \\ = \frac{25+4}{25+1+4+0} \times 100 = 96.67\%$$

DISCUSSION

Fracture of facial bone is more in male population and in third decade of age group which is similar to other studies.⁹ This may be because male are more involved in outdoor activities and they are more prone for alcohol abuse, drink and drive and interpersonal violence.

Among facial trauma fracture of Zygomaticomaxillary complex (ZMC) is very common.^{9,10} wide face, and prominence of malar bone in Asian population may be attributed reasons. When blow/impact is from lateral direction, fracture of zygomatic arch can occur.³ Fracture of zygomatic arch is best shown by CT scan. Ultrasound fails to delineate bony lesion as it creates echogenic shadow due to reflection of sound from bony surface. Discontinuity of the echogenic shadow, due to displacement of the bony fragments, typically aids in diagnosing fracture in midface.¹¹ Few studies comparing USG with the gold standard CT scan for determining fractures showed the USG possess good sensitivity and specificity in diagnosis of facial fracture.¹²⁻¹⁴

Isolated zygomatic arch fracture, when occurs, may present with limited mouth opening due to impingement of coronoid

process by the fractured arch.¹⁵ It also causes facial asymmetry for which treatment by reduction of the fractured bone is wanted.^{7,16} The zygomatic arch rests below the facial nerve threatening for open reduction. To overcome the threat complex hemicoronal approach is required which may not be a good option for isolated depressed isolated zygomatic arch.¹⁷ Hence closed reduction is preferred over open reduction. Of different closed methods described, Gillies temporal approach and Keens intraoral approaches are most popular and variably used.^{4,18}

Irrespective of the approaches to reduce the bone both these closed method, readily depends on tactile sensation and auditory click heard by the operator.¹⁹ These methods are subjective and no adequacy of reduction can be determined intraoperatively. Post-operative radiographs taken within 24 hours have shown inadequate reduction.⁷ In such scenario either re-surgery or leaving in compromised state will be only options. USG,²⁰ Navigation,²¹ C-arm CBCT,^{22,23} C-arm fluoroscopy^{24,25} have been described to intraoperatively determine the adequacy of reduction.

Akizuki demonstrated 3 cases where zygomatic arch was reduced under USG guidance.²⁰ Ultrasonography is noninvasive, risk free, quick and easy modality.^{11,19} The study conducted by Gulicher.⁷ using USG intraoperatively helped the operator to accurately determine the reduction (24 out of 25) which is in accordance to our study. Using USG as a real time modality it guided in mobilizing fracture fragments intraoperatively when manual reduction was insufficient as in the previous studies similar to what we observed.^{7,15,26} Use of USG also aids the novice maxillofacial surgeon to mark the location of the elevator during closed reduction.

This study considered only the isolated zygomatic arch fracture, and small sample size was taken into consideration. Final outcome of the adequacy was based on the observation of the operator without fixed measuring unit or land marks.

CONCLUSION

USG can practically be considered as a third eye to reduce the zygomatic arch fracture. It can also be a good adjuvant to determine the adequate reduction in more complex ZMC fractures. More extensive study with larger sample size and for complex ZMC fractures using USG is recommended.

CONFLICT OF INTEREST: None

FINANCIAL DISCLOSURE: None

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