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The Effect of Deformity on Functional Scores in Humerus Shaft Fractures Treated With Functional Bracing

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ABSTRACT

Purpose: The aim of the study is to evaluate the effect of deformity on functional scores of humeral shaft fracture patients who treated conservatively with functional bracing.

Methods: Patients who had humeral shaft fracture and treated with functional bracing between 2014 and 2019, were included in this study. Second or third day, two part functional brace was applied. The deformity angle of the humerus on the anteroposterior and lateral radiography was measured and divided into 3 groups. Elbow range of motion (ROM), shoulder abduction and the difference of range of external rotation (ER) compared to contralateral shoulder was evaluated. Moreover, Constant scores of the shoulder and Mayo scores of the elbow were evaluated.

Results: Forty-two patients were evaluated. The mean healing time was determined as 12.11 ± 2.31 weeks. Thirty-seven of the patients were successfully treated. Nonunions were detected in only 5 patients during follow-up. The varus deformity was measured between 6°-10° in 18 patients, >11° in 12 patients, and between 0°-5°in 7 patients. In the varus deformity groups, a statistically significant difference was observed for the external rotation measurements (p:0.044) and for elbow ROM measurements (p: 0.048). The reason of the external rotation and elbow ROM measurements difference was >11° varus deformity group. There was no statistically significant difference between the shoulder abduction range, Mayo scores and shoulder constant scores of the varus deformity groups (p>0.05).

Conclusion: Our clinical and radiological datas show that satisfactory results are obtained in most of the humeral shaft fractures treated with functional bracing.

Keywords: Humeral shaft fractures, functional bracing, nonoperative treatment of Humerus fractures

Fonksiyonel Breys ile Tedavi Edilen Humerus Şaft Kırıklarında Deformitenin Fonksiyonel Skorlar Üzerine Etkisi

ÖZET

Amaç: Bu çalışmanın amacı, fonksiyonel breys ile konservatif tedavi edilen humerus cisim kırığı hastalarında deformitenin fonksiyonel skorlar üzerindeki etkisini değerlendirmektir.

Yöntem: 2014-2019 yılları arasında humerus cisim kırığı olan ve fonksiyonel breys ile tedavi edilen hastalar bu çalışmaya dahil edildi. Kırıktan sonra ikinci veya üçüncü gün, iki parçalı fonksiyonel korse uygulandı. Ön-arka ve yan radyografilerde humerusun deformite açısı ölçüldü ve 3 gruba ayrıldı. Dirsek hareket açıklığı(EHA), omuz abdüksiyonu ve karşı omuza göre dış rotasyon açıklığı farkı değerlendirildi. Ayrıca omuz Constant skorları ve dirsek Mayo skorları değerlendirildi.

Bulgular: 42 hasta değerlendirildi. Ortalama iyileşme süresi 12.11 ± 2.31 hafta olarak belirlendi. 37 hasta başarıyla tedavi edildi. Takiplerde sadece 5 hastada kaynamama saptandı. Varus deformitesi 18 hastada 6°-10°, 12 hastada >11° ve 7 hastada 0°-5° arasında ölçüldü. Varus deformitesi gruplarında dış rotasyon ölçümlerinde (p:0.044) ve dirsek EHA ölçümlerinde (p:0.048) istatistiksel olarak anlamlı fark gözlendi. Dış rotasyon ve dirsek EHA ölçümleri farkının nedeni >11° varus deformitesi grubuydu. Varus deformitesi gruplarının omuz abdüksiyon aralığı, Mayo skorları ve omuz constant skorları arasında istatistiksel olarak anlamlı fark yoktu (p>0.05).

Sonuç: Klinik ve radyolojik verilerimiz fonksiyonel breys ile tedavi edilen humerus cisim kırıklarının çoğunda tatmin edici sonuçlar alındığını göstermektedir.

Anahtar kelimeler: Humerus şaft kırıkları, fonksiyonel breys, humerus kırıkları cerrahi dışı tedavisi

Humeral shaft fractures account for 1-3% of all adult fractures (1,2). And incidance is about 10-20/100.000 person-years. In elderly patients it increases up to 100/100000 (3,4). Generally causes of humeral shaft fractures are simple falls, sport injuries and traffic accidents (5).

There is a consensus that most of the humerus shaft fractures can be treated by conservative methods (2,3). And functional bracing treatment is the most widely used method for acute, isolated and closed humeral shaft fracures (3). On the other hand surgery is recommended in case of neurovascular injuries, open fractures, multitrauma, floating elbow, bilateral humeral shaft fracture, pathological fracture, improper reduction and brachial plexus or vascular pathology with humeral shaft fracture (4,5). The most important advantage of the open reduction is visualization of fracture sites for anatomic reduction. Also, different complications can occur. Such as pseudoarthrosis, infection, shoulder stiffness, axillary nerve palsy, radial nerve palsy, tendon injuries and implant failure (6,7).

The treatment firstly requires follow-up for approximately 2 weeks in a well molded splint. Then a functional brace is used. Sarmiento et al. popularized that procedure in 1970's. Working principles of the humeral functional braces are circumferentially compression effect, active contraction of the muscles and gravity effect. Functional bracing allows full range of motion at the shoulder and elbow joints and good or excellent outcomes. Moreover, shoulder function problems, malunion, and non-unions were reported after conservative treatment (8,9). Nonunion with a functional bracing is rare. However, it occurs commonly in the proximal third of humeral shaft fractures (10).

Functional bracing treatment for humeral shaft fractures is a challenging process for the physician and patient. In the first 3-6 weeks, patients are followed up in weekly outpatient controls. It is checked whether the angulation is within acceptable limits with radiographs (11). Acceptable limits are maxium 3 cm shortening, 20° anterior-posterior angulation and 30° varus-valgus angulation and 15° pamalrotation.

The aim of the current study is to evaluate the effect of deformity on functional scores of humeral shaft fracture patients who treated conservatively with functional bracing.

MATERIALS AND METHODS

Patients who had humeral shaft fracture and treated with functional bracing between November 2014 and December 2019, were included in this study. The study was approved by the Institutional Review Board. Patients data records and radiographic images were analyzed retrospectively. Patients age, sex, fracture site, mechanism of injury, and duration of fracture union were recorded.

Proximal and distal humerus fractures, bilateral humerus fractures, polytraumatised patients, neurovascular injury, patients under 18 and over 85 years, intraarticular fractures, pathologic fractures, open fractures, humeral shaft fracture with shouder or elbow pathologies, another trauma affecting the same extremity, and prior shoulder, humerus or elbow surgery were excluded from the study.

At the beginning, all patients were immobilized with a U splint and an arm sling. After that patients were followed up in the outpatient clinic. When the pain and edema of the arm subsided, two part functional brace was applied about second or third day (Figure 1). The brace was fitting properly to the soft tissue curves and creases of the arm. It was fitted by an orthopedic surgeon and plaster technician who was experienced. The same brace was applied to all humeral shaft fractures. After aplication of the brace, fracture reduction was evaluated in control humerus AP and lateral radiographs. Rehabilitation was started in patients whose reduction was within acceptable limits. Pendular shoulder exercises and flexion and extension of the elbow was begun immediately. After 3 weeks passive range of motion (ROM) exercises of shoulder started. After 6 weeks active exercises and after 9 weeks scapulohumeral rhythm exercises were started. In order to avoid the angulation of fracture patients were told not to lean on their elbow and abduct the shoulder. Except the times spent for personal hygiene, functional orthesis was used for all the time. The brace was used until bony union.

In the first month, patients were followed up every week, after the first month twice a month. In all outpatient clinic controls, radiological evaluations of the patients were performed on AP and lateral humerus radiographs. The functional bracing treatment was ended after the clinical and radiological fracture union was achieved. Union was defined when there was no pain and abnormal movement at the fracture site and radiologically bridging between the fragments was visualized.

Figure 1: Functional brace

At the outpatient control, the deformity angle on the anteroposterior x-ray was measured and coronal plane deformities were divided into three groups, namely 0°-5°, between 6°-10°, and >11° varus. And the deformity angle on the lateral x-ray was measured ande sagittal plane deformities were divided into three groups, namely 0°-5°, between 6°-10°, and >11° extension/flexion (ext/flex) deformity. X-ray images of one patient are shown below (Figure 2). And elbow range of motion (ROM), shoulder abduction and the difference of range of external rotation (ER) compared to contralateral shoulder was evaluated. Constant scores of the shoulder and Mayo scores of the elbow were evaluated. In addition, complications were recorded.

Statistical Analysis

Statistical analysis was performed by using SPSS 22.0 version software program for Windows. Shapiro Wilks test was used to determine parameters distribution. Kruskal Wallis test was used for comparison of qualitative data between the groups and Mann Whitney U test was used to determine the difference between the groups. Mann Whitney U test was also used to compare the parameters between the two groups. In order to analyze the relation between the parameters Spearman's rho correlation analysis was used. The results were evaluated within the 95% confidence interval and P <0.05 was considered as statistically significant.

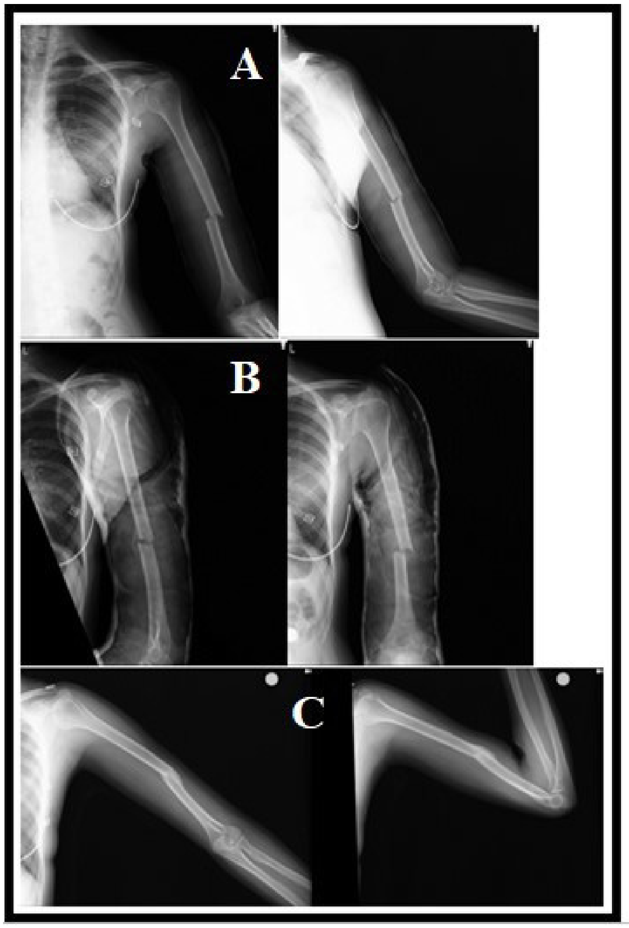

Figure 2: Outpatient control radiographies (A: inital radiographies, B: first month radiograhies, C: first year radiographies)

RESULTS

In the current study, 55 humeral shaft fracture were treated with functional bracing. Forty-two of the patients data records were obtained. The mean age was 53.43 ± 16.88 (22-85) years. Twenty-three patients had a right sided fracture and the remaining 14 patients had left sided fracture. The mechanism of injury of 24 patients was simple fall, 11 patients suffered traffic accident, and 2 patients had forensic incident. Sixteen patients had comorbidity. Nine of them had hypertension, 3 of them had hypertension and diabetes, 2 of them had hypertension and chronic pulmonary disease, one of them had chronic pulmonary disease and diabetes and the remaining one had Parkinson, chronic pulmonary disease and hypertension (Table 1).

Table 1: Demographic characteristics of the patients	
Gender (Male / Female)	22 / 15
Age (years)	53.43 ± 16.88 (22-85)
Fracture side (Left / Right)	14 / 23
Mechanism of injury	
Simple fall	24
Traffic accident	11
Forensic incident	2
Comorbidity (Yes / No)	16 / 21

The mean healing time was 12.11±2.31 (8-16) weeks. Thirty-seven (22 male, 15 female) of the patients included in the study were successfully treated. Nonunions were detected in only 5 patients during follow-up (Table 2). The radial nerve injury was determined in two patients who were completely healed in their follow-up.

The varus deformity was measured between 6°-10° in 18 patients, >11° in 12 patients, and between 0°-5° in 7 patients. The flexion/extension deformity was measured as 6°-10° in 13 patients, >11° in 9 patients, and between 0-5 ° in 15 patients (Table 2).

The mean value for shoulder external rotation was -7.84° ± 6.62 (-20-0), for abduction 110.81° ± 11.64 (90-120). The mean value for elbow ROM was 134.32° ± 12.59 (110-150). Elbow Mayo scores mean value was 86.97 ± 6.22 (75-95) and for the shoulder Constant score it was 77.51 ± 4.57 (70-85) (Table 2).

In the varus deformity groups, a statistically significant difference was observed for the external rotation measurements (p=0.044). In order to determine which group caused the difference Mann-Whitney U test applied. There was no statistically significant difference between external rotation measurements of the varus deformity groups 6°-10° and 0°-5° (p=0.516). But a statistically significant difference was determined between >11° and the other varus deformity groups (p1= 0.030; p2= 0.046). The reason of the external rotation measuremnt difference was >11° varus deformity group. External rotation of the >11° varus group was more restricted.

Moreover, in the varus deformity groups, there was a statistically significant difference for elbow ROM measurements (p= 0.048). Mann-Whitney U test performed to detect which group caused the difference. There was no statistically significant difference between the elbow ROM measurements of the varus deformity groups 6°-10° and >11° (p= 0.082). But a statistically significant difference was determined between >11° and 0-5° varus deformity groups (p=0,027). The reason of the elbow ROM measurement difference was >11° varus deformity group. Elbow ROM of the >11° varus group was more restricted like external rotation.

Table 2: Clinical and functional scores of patients		
Healing time (weeks)		12.11 ± 2.31 (8-16)
Union		37
Nonunion		5
Varus deformity	Varus deformity 0°-5°	7
	Varus deformity 6°-10°	18
	Varus deformity >11°	12
Extension / Flexion deformity	Ext / Flex deformity 0°-5°	15
	Ext / Flex deformity 6°-10	13
	Ext / Flex deformity >11°	9
Shoulder ER limitation		-7.84 ± 6.62 (-20-0°)
Shoulder abduction		110.81 ± 11.64 (90-120°)
Elbow ROM		134.32 ± 12.59 (110-150°)
Elbow Mayo Score		86.97 ± 6.22 (75-95)
Shoulder Constant Score		77.51 ± 4.57 (70-85)
ER: External rotation, ROM: Range of motion		

A statistically significant difference was not determined between shoulder abduction range, Mayo scores, and shoulder constant scores of varus deformity groups (p>0.05).

There was no statistically significant difference between the shoulder abduction measurements, elbow ROM measurement, elbow Mayo scores, and shoulder Constant scores of the extension/flexion deformity groups (p>0.05).

There was no statistically significant relationship between the age of the patients and external rotation and elbow ROM measurements (r= 0.284; p>0.05). Although, a negative relationship was determied between age of the patients and shoulder abduction measurement, shoulder Constant scores and elbow Mayo scores (r= 0.702; p= 0.001 and r= 0.458; p= 0.004, respectively).

A statistically significant relationship was not determined between age and shoulder abduction measurement, external rotation, shoulder Constant score and elbow ROM (p>0.05). Also, statistically significant relationship was not determined between fracture side and shoulder abduction, external rotation, elbow ROM, shoulder Constant, and elbow Mayo scores (p>0.05). Elbow Mayo scores of the male patients were higher (p= 0.018).

DISCUSSION

For the management of humerus shaft fractures, functional bracing is still the first choice and gold standard treatment method. Functional bracing for humeral shaft fractures provides high rate of fracture union, good functional results, patient comfort, and less expenses. Also, it provides avoiding the complications of surgical treatment (12). In the literature, the union rate of humerus shaft fracture with functional bracing is between 77.4-100% (13,14) and the healing time is between 7-12.6 weeks (8,14). In the current study the healing rate was 90.47% and the mean healing time was 12.11 ± 2.31 weeks. The rate of follow up was 76.36% and it was smilar to previous studies (7).

The most common complication with functional bracing is angular deformity of the arm and the most common deformity is varus angulation (15,16). In the literature, varus angulation is usually between 4°-9 ° (13,16). The angulation in sagittal plane is between 3°-6.2° (13,16). In our current study, average varus angulation was 8.72 ± 3.1°. No valgus deformity was determined in radiographies. Sarmiento et al. obtained %3 valgus deformity in 69 healed fracture (17).

Full shoulder range of motion can be achieved in 55-93% of patients (15,16). External rotation is usually affected in humeral shaft fractures which are treated with functional bracing. However, the limitation of this movement is rarely above 10° (6,7,15). In the current study, the limitation of ER was 7.84° ± 6.62 and the average shoulder abduction was 110.81° ± 11.64.

In the different studies, full elbow ROM is obtained with functional bracing in 76-100% of the patient (6,7,15,16). The most commonly limited movement in the elbow is flexion, but the limitation of flexion is rarely above 10 ° (6,13). In the current study, the elbow flexion were 134.32° ± 12.59 and it is consistent with the literature.

In the literature, different functional bracing systems were used for treatment of humeral shaft fractures. Unlike sarmiento, we used two piece brace, which was easier to use. Good and excellent results were reported for 80.7-100% of patients (6-7). In our study, the mean shoulder Constant score was 77.51 ± 4.57.

Functional bracing does not provide anatomical reduction but provides a cosmetically and psychologically acceptable alignment (7,16,18). Generally, residual deformity is seen in patients with short and obese arms (15). And varus angulation is commonly seen. In the current study, the shoulder external rotations and elbow ROM measurements are limited in the patients with > 11° varus deformity compared to other groups. However, shoulder abduction, Constant scores, and elbow Mayo scores are not affected by varus deformity. Extension/flexion deformity does also not affect shoulder external rotation, shoulder abduction, Constant scores and elbow Mayo scores.

The current study has some limitations. Firstly, the study was designed retrospectively. Secondly, limited number of the patients included in the study. Thirdly, more specific subgroups could be formed according to the localization and shape of the fracture. Another limitation of the study is the lack of the control group.

In conclusion, sagittal plane deformities don't affect shoulder and elbow joint ROM in the patients who have humeral shaft fracture and treated with functional bracing. Shoulder Constant Scores and elbow Mayo Scores do not change in the patients with varus deformity greater than 11°. However, it may cause limitation in elbow ROM and shoulder external rotation. Our clinical and radiological datas show that satisfactory results are obtained in most of the humeral shaft fractures treated conservatively with functional bracing.

DECLARATIONS

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Conflict of Interest

No conflicting relationship exists for any author.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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