Double Screws technique for management of unstable transverse humeral fractures: A comparative study

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Background
Plate osteosynthesis is considered the gold standard treatment for unstable humeral shaft fracture. During the surgery, it is usually advisable to achieve a preliminary reduction while applying compression on the fracture site before the plate application. While this can be easily achieved in oblique and spiral fractures using the interfragmentary screws, it is almost impossible to achieve in the transverse fractures. As a result, we introduce the Double Screws (DS) technique as a reliable solution for this problem comparing it with the traditional indirect reduction by the plate itself.
Materials and methods:
Patients with unstable transverse humeral shaft fractures admitted at Mansoura Trauma and Emergency Hospital during the period from July 2020 to July 2021 were collected. They were divided into two groups: one for DS reduction technique and the other for the traditional indirect reduction by the plate. Results regarding operative time, intra-operative blood loss, healing, and other complications were reported.
Results:
the mean operative time was significantly lower in DS group being 101.3 ± 2.3 min compared to 120.4 ± 11.2 min in the traditional group (P=0.0015). Similarly, the mean blood loss was significantly lower in DS group being 320.9 ± 15.7 ml compared to 344.16 ± 15.6 ml in the traditional group (P=0.0035). Time to union was comparable being 14.8 ± 0.8weeks and 14.3 ± 1.6weeks in the DS and traditional groups respectively (P=0.46).
Conclusion
DS technique is considered a reliable, time efficient and less bloody method for reduction of unstable transverse fracture pattern of humeral diaphysis.

Keywords:
double screws, indirect reduction, transverse, unstable

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Background

Humeral shaft fractures account for nearly 3% of all fractures. Fracture union with acceptable humeral alignment remains the main goal of treatment to restore the patient's functional status [1]. According to AO/ASIF classification, humeral shaft fractures are divided into three types with further subdivisions; A - simple fracture, A1 - spiral fracture, A2 - oblique fracture, A3 - transverse fracture, B - wedge fractures, B1 - spiral wedge, B2 – bending wedge, B3 – fragmented wedge, C- complex fractures, C1 – complex spiral, C2 complex segmental fractures, C3 – complex irregular fractures [2].

Operative treatment has usually been reserved for the cases of unacceptable reduction, compound fractures, floating elbow, polytrauma, fractures with neurovascular complications and obese patients who are at risk of developing varus angulation [3]. Surgical management of transverse diaphyseal fracture (A3) includes plate osteosynthesis, intra-medullary nailing or external fixation. Plate osteosynthesis remains the gold standard for the operative fixation of humeral shaft fractures. Platting has a lower risk of nonunion when compared to intramedullary nailing [4].

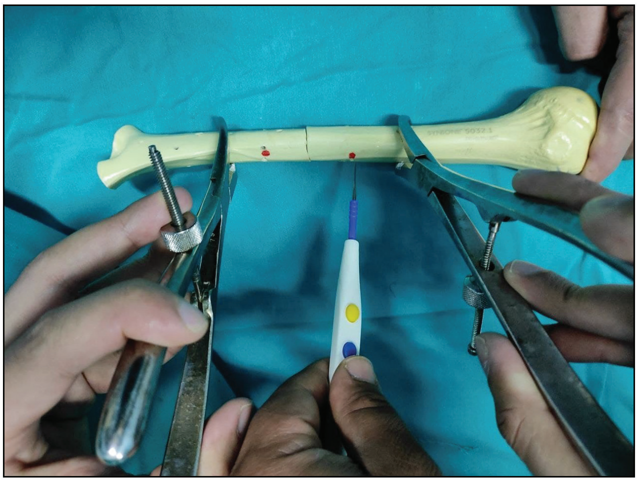
The interfragmentary screw provides a reliable and easy method to maintain reduction while achieving compression till securing the neutralizing plate. However, this is only applicable for the oblique and spiral types of fractures (A1 and A2) [5]. On the other hand, intraoperative reduction of a displaced transverse fracture (A3) is usually attained via indirect reduction on the plate itself. This usually represents a tedious, lengthy, and challenging intraoperative step before fixation especially with inexperienced surgeon [5]. The aim of this study is to introduce a new simple and applicable technique that we call a Double Screws (DS) technique to facilitate, maintain reduction and achieve compression at the fracture site, while applying the plate to fix unstable transverse humeral shaft fracture.

Materials and methods

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of the author's institution with number R.22.01.1599.R1. 23 patients with simple transverse mid-shaft humeral fracture (A3) were retrospectively included. They were allocated in two groups; the first group of 11 cases represented our DS technique, while the second group of 12 cases represented the ordinary indirect reduction group. Cases with neurovascular injury, younger than 18 years, open fractures, pathological, and old fractures more than a week were excluded. All patients were admitted at the author's institution in the period from July 2020 to July 2021. All cases completed follow-up for at least a year. All procedures were performed by the same senior trauma surgeon in the period of two to three days of the initial trauma.

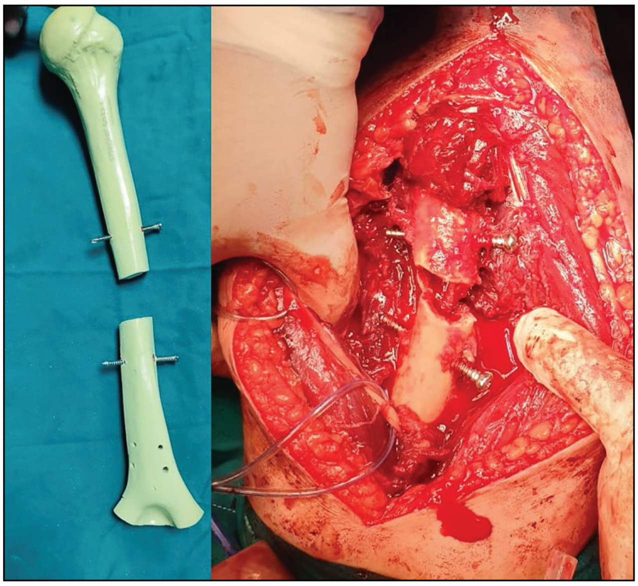
All patients underwent posterior exposure for fracture fixation [6,7]. In the first group, a preliminary reduction was performed using two serrated bone forceps. Using electrocautery, two marks were applied on an imaginary line on the medial or the lateral humeral surface; each is on one of the bony segments about one cm from the fracture site (Fig. 1). These marks were used as the entry points for the screws insertion to guarantee the anatomical reduction and guard against malrotation. Afterwards, the preliminary reduction was released to allow for easy manipulation. Then using those entry points, a 50 mm length 4.5 mm cortical screw was inserted proximal to the fracture site from one side to the other in a manner that five to six serrations of the screws were clear both medially and laterally (Fig. 2). Another screw was inserted distal to fracture site by the same method. Then, two-pointed reduction forceps were applied medially and laterally on the exposed serrations of both screws to approximate the exposed medial and lateral serrations to each other respectively. Once approximated, the reduction was easily achieved, and preliminary stability was attained while the posterior surface was totally cleared for the plate seating and securing (Fig. 3). Subsequently, a straight 4.5-mm dynamic compression plate was applied on

Figure 1



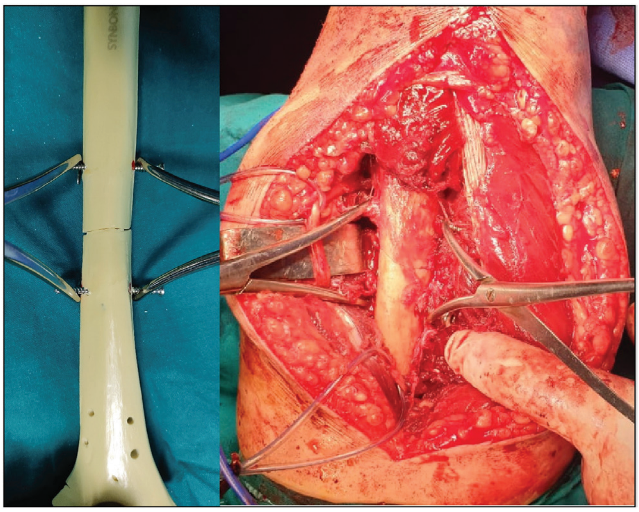
Marking the entry points for the screws with electrocatery.

Figure 2



Screws insertion leaving 6 serrations clear on both sides.

Figure 3



Achieving anatomically compressed fracture using two pointed redcudtion forceps.

posterior humeral surface to fix the fractures with at least three screws in each side of the plate (Fig. 4). Subsequently, the two screws were removed. Patients in the second group underwent reduction by ordinary indirect reduction by the plate.

Arm sling was used postoperatively, and range of motion exercise started immediately after the operation. Any labor with the managed limb was not allowed until the appearance of bridging callus or union. Clinical and radiological follow-up for union were judged in all patients for 1 year. The operative time from incision to closure finalization was collected from the operative room records. We calculated the average blood loss from each patient record using the Gross Formula: Blood loss = blood volume (body weight × 70 ml/kg)×(first Htc- last Htc)/ average Htc [8,9].

Data was fed to the computer and analyzed using IBM SPSS Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp. Qualitative data were described using number and percent. Quantitative data were described using median (minimum and maximum) for nonparametric data and mean with standard deviation for parametric data. Data was tested for normality using the Kolmogorov-Smirnov Test. Comparing two independent normally distributed groups was performed using the unpaired t-test. The Man Witney U test was used to compare two abnormally distributed independent groups. The significance of the obtained results was judged at the (0.05) level.

Figure 4

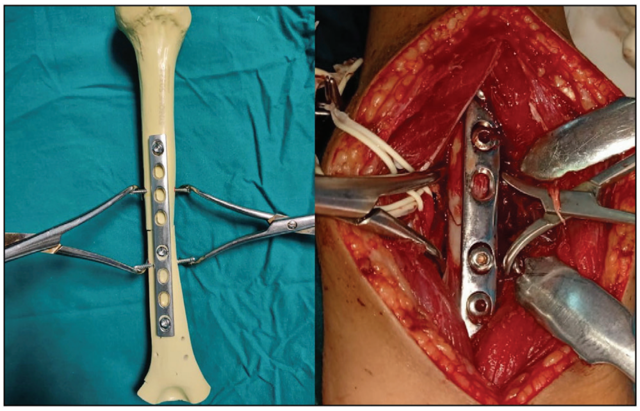


Plate securing to the humerus.

Results

This study included 14 males and 9 females. The left side was severed in 12 cases, whilst 9 cases were presented with the right side. Isolated humeral fracture was documented in all cases except for 2 cases with floating elbow with fracture both bone forearm. We used the DS technique in eleven cases, while twelve fractures were managed using the traditional indirect reduction technique utilizing the plate itself. All patients were followed with average 13.2 ± 1.8 months. The mean age of included patients was 34.7 ± 7 years and 35.1 ± 6.5 years in DS group and traditional group respectively (*P*=0.87).

As mentioned in Table 1, the mean operative time was significantly lower in DS group being 101.3 ± 2.3 min in DS group and 120.4 ± 11.2 min in traditional group (*P*=0.0015) (Fig. 5). Similarly, the mean blood loss was significantly lower in DS group. The mean blood loss was 320.9 ± 15.7 ml in DS group and 344.16 ± 15.6 ml in traditional group (*P*=0.0035). Moreover, time to union was comparable between both groups; 14.8 ± 0.8weeks and 14.3 ± 1.6weeks were the averages in DS group and traditional groups respectively (*P*=0.46) (Fig. 5).

All patients had their fractures united by the end of follow up. Two patients presented with radial nerve injury postoperatively (neuropraxia), one from each group. Both recovered completely without any surgical intervention after three months. No other complications were reported.

Discussion

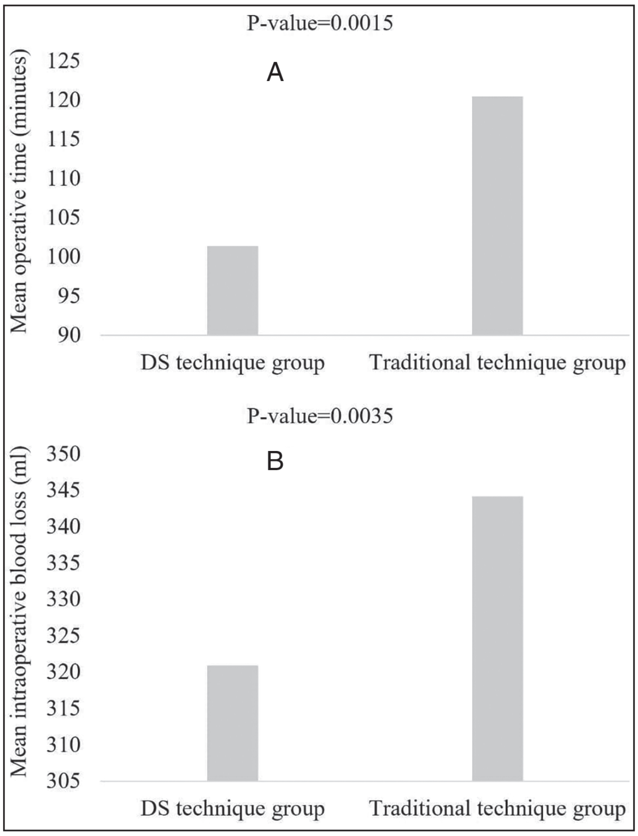
Accurate reduction of transverse humeral shaft fractures remains an important entity to achieve appropriate plate positioning, early bone healing and to limit the risks of

Table 1 Results difference between the two reduction methods

Compared variables	Double Screws technique	Traditional technique	P value
Age	34.7 ± 7 years	35.1 ± 6.4 years	*P*=0.87
Gender	8 males, 3 females	6 males, 6 females	
Side	9 (left), 2 (right)	7 (left), 5 (right)	
Intervention time (days)	1.45 ± 0.6days	1.6 ± 0.7days	*P*=0.58
Operative time (minutes)	101.3 ± 2.3 min	120.4 ± 11.2 min	*P*=0.0015*
Blood loss (ml)	320.9 ± 15.7 ml	344.16 ± 15.6 ml	*P*=0.0035*
Healing time (weeks)	14.8 ± 0.8weeks	14.3 ± 1.6weeks	*P*=0.46
Radial nerve injury (number)	1/ 11cases	1/ 12 cases	

Data were recorded as Mean±SD.
* was used for statistically significant value.

Figure 5



(a) The mean operative time between both groups. (b) The mean blood loss between both groups.

nonunion and further surgical interventions. A crucial step to achieve that is to achieve a stable compressed preliminary reduction prior to the plate application. The only way to achieve this is to apply forces in a trajectory that is perpendicular to the fracture site. While this could be easily achieved in the oblique and spiral fractures using the interfragmentary screw, it is almost impossible to achieve in the transverse fracture pattern [5].

Given the geometry of the transverse fracture, the surgeon usually utilizes the plate as a tool for indirect reduction. Besides being an extremely difficult and lengthy maneuver, it may also produce a step in the reduction as the plate is nonanatomical [4]. Moreover, the length of operation may correlate with the post-operative infection risk [10-12]. So, matching with our hypothesis, the DS technique has been proved to be a reliable method to apply and maintain compressive forces on the transverse fracture humerus making it easier to apply and secure the plate.

All patients were managed as early as possible with a mean time between initial trauma to surgery of 1.56 ± 0.7 days. The shorter the time between the occurrence of fracture and surgery, the quicker the healing occurs. Besides, delayed surgery requires delayed physical therapy leading to delayed recovery [13,14].

A prolonged operative time is considered a risk factor for post-operative infections in all age groups [15,16]. The mean operative time was significantly 19 min shorter in the DS group compared to the conventional group (P=0.0015). However, not a single case had presented with post-operative infection in both groups. Fracture healing time was comparable in the two groups. The average healing time was 14.8 ± 0.8weeks and 14.3 ± 1.6weeks in DS and traditional groups respectively (P=0.46).

The mean blood loss was significantly lower in DS group being 320.9 ± 15.7 ml compared to 344.16 ± 15.6 ml in the traditional group (P=0.0035). A lower blood loss rate may be explained by the lower operative time plus the less manipulation needed to be exerted to achieve the reduction. Iatrogenic radial nerve palsy was documented in two cases: one in each group. Both cases were managed conservatively and recovered well in a mean time of three months indicating a neuropraxic type of injury

This study has some limitations. This technique may not be applicable in case of seating the plate medially or laterally to humerus; in this occasion, the two screws may be hazardous anteriorly on the neurovascular structures. Additionally, our technique may require radial and ulnar nerves exploration distally in case of a more distal fracture, which may consume more time. Furthermore, Pain and functional scoring of patients were not investigated because the study was based on examining time effectiveness and blood loss assessment between the two techniques.

In Conclusion, DS technique is considered a novel, reliable, less bloody, and more time-consuming technique in reduction of unstable transverse humeral fracture.

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Conflicts of interest
No conflict of interests to be declared.

References

1 Wang, X, *et al*., [Effectiveness comparison of two minimally invasive plate osteosynthesis techniques for proximal humeral shaft fractures]. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi 2023; 37:147-152. DOI: 10.7507/1002-1892.202211079.

2 Kelany, OA-W, *et al*., Interlocking Medullary Nail Versus Plate Fixation in Management of Diaphyseal Humeral Fracture. Egypt J Hospital Med 2020; 80:1067-1073. ISSN: 1687-2002.

3 Daoub, A, *et al*., Humeral Shaft Fractures: A Literature Review on Current Treatment Methods. Open Orthop J 2022; 16. DOI: 10.2174/18743250-v16-e2112091.

4 Gallusser, N, B Barimani, and F Vauclair, Humeral shaft fractures. EFORT Open Rev 2021; 6:24-34. DOI: 10.1302/2058-5241.6.200033.

5 van de Wall, BJM, *et al*., Absolute or relative stability in plate fixation for simple humeral shaft fractures. Injury 2019; 50:1986-1991. DOI: 10.1016/j.injury.2019.08.004.

6 Hoppenfeld, S, P DeBoer, and R Buckley, Surgical exposures in orthopaedics: the anatomic approach. 2012: Lippincott Williams & Wilkins.

7 Saracco, M, *et al*., Surgical approach for fracture of distal humerus: Posterior vs lateral. Orthop Rev (Pavia) 2020; 12(Suppl 1):8664. DOI: 10.4081/or.2020.8664.

8 Gross, JB, Estimating allowable blood loss: corrected for dilution. Anesthesiology 1983; 58:277-280. DOI: 10.1097/00000542-198303000-00016

9 Jaramillo, S, *et al*., Perioperative blood loss: estimation of blood volume loss or haemoglobin mass loss? Blood Transfus 2020; 18:20-29. DOI: 10.2450/2019.0204-19.

10 Najafi, F, *et al*., Prevention of prosthetic joint infection/surgical site infection: what did the International Consensus Meeting decide? Expert Rev Med Devices 2023; 20:71-74. DOI: 10.1080/17434440.2023.2174849.

11 Putnam, JG, *et al*., Early post-operative outcomes of plate versus nail fixation for humeral shaft fractures. Injury 2019; 50:1460-1463. DOI: 10.1016/j.injury.2019.06.014

12 Calegari, IB, *et al*., Post-discharge surveillance methods for infection of the surgical site: integrative review. Acta Paulista de Enfermagem 2023; 36:eAPE019631. DOI: 10.37689/acta-ape/2023AR0196331.

13 Furuhata, R, *et al*., Influence of Timing on Surgical Outcomes for Acute Humeral Shaft Fractures. Adv Orthop 2021; 2021:8977630. DOI: 10.1155/2021/8977630. eCollection 2021.

14 Yiğit, Ş, What should be the timing of surgical treatment of humeral shaft fractures? Medicine 2020; 99:e19858-e19858. DOI: 10.1097/MD.0000000000019858.

15 Cheng, H, *et al*., Prolonged Operative Duration Increases Risk of Surgical Site Infections: A Systematic Review. Surg Infect 2017; 18:722-735. DOI: 10.1089/sur.2017.089.

16 Gallucci, GL, *et al*., Posterior minimally invasive plate osteosynthesis (MIPO) of distal third humeral shaft fractures with segmental isolation of the radial nerve. Chir Main 2015; 34:221-226. DOI: 10.1016/j.main.2015.06.007.