Minimally invasive plate osteosynthesis versus conventional open reduction and internal plate fixation for treatment of humeral shaft fractures

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Abstract

Background
various methods are used to treat humeral shaft fractures. Most of the fractures can be effectively treated conservatively. When operative treatment is indicated, plate osteosynthesis is considered the treatment of choice. Minimally invasive plate osteosynthesis is an emerging procedure to treat these fractures with the benefit of the preservation of the biological media of the fracture site.

Patients and methods
in this retrospective study we have two groups of patients. The first group was 15 patients with humeral shaft fractures treated surgically with ORIF. They were 10 males, 5 females, 2 cases were Gustillo type I open fracture with an average age of 36 years (20 to 64). The second group was 15 patients with humeral shaft fracture who were treated with the MIPO technique. They were 11 males, 4 females, only one case was Gustillo type I open fracture with an average age of 33 years (24-58). All patients were followed up for a period between 6-12 months postoperatively. Shoulder function was assessed using the UCLA (University of California, Los Angeles Shoulder Scale). Elbow function was assessed using MEPS (Mayo Elbow Performance Score). According to MEPS, the ORIF group showed, 7(46.6%) cases excellent, 4(26, 6%) cases good, and 4(26.6%) cases had fair results. In the MIPO group, 9(60%) cases had excellent results, 5(33.3%) cases good results, and only one case (6.6%) fair result.

Results
Results of the two methods showed that the mean fracture union time in the first group treated with ORIF ranged from 12 to 52 weeks with a median of 18 weeks and mean ± SD was 22.47 ± 11.79 weeks and in the minimally invasive group the range was from 8 to 24 weeks with a median of 12 weeks and mean± SD was 14.67 ± 4.76 weeks. Comparison between two patients' groups shows that time to the union was statistically significantly higher in the conventional group than the minimally invasive group ($p<0.05$). Iatrogenic radial nerve palsy occurred in 3 cases of fractures treated with ORIF, with no cases of nerve injury in fractures treated with the MIPO technique. Superficial infection occurred in two cases treated with the conventional plating technique. Intraoperative blood loss was less in the MIPO treated fractures. When regarding functional outcome according to UCLA scoring system, in the first group who were treated with ORIF, 4(26.6%) cases were excellent, 7(46.6%) good, 3(20%) fair, and one case (6.6%) was poor. In the MIPO group of patients, 7(46.6%) cases were excellent, 5(33.3%) cases good, 3(20%) cases had fair results, and no patients had a poor result.

Conclusion
When compared to the conventional plating technique, MIPO offers advantages in terms of accelerated fracture union, reduced incidence of iatrogenic radial nerve palsy, less bleeding, and better functional outcome of shoulder and elbow.

Keywords
Humeral shaft, minimally invasive osteosynthesis, conventional open reduction.

Introduction

Fractures of the humeral shaft account for approximately 1-3% of all fractures, 5-10% of all long bone fractures, and 20% of all humeral fractures[1]. Nonsurgical management of humeral shaft fractures with functional bracing is arguably the standard care of these fractures.

Surgical management is indicated in certain situations, including polytraumatic injuries, open fractures, vascular injury, ipsilateral articular fractures, floating elbow injuries, segmental fractures, and fractures that fail nonsurgical management.

Surgical options include open reduction and internal fixation, minimally invasive plate osteosyntheses, external fixation, intramedullary nailing, either antegrade or retrograde. Each of these techniques has advantages and disadvantages, and the rate of fracture union varies based on the technique used. Radial nerve injury is a common complication following different methods of surgical management of humeral shaft fractures[2].

Although controversy exists over which is the better technique, most authors believe that open reduction and internal fixation with a dynamic compression plate is a more reliable method. The advantages include anatomical reduction of fractures and less interference to elbow and shoulder function[3]. The major disadvantages of this technique are extensive soft tissue stripping and disruption of periosteal blood supply, which increases the risk of nonunion and iatrogenic radial nerve injuries[4].

Minimally invasive plate osteosyntheses (MIPO) were developed as an alternative method for the surgical management of humeral shaft fractures. Studies compared results of humeral shaft fracture management with MIPO versus either open reduction and internal fixation(ORIF) or intramedullary nailing(IMN) increasingly favors the MIPO technique as equally effective with less risk of complications[5, 6]. Although the intent of ORIF is rigid fixation, any MIPO procedure aims to achieve relative stability and secondary bone healing, using the locked plate to bridge the fracture site[7].

Indirect reduction of the fracture limits soft tissue damage to preserve local vasculature and avoid disrupting early callus, resulting in a more biologically compatible form of plating[8]. The anterior surface of the humeral shaft provides a safe location for plate application, using small incisions proximally and distally for percutaneous insertion of the implant. Mounting evidence demonstrates that the use of this less invasive technique results in a high rate of rapid union with a decreased incidence of iatrogenic radial nerve palsy[9]. This technique incorporates the benefits of minimally invasive stabilization, as with an intramedullary nail, yet avoids the associated shoulder complications, while simultaneously minimizing the risk of the other complications associated with open plating[10].

This study aims to compare the clinical results, assessing fracture union and functional outcomes of two groups of patients complaining of fracture shaft humerus, those treated with conventional open reduction and plate fixation using either anterolateral or posterior approach and those who were treated with minimally invasive plate osteosyntheses through two small anterior incisions.

Aim of the study:

This study aims to compare the clinical results, assessing fracture union, complications, and functional outcomes of two groups of patients complaining of fracture shaft humerus, those treated with conventional open reduction and plate fixation using either anterolateral or posterior approach and those who were treated with minimally invasive plate osteosyntheses through two small anterior incisions.

Patients and methods

Thirty patients with mid-distal third humeral shaft fractures were included in this study, they were classified according to the AO classification system and divided into two groups:

1- Group A: this group comprised 15 patients with humeral shaft fractures treated surgically with ORIF. They were 10 males, 5 females, 2 cases were Gustillo type I open fracture with an average age of 36 years (20 to 64). According to AO classification system, 6 patients with type A, 5 patients Type B, and 4 patients Type C. There were no radial nerve or vascular injuries, two patients had associated limb fractures.

2- group B: this group comprised 15 patients with humeral shaft fractures treated surgically with MIPO. They were 11 males, 4 females, only one case was Gustillo type I open fracture with an average age of 33 years (24-58). According to AO classification system, 4 patients with type A, 7 patients Type B, and 4 patients Type C. There were no radial nerve or vascular injuries, three patients had associated limb fractures. (Table 1)

All patients were followed up for a period between 6-12 months postoperatively.

Exclusion criteria:

1- Skeletally immature fractures.

2- Pathological fractures.

3- Open fractures more than Gustillo I, or gunshot injury fractures.

4- Fractures associated with radial nerve injury, or vascular injury.

5- Fracture levels that were not at least 5 cm distal to the surgical neck and not at least 5 cm proximal to the

proximal edge of the olecranon fossa.

6- Patients in which time lag between injury and surgical intervention exceeded three weeks.

Surgical Technique:

In the MIPO technique patient's group, the patient was placed in a beach-chair or supine position, a pad was placed beneath the scapula to elevate the limb, and the arm was draped free to facilitate access to the shoulder and elbow. The limb was supported on an arm board, the forearm positioned in supination and the elbow flexed 70°. Obtaining closed reduction was the crucial step in the whole procedure, which was done under image guidance. A 3-5 cm proximal incision was then made approximately 5 cm distal to the anterior part of the acromion process, the dissection was carried down to the proximal humerus between the biceps tendon medially and the deltoid tendon and cephalic vein laterally. Distally, a 3-4 cm incision was made on the anterior surface of the arm along the lateral border of the biceps, extending to within 5 cm proximal to the flexion crease of the elbow. In protection of the lateral antebrachial cutaneous nerve and the musculocutaneous nerve, the brachialis muscle was split longitudinally in its distal third for 3-5 cm to expose the anterior aspect of the humerus. The musculocutaneous nerve was retracted together with the medial half of the split brachialis, whereas the lateral half served as a cushion to protect the radial nerve, which at this point, had pierced the lateral intermuscular system and was lying between the brachioradialis and brachialis muscles. Then, a sub-brachial tunnel was created from each incision to the fracture site over the periosteum deep to the brachialis muscle. Through this tunnel, LCP of proper length attached with a handle was inserted. A 4-5mm narrow or broad locked compression plate with the number of holes depending on the length of the fracture was gently inserted through the submuscular tunnel from proximal or distal incision depending on the location of the fracture. After reducing the fracture by applying gentle traction and abduction, a screw was inserted in the distal fragment, the quality of the reduction was evaluated using an image intensifier. If the reduction was acceptable, a second screw was inserted in the proximal fragment, then one or two more screws were inserted on each side of the fracture to make the fixation more secure. Wound closure was done in the standard fashion, no drain was used.

In the ORIF patient's group, the plate was placed through either anterolateral or posterior approach according to the fracture site and the radial nerve was exposed and carefully protected. The fracture sites were dissected and hematoma and soft tissue interposing between the fragments were removed. The fractures were reduced and a 4-5mm DCP or LDCP was applied to fix the fracture with at least three screws at each end of the plate. The wound was closed after placing a drainage tube sum-muscularly. 11 patients were treated through the posterior approach and 4 patients through an anterolateral approach.

Postoperative treatments in both groups were the same except for removing the drainage tube in group A. The arms were immobilised with a collar and cuff sling and the patients were encouraged to move the shoulders and elbows early as pain permits. The stitches were removed 12-14 days postoperatively. All patients were followed up periodically. The range of motion of the shoulders and elbows was recorded. Radiographs of the fractured arm were taken. More active exercises were started when callus appeared.

Fig. 1: Range of motion of the elbow and the two limited scars after stitches removal 2 weeks postoperative in a patient with fracture shaft humerus treated with MIPO technique.

For data collection, the operative time was defined as the time from skin incision to skin closure. Postoperative complications, time to union, and shoulder and elbow function were also recorded. Union was defined as the absence of pain and the presence of a bridging callus of three of the four cortices seen on the anteroposterior and lateral radiographs views of the humerus. Malunion was defined as healing occurring at >15° of angulation. A non-union was diagnosed when healing had not occurred after six months Shoulder function was assessed using the UCLA (University of California, Los Angeles Shoulder Scale), the parameters including pain(10 points), motion(10 points), function(10 points), and patient satisfaction(5 points). Subjective criteria constitute 15 points of a total of 35 points, and the findings on examination comprise the remaining 20 points. The sores were further divided into excellent (34-35 points), good (29-33 points), fair (21-28 points), and poor(0-20 points) according to

Ellman(11). Elbow function was assessed using MEPS(Mayo Elbow Performance Score), which evaluates patients on a 100-point scale regarding pain(45 points), range of motion(20 points), stability (10 points), and function (25 points). Function of the joint is classified as excellent(>90 points), good (75-89 points), fair (60-74 points), or poor (<59 points). An independent sample t-test was used to compare the result of the patient's age, duration of injury, operation time, bone healing time, the motion of the shoulder and elbow, and score of UCLA and MEPS. The level of significance was set at $p< 0.05$.

Results

Statistical analysis: Data were coded and entered using the statistical package for the Social Sciences (SPSS) version 26 (IBM Corp., Armonk, NY, USA). Data were summarized using mean, standard deviation, median, minimum and maximum in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. Comparisons between quantitative variables were done using the non-parametric Mann-Whitney test *(Chan, 2003a)*. For comparing categorical data, Chi-square (X^2) test was performed. Exact test was used instead when the expected frequency is less than 5 *(Chan, 2003b)*. P-values less than 0.05 were considered statistically significant.

Patients were divided into two groups in this study.

Table (1) shows that the mean age in the Conventional group was 35.87±14.07 and the minimally invasive group was 33.67±11.78 years. Comparison between two patients' groups shows that means of age were nearly equal between both groups with no statistically significant difference (p 0.05). Males were more prevalent in both groups 10(66.7%) and 11(73.3%) in the Conventional group and minimally invasive group respectively. No statistically significant difference was found by comparison between the two patients' groups as regards gender.

Table (2) shows that in the conventional group, the mechanisms of injury distribution were 9(60%) RTA, 5(33.3) fall on the ground, and 1(6.7%) blunt trauma which was identical to the minimally invasive group with no statistically significant difference. Also, the injury was classified in the conventional group to 6(40.0%) type A, 5(33.3%) type B, and 4(26.7%) type C and in minimally invasive group 4(26.7%) type A, 7(46.7%) type B, and 4(26.7%) type C with no statistically significant difference. The closed injury was more prevalent in both groups 13(86.7%) and 14(93.3%) in the conventional group and minimally invasive group respectively with no statistically significant difference. The level was 7(46.7%) distal third and 8(53.3%) mid-shaft in both groups, which was not statistically significantly different. The dominant arm was 8(53.3%) right, and 7(46.7%) left in the Conventional group and was 7(46.7%) right and 8(53.3%) left in the minimally invasive group with no statistically significant difference.

Table (3) shows that there was associated injury in 2(13.3%) patients in the conventional group, one of them had a fractured femur, and the other had a fractured forearm, and in the minimally invasive group there was associated injury in 3(20.0%) patients, the first had a fractured femur, the second fracture tibia, and the third had a fractured radius. There was no statistically significant difference found by comparison between the two patients' groups as regards associated injury.

Table (5) shows that the interval between injury and operation in the day in the conventional group ranged from 2 to 13 days with a median of 6 days and mean± SD was 6.33 ± 3.52 and in the minimally invasive group the range was from 2 to 16 days with a median of 9 days and mean± SD was 8.53 ± 4.49 days. It also shows that the operative time in minutes in the conventional group ranged from 60 to 160 minutes with a median of 90 minutes and mean± SD was 104.00 ± 35.06 and in the minimally invasive group the range was from 70 to 195 minutes with a median of 100 minutes and mean± SD was 105.00 ± 36.30 minutes. Comparison between two patients' groups shows that there was no statistically significant difference between the two groups as regards interval between injury and operation, and Operative time (p 0.05).

Table (6) shows that blood loss in cc in the Conventional group ranged from 250 to 550 cc with a median of 390 cc and mean± SD was 391.33 ± 83.05 cc and in the minimally invasive group the range was from 50 to 130 cc with a the time to union in weeks in the Conventional group ranged from 12 to 52 weeks with a median of 18 weeks and mean± SD was 22.47 ± 11.79 weeks and in the minimally invasive group the range was from 8 to 24 weeks with a median of 12 weeks and mean± SD was 14.67 ± 4.76 weeks. Comparison between two patients' groups shows that blood loss in cc, and time to the union were statistically significantly higher in the conventional group than minimally invasive group ($p<0.05$).

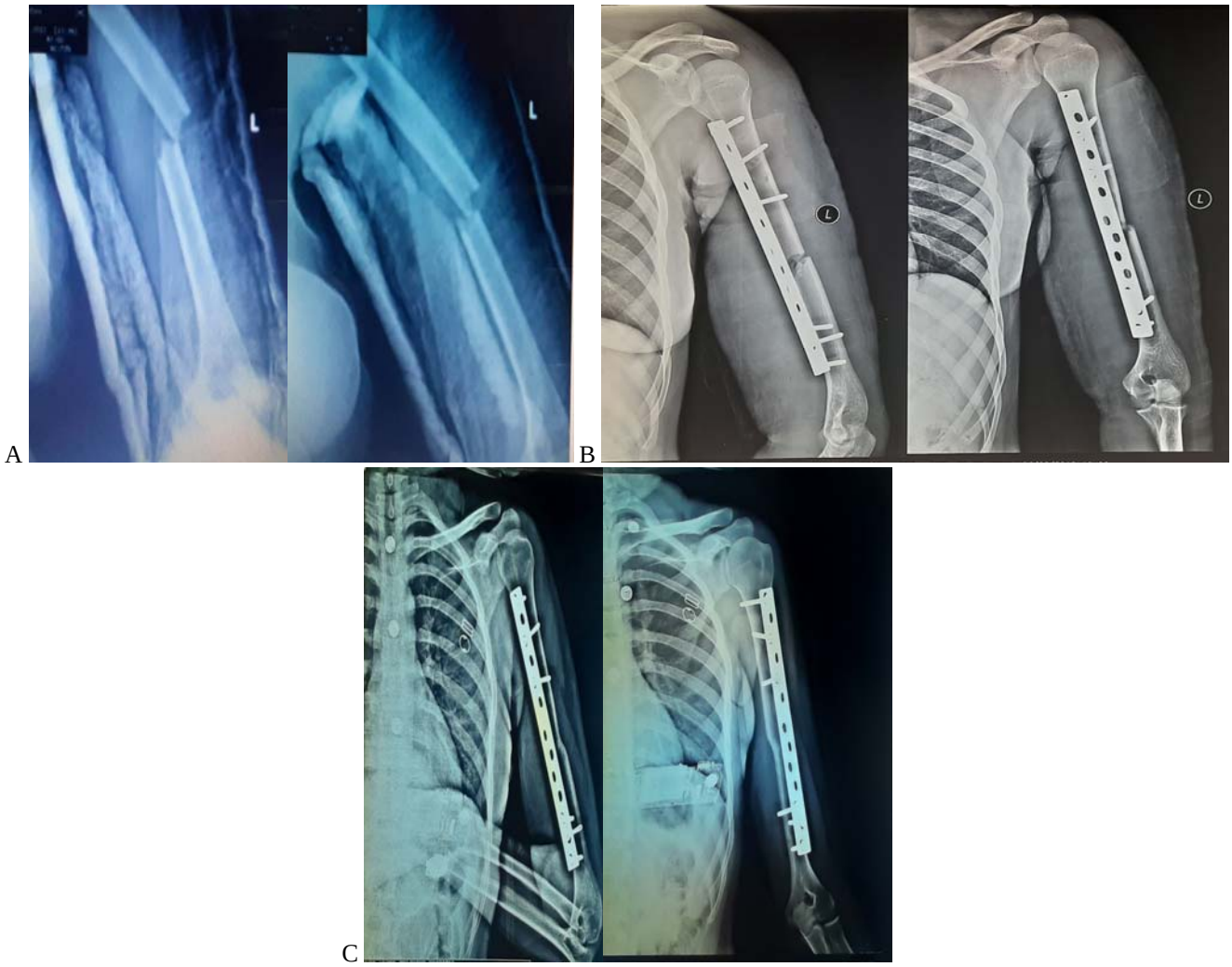

Fig 2: A mid-shaft fracture of the left humerus of a 36 years old, female patient, treated with the MIPO technique. A: pre-operative X-rays show the fracture. B: Radiographs immediately postoperative**.** C: radiographs after the complete union.

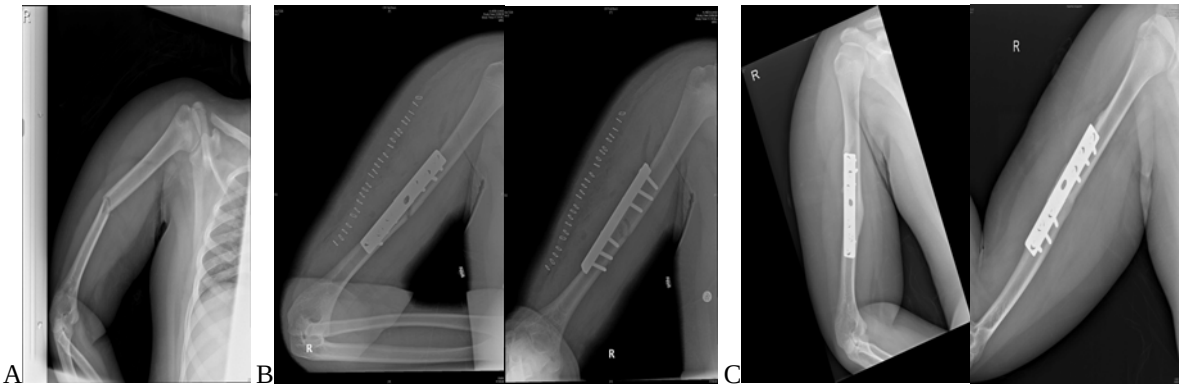

Fig 3: a: preoperative radiographs of a fracture shaft humerus in a 27 years old male patient, b: immediate postoperative X-rays after open reduction and internal fixation with a plate and screws, c: Radiographs after the complete union.

Regarding functional outcome according to UCLA scoring system, in the first group who were treated with ORIF, 4(26.6%) cases were excellent, 7(46.6%) good, 3(20%) fair, and one case (6.6%) was poor.

In the MIPO group of patients, 7(46.6%) cases were excellent, 5(33.3%) cases good, 3(20%) cases had fair results, and no patients had a poor result.

According to MEPS, the ORIF group showed, 7(46.6%) cases excellent, 4(26, 6%) cases good, and 4(26.6%) cases had fair results. In the MIPO group, 9(60%) cases had excellent results, 5(33.3%) cases good results, and only one case (6.6%) fair result.

Table 1: Comparison between two patients' groups as regards sex and age

		Conventional group		Minimally invasive group		P-value
		Count	%	Count	%	
sex	Male	10	66.7%	11	73.3%	1
	Female	5	33.3%	4	26.7%	
Age	Median (Minimum-Maximum) Mean± SD	32.00 (19-64) 35.87±14.07		31 (20-58) 33.67±11.78		0.838

Table 2: Comparison between two patients' groups as regards the injury mechanism, classification, open or closed, and level, and the dominant arm

		Conventional group		Minimally invasive group		P-value
		Count	%	Count	%	
Mechanism of injury	R.T. A	9	60.0%	9	60.0%	1
	Fall on ground	5	33.3%	5	33.3%	
	blunt trauma	1	6.7%	1	6.7%	
Classification	Type A	6	40.0%	4	26.7%	0.895
	Type B	5	33.3%	7	46.7%	
	Type C	4	26.7%	4	26.7%	
Open or closed	open	2	13.3%	1	6.7%	1
	closed	13	86.7%	14	93.3%	
Level	distal third	7	46.7%	7	46.7%	1
	Mid shaft	8	53.3%	8	53.3%	
dominant arm	Rt	8	53.3%	7	46.7%	0.715
	Lt	7	46.7%	8	53.3%	

Table 3: Comparison between two patients' groups as regards associated injury and associated injury details

		Conventional group		Minimally invasive group		P-value
		Count	%	Count	%	
Associated injury	Yes	2	13.3%	3	20.0%	1
	No	13	86.7%	12	80.0%	
Associated injury details	fracture femur	1	6.7%	1	6.7%	1
	fr. Rt. Tibia	0	0.0%	1	6.7%	
	fr. lt. radius	0	0.0%	1	6.7%	
	Fracture lt. orearm	1	6.7%	0	0.0%	
	No	13	86.7%	12	80.0%	

Table 4: Comparison between two patients' groups as regards Perioperative, and Late complications

		Conventional group		Minimally invasive group		P-value
		Count	%	Count	%	
Perioperative complications	Radial n. injury	4	26.7%	0	0.0%	0.100
	Superficial infection	0	0.0%	1	6.7%	
	no complications	11	73.3%	14	93.3%	
Late complications	Delayed union	1	6.7%	1	6.7%	1
	no complications	14	93.3%	14	93.3%	

Table 5: Comparison between two patients' groups as regards interval between injury and operation in days, and Operative time in minutes

		Conventional group	Minimally invasive group	P-value
Interval between injury and operation (D)	Median (Minimum-Maximum) Mean± SD	6.00 (2.00-13.00) 6.33 ± 3.52	9.00 (2.00-16.00) 8.53 ± 4.49	0.187
Operative time (m)		90.00 (60.00-160.00) 104.00 ± 35.06	100.00 (70.00 - 195.00) 105.00 ± 36.30	0.806

Table 6: Comparison between two patients' groups as regards blood loss in cc, and time to union

		Conventional group	Minimally invasive group	P-value
Blood loss in cc	**Median (Minimum - Maximum) Mean± SD**	**390.00 (250.00 - 550.00) 391.33 ± 83.05**	**70.00 (50.00 - 130.00) 80.33 ± 25.53**	**0.001**
Time to union range frame (10 - 52w)		**18.00 (10.00 - 52.00) 22.47 ± 11.79**	**12.00 (8.00 - 24.00) 14.67 ± 4.76**	**0.037**

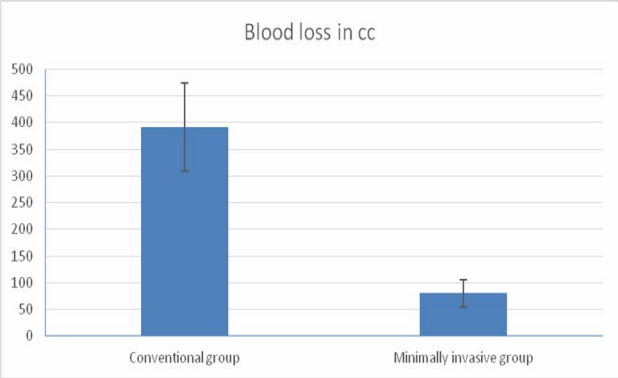

Figure 1: Comparison between two patients' groups as regards blood loss in cc.

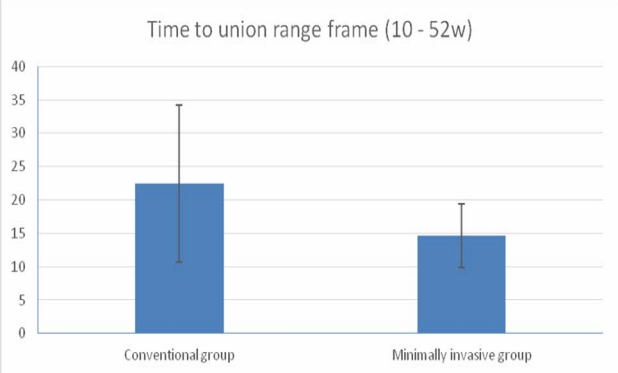

Figure 2: Comparison between two patients' groups as regards time to union

Discussion

Open reduction internal fixation of humerus shaft fractures is considered the standard operative modality. Many kinds of literature on this treatment report healing rates that range between 88% and 100%. Adequate fracture reduction is consistently reported, with malunion occurring in less than 5% of cases[12, 13,14].

Because of the numerous complications of conventional open reduction and internal fixation of humeral shaft fractures, such as wound healing problems, infections, and iatrogenic radial nerve palsy, MIPO has emerged as a procedure for managing such fractures[3].

In a study by Paris et al., the rate of nonunion after open reduction and internal fixation of humeral shaft fractures was 5.8% (8/138 humeral shaft fractures)[15].

In a study conducted by Jiang R, et al[16], among 21 patients with humeral shaft fractures who were treated with MIPO technique, 19 fractures (90.4%) achieved a solid union in an average of 14.3 weeks. Nonunion developed in two patients and a second bone grafting operation was performed to achieve union.

In another study by Zhiquan An, et al, 17 humeral shaft fractures who were treated with MIPO technique united in a mean of 15 weeks, while the 16 fractures treated with ORIF united in 21 weeks. One case of delayed union occurred which resulted from the loosening of the screws in the proximal end of the plate. The patient was treated nonoperatively with union occurred at 17 months postoperatively[17].

Fang Ji, et al, conducted a study on 22 patients with humeral shaft fracture treated with MIPO technique. The union time was 6.3 weeks(range, 4-11 weeks). Union was achieved in all patients without bone grafting[18].

Juan M, reported a 91% union rate out of 35 patients after a mean of 12 weeks(range 8-16 weeks) with humeral shaft fracture who were treated with MIPO technique. Among them, 15 patients with an open fracture, 6 had preoperative radial nerve palsy, and 9 had concomitant thoracic, musculoskeletal or vascular injury[19].

Malhan S, et al, studied the results of MIPO using a locking compression plate and found that all fractures united after 14 weeks except for 2 cases with the delayed union, and only one patient had iatrogenic radial nerve palsy[20].

An et al.[14] demonstrated the results of ORIF and MIPO in the treatment of shaft humerus fractures. The mean fracture union time was 15.29 weeks in the MIPO group and 21.25 weeks in the ORIF group.

In our study, all cases treated with plate and screws have been united with a median of 18 weeks without the need for secondary intervention or bone grafting procedure. However, one case of delayed union which needed bone grafting procedure canceled because of patient refusal and ended finally in the sound union after about 52 weeks. On the other hand, the group of patients treated with MIPO technique showed better fracture union time with a median of 12 weeks.

The radial nerve does not need to be explored or dissected during MIPO technique procedures, which is an advantage in contrast to the open reduction technique in which radial nerve should be carefully exposed and protected during the whole operation. The incidence of radial nerve injury after open technique and despite meticulous nerve protection is reported to be from 5.1% [15] to 17.6%[21].

According to Apivatthakakul et al, when a plate is placed on the anterior side of the humeral shaft, the mean distance from the closest part of the plate to the radial nerve is 3.2mm[22]. The brachial muscle that covers most of the anteriorly placed plate protects the radial nerve when a plate is inserted sub-muscularly through two small incisions on the anterior side of the arm away from the fracture site.

Pospula, et al reported only one case of iatrogenic radial nerve palsy in a series of 12 cases of humeral shaft fracture treated with MIPO technique [23], while Fang et al reported one case out of 23 cases of fracture shaft of the humerus which recovered 5 months after a second operation for radial nerve exploration which confirmed that traction is the cause of the nerve dysfunction[18].

Livani et al reported good results in 35 cases of fracture shaft humerus treated with MIPO technique without iatrogenic radial nerve injury[24].

In the study of Zhiquan An et al[17], among 17 cases of fracture shaft humerus treated with MIPO technique, no iatrogenic radial nerve palsy was reported, on the other hand, 5 out of 16 patients treated with ORIF had iatrogenic radial nerve injury.

An et al, study[14] reported iatrogenic radial nerve palsy in five cases in the ORIF group, which recovered spontaneously, while there was no radial nerve palsy in the patients treated with the MIPO technique.

In our study, Iatrogenic radial nerve injury was noticed in 3 cases treated with the ORIF technique out of 15 fractures(20%), which recovered spontaneously. No radial nerve palsy occurred in MIPO group.

In Jiang R et al study and at the last follow-up of this group of patients, 20 cases out of the 21 patients had a good alignment(less than 5° of angulation in either plane), and only one had mild varus alignment of 8°. As regards functional recovery, all patients had a good to excellent elbow function. Eighteen patients achieved satisfactory shoulder function. Neither implant failure nor deep infection was found during the follow-up period[16].

In the study of An et al,[14] were 19 fractures were treated with MIPO technique and 21 fractures with ORIF technique. The mean UCLA shoulder score was 34.78 in the MIPO group and 34.42 in the ORIF group. The MEPS in these two groups was 99.44 and 99.74 respectively. Concha et al,[19] studied a series of 35 patients who underwent MIPO for humerus shaft fractures and reported the occurrence of only one deep and one superficial infection, which represents a 6% infection rate.

In Fang et al series, functional outcomes for shoulder and elbow function were similar in both groups(18).

We found that blood loss in cc, in the Conventional group ranged from 250 to 550 cc, and in the minimally invasive group, the range was from 50 to 130 cc.

In Jiang study [16], blood loss with MIPO technique was more, range from 300-600 cc. On contrary, Lee HJ, et al [25] gave better results concerning blood loss intraoperatively on fractures treated with MIPO technique, ranging from 50-128 cc similar to our results.

In our study, There were two cases of superficial infection in the ORIF group, which recovered completely with daily dressings and local antiseptics without the need for surgical debridement.

Regarding functional outcome in our two group patients, and according to UCLA scoring and MEPS scoring system. Both showed better functional recovery in the MIPO group than the ORIF group.

Also, we had no significant postoperative deformities in either group.

Conclusion

When compared to the conventional plating technique, MIPO offers advantages in terms of accelerated fracture union, reduced incidence of iatrogenic radial nerve palsy, less incidence of infection, and better functional outcome of shoulder and elbow. However, MIPO technique requires more learning curves to achieve the best results and functional outcome of this technique.

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