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Original Research Article

Function of Infected Nonunion of the Distal Humerus Using Ilizarov Treatment-A Prospective Study

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Abstract: ***Introduction*:** Infected nonunion of the distal humerus is a challenging condition to treat, and Ilizarov treatment may be a viable option in some cases. Ilizarov treatment involves the use of an external fixation device to stabilize the bone and promote bone healing. ***Aim of the Study*:** The aim of this study was to evaluate the function of infected nonunion of the distal humerus using Ilizarov treatment. ***Methods*:** This prospective study was conducted in Department of Orthopedics, Dhaka Medical College Hospital, Dhaka, Bangladesh, during the period from June 2003 to June 2007. Total 203 patients with infected nonunion of the distal humerus were included in this study. ***Result*:** In our study, mean age of the sample is 41.9 (SD±16.31) years. Majority of the study subject (58.6%) were female. The mean value of time to union was 8.1 months, with a standard deviation of 2.34 months. Mean follow up period was 35.5 months, with a standard deviation of 15.7 months. In bone results, majority of the study subject (63.1%) had an excellent outcome. In the functional results, most of the study subject (69.5%) had an excellent outcome. Regarding complications, majority of the study population (41.4%) had pin tract infection. For the elbow ROM arc parameter, there is a statistically significant difference between the preoperative and postoperative values (P=0.0016). The mean shoulder abduction reduced from 128.02° (SD±32.56°) to 123.75° (SD±24.25°) after treatment. For the shoulder abduction parameter, there is no statistically significant difference between the preoperative and postoperative values (P=0.1348). The DASH score decreased from a mean of 31.14 to 9.61 after treatment. For the DASH score, there is a highly statistically significant difference between the preoperative and postoperative values (P<0.0001). The mean preoperative VAS score was 7.05. After completion of treatment, the mean VAS score dropped to 2.21. For VAS score, there is a highly statistically significant difference between the preoperative and postoperative values (P<0.0001). ***Conclusion*:** From the findings of this study, it can be concluded that Ilizarov technique is effective in the treatment of infected nonunion of the distal humerus, as regards bone healing and eradication of infection with a relatively low incidence of complications.

Keywords: Function, Infected Nonunion, Distal Humerus and Ilizarov.

I. INTRODUCTION

A distal humerus fracture makes up around 4% of all fractures [1]. Between 2% and 5% of these fractures progress to nonunion [2, 3]. Distal humerus fractures progressing to nonunion tend to be difficult to bring to union [4-6]. Bony union failure after a distal humerus fracture is painful and incapacitating. Motion at the nonunion site contributes to pain, decreased elbow function, and disability [7-10]. Hardware will eventually fail or loosen, frequently creating a windshield wiper effect of the screws in the bone, further compromising bone stock [11, 12]. The increased motion at the supracondylar level, excessive scar formation, and inflammation around the ulnar nerve can cause nerve symptoms such as pain, numbness, and/or paresthesias. Because of a combination of inadequate stability and low biological activity, a nonunion of the distal humerus is frequently

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oligotrophic. Supracondylar, transcondylar, intercondylar, unicondylar (medial or lateral), or osteochondral subclassifications are possible dependent on where they are found [13, 14]. Despite receiving the necessary medical and surgical treatment, a distal humerus nonunion might last for years [5, 15]. With a distal humeral nonunion, infection makes treatment more difficult and is linked to inferior functional results, fewer alternatives for fixation, and worse success rates for bony union [16, 17]. Treatment for nonunion of the humerus can be challenging since, in the majority of patients, past repeated surgical interventions have left scarring and fibrosis as well as accompanying shoulder and elbow stiffness [18]. Treatment for infected humeral nonunion has been accomplished using a variety of external fixators [19-21]. External Ilizarov fixators have proven to be more effective in treating such situations than other techniques [19-25]. The Ilizarov method's fundamental idea is to stimulate ossification by applying compression stress, which creates an environment that is conducive to bone fragment mending and biosynthetic processes that boost local resistance to infection incidence [26]. The Ilizarov technique has been proven to be successful in treating humeral diaphysis nonunions [19]. In addition to treating cubitus varus and valgus deformities, the Ilizarov procedure has also been utilized to treat supracondylar fractures [27-30]. In infected nonunion, the usual treatment protocol is removal of hardware, if any, debridement and some form of external fixation followed by bone grafting once the infection subsides [31-33]. The advantage of Ilizarov's method is that it can be done even in the presence of infection and the deformity, if any, can also be corrected simultaneously. There is no necessity for bone grafting in most cases [19, 24, 34]. The present study was conducted to assess the function of infected nonunion of the distal humerus using Ilizarov treatment.

II. OBJECTIVES

To evaluate the function of infected nonunion of the distal humerus using Ilizarov treatment.

III. METHODOLOGY & MATERIALS

This prospective study was conducted in Department of Orthopedics, Dhaka Medical College Hospital, Dhaka, Bangladesh, during the period from June 2003 to June 2007. Total 203 patients with infected nonunion of the distal humerus were included in this study. Consent of the patients and guardians were taken before collecting data. After collection of data, all data were checked and cleaned. After cleaning, the data were entered into computer and statistical analysis of the results being obtained by using windows-based computer software devised with Statistical Packages for Social Sciences version 22. After compilation, data were presented in the form of tables, figures and charts, as necessary. Numerical variables were expressed as mean and standard deviation, whereas categorical variables were count with percentage. Quantitative data among groups were analyzed by ANOVA test followed by exploration of significant difference between all possible paired group means by Bonferroni test. P value of less than 0.05 was considered statistically significant.

IV. RESULT

Table-I shows the demographic characteristics of the study people. In our study, majority of the study people were aged between 41-50. The mean age of the sample is 41.9 (SD±16.31) years. The sample is predominantly female, with women comprising 58.6% of the study people. The mean time from injury to the time of the study's presentation is 7 months, with a standard deviation of 5.2 months. The majority of study people have a closed fracture (79.3%), while the remaining study people have an open fracture (20.7%). The majority of study people have a stiff non-union (71.4%), while 27.1% of study people have a mobile non-union. More than half of the study people have had at least one previous surgery (72.4%), and about a third of study people have had two or more previous surgeries. Table II shows the post treatment outcome of the study people. The mean value of time to union was 8.1 months, with a standard deviation of 2.34 months. Mean follow up period was 35.5 months, with a standard deviation of 15.7 months. In bone results, 128 study people (63.1%) had an excellent outcome, 50 (24.6%) had a good outcome, 25 (12.3%) had a fair outcome, and none had a poor outcome. In the "Functional results" category, 141 study people (69.5%) had an excellent outcome, 45 (22.2%) had a good outcome, 10 (4.9%) had a fair outcome, and 7 (3.4%) had a poor outcome. Regarding complications, 84 study people (41.4%) had a pin tract infection, 8 (3.9%) had a nerve injury, 6 (3.0%) had elbow stiffness, and 5 (2.5%) had a refracture. Table III compares the preoperative and postoperative values of elbow ROM arc, shoulder abduction, DASH score and VAS score. For the elbow ROM arc parameter, there is a statistically significant difference between the preoperative and postoperative values (P=0.0016), indicating that there was a significant improvement in elbow range of motion following the surgery. The mean shoulder abduction reduced from 128.02° (SD±32.56°) to 123.75° (SD±24.25°) after treatment. For the shoulder abduction parameter, there is no statistically significant difference between the preoperative and postoperative values (P=0.1348). The DASH score decreased from a mean of 31.14 to 9.61 after treatment. For the DASH score, there is a highly statistically significant difference between the preoperative and postoperative values (P<0.0001). The mean preoperative VAS score was 7.05. After completion of treatment, the mean VAS score dropped to 2.21. For VAS score, there is a highly statistically significant difference between the preoperative and postoperative values (P<0.0001).

Table-I: Demographic characteristics of the people (N=203).

Characteristics		n	%
Age	≤30	26	12.8
	31-40	68	33.5
	41-50	79	38.9
	>50	30	14.8
	Mean ±SD	41.9±16.31	
Sex	Male	84	41.4
	Female	119	58.6
Time from injury to presentation (Months)	Mean ±SD	7±5.2	
Fracture type	Closed	161	79.3
	Open	42	20.7
Type of Non- union	Mobile	55	27.1
	Stiff	145	71.4
Number of previous surgery	None	31	15.3
	One	86	42.4
	Two	56	27.6
	More than two	30	14.8

Table-II: Post treatment outcome of the study people (N=203)

Outcome		n	%
Time to union (Months)	Mean ±SD	8.1±2.34	
Follow up (Months)	Mean ±SD	35.5±15.7	
Bone results	Excellent	128	63.1
	Good	50	24.6
	Fair	25	12.3
	Poor	0	0.0
Functional results	Excellent	141	69.5
	Good	45	22.2
	Fair	10	4.9
	Poor	7	3.4
Complications	Pin tract infection	84	41.4
	Nerve injury	8	3.9
	Elbow stiffness	6	3.0
	Refracture	5	2.5

Table-III: Comparison of preoperative and postoperative elbow ROM arc, shoulder abduction, DASH score and VAS score of the study people (N=203)

Parameter	Preoperative (Mean ±SD)	Postoperative (Mean ±SD)	P-value
Elbow ROM arc	96.70±29.18	105.84±28.71	0.0016^{S}
Shoulder abduction (°)	128.02±32.56	123.75±24.25	0.1348^{NS}
DASH score	31.14±14.45	9.61±11.37	$<0.0001^{S}$
VAS score	7.05±1.33	2.21±1.95	$<0.0001^{S}$

ROM- Range of Motion, DAS- Disabilities of Arm Shoulder and Hand, VAS- Visual Analogue Score, S- Significant, NS- Not significant

V. DISCUSSION

Nonunions of the distal humerus are a rare occurrence, and typically result in instability, reduced elbow mobility, strength loss, pain, and functional loss [35]. Inadequate selection of surgical techniques or implants during the primary fracture operation is an important factor that contributes to the development of nonunion of the distal humerus [36]. Treating nonunions in this region after previously unsuccessful surgeries is challenging and complex [37]. In this series, we have used the Ilizarov method in treating patients with infected nonunion of the distal humerus. In our study, mean age of the sample is 41.9 (SD±16.31) years. Lammens J *et al.*, [38] found an average age of 39 years (range, 15-71 years) of the study people at the time of surgery. Majority of the study subject (58.6%) were female. In the study of Mofakhkharul B *et al.*, [39], a higher predominance of female patients was seen which is similar to our study. In our study, the mean time from injury to the time of the study's presentation is 7 (SD±5.2) months. The majority of study participants had a closed fracture and a stiff non-union, and more than half had undergone at least one previous surgery.

The mean value of time to union was 8.1 months, with a standard deviation of 2.34 months with a mean follow up period of 35.5 (SD±15.7) months. In the study of Safoury YA *et al.,* [40] the mean time to achieve full union was 6.87± 0.99 months (range, 6-8 months) with a mean follow-up period after frame removal of 3.22±0.65 years (range, 2.40-4.20 years). In another study of Tomić S *et al.,* [41], all the patients achieved solid bony union after an average of seven months from the application of the external fixator. The findings of these studies are in line with our study. In terms of treatment outcomes, the study found that most study participants had excellent or good outcomes in both bone and functional measures, with only a small percentage having fair or poor outcomes. Similar outcomes were found in many studies. In the study of Meselhy MA *et al.,* [42], in both bone and functional measures, most of the study participants had excellent or good outcomes. In another study of Das DK *et al.,* [43] the bone healing and functional outcome were excellent in most of the cases. The study also noted that a significant percentage of participants experienced complications, such as pin tract infection, nerve injury, elbow stiffness, and refracture. Pin tract infection was the commonest complication in other studies also [24, 38, 40, 42]. For the elbow ROM arc parameter, there is a statistically significant difference between the preoperative and postoperative values (P=0.0016). The mean shoulder abduction reduced from 128.02° (SD±32.56°) to 123.75° (SD±24.25°) after treatment but there is no statistically significant difference between the preoperative and postoperative values (P=0.1348). In the study of Meselhy MA *et al.,* [44] the elbow ROM arc parameter significantly reduced from 97.0±31.68 to 106.75±30.49 and mean shoulder abduction reduced from 127.25±36.47 to 123.5±22.07. In another study of Safoury YA *et al.,* [40], there was improvement of shoulder and elbow motion after treatment. The DASH score decreased from a mean of 31.14 to 9.61 after treatment. For the DASH score, there is a highly statistically significant difference between the preoperative and postoperative values (P<0.0001). The mean preoperative VAS score was 7.05. After completion of treatment, the mean VAS score dropped to 2.21. For VAS score, there is a highly statistically significant difference between the preoperative and postoperative values (P<0.0001). These findings are comparably similar to other studies [40, 44]. In the study of Safoury YA *et al.,* [40], the mean DASH score before surgery was 90.66±5.66, whereas that after surgery was 24.62±3.85. There was a significant improvement in the DASH score after surgery; the mean difference was 66.04±1.81 (P < 0.001). In the study of Meselhy MA *et al.,* [44], DASH score significantly reduced from 29.27±11.52 to 7.54±13.69 and the VAS score significantly reduced from 7.15±1.46 to 1.9±2.1 after completion of the treatment. The findings of this study show good outcomes in terms of bone and functional assessments for the majority of study people, with relatively low incidence of complications. Overall, the surgery was effective in improving elbow range of motion and reducing patient-reported disability and pain following the surgery, but did not have a significant impact on shoulder abduction. It's important to note that the study has its own limitations and the results may not be generalizable to other populations.

Limitations of the study

In our study, there was small sample size and absence of control for comparison. Study population was selected from one center in Dhaka city, so may not represent wider population. The study was conducted at a short period of time.

VII. CONCLUSION AND RECOMMENDATIONS

From the findings of this study, it can be concluded that Ilizarov technique is effective in the treatment of infected nonunion of the distal humerus, as regards bone healing and eradication of infection with a relatively low incidence of complications. Further study with larger sample size is required to have better understanding about the use of Ilizarov technique for the treatment of infected nonunion of the distal humerus

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