

CLINICAL EFFECTIVENESS OF FUNCTIONAL BRACING VERSUS SLING
IMMOBILIZATION IN THE MANAGEMENT OF HUMERAL SHAFT
FRACTURES: A QUASI-EXPERIMENTAL STUDY

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Abstract

Background: In most cases, a humeral shaft fracture is treated conservatively with a functional brace or with a sling. There are limited comparisons of both interventions.

Objective: To compare the clinical effectiveness of functional bracing and sling immobilization in patients with humeral shaft fractures.

Methods: A quasi-experimental study was done in 40 patients with humeral shaft fractures from LLRC Lahore and Aziz Fatima Hospital Faisalabad. The study population was split into two groups: Functional Brace Group (FBG, n=20) and Sling Group (SG, n=20). The Disabilities of the Arm, Shoulder and Hand (DASH) score, Numeric Rating Scale (NRS), Constant-Murley Score (CMS) and

Mayo Elbow Performance Score (MEPS) were chosen as outcome measures. Baseline and post-treatment (6–8 weeks) assessments were conducted. Wilcoxon Signed-Rank test and Mann-Whitney U test were used for data analysis.

Results: There was a significant difference after treatment between both treatment groups ($p < 0.001$). Yet the functional brace group had significant improvements with all outcome measures. The mean difference in improvement of the brace group was -47.76 ± 9.67 compared with -35.17 ± 8.52 for the sling group. CMS improvement was 25.90 ± 5.97 versus 18.50 ± 6.05 , while MEPS improvement was 58.00 ± 10.81 versus 49.90 ± 9.39 in favor of functional bracing. All of the differences between groups for DASH ($p < 0.001$), NRS ($p = 0.002$), CMS ($p < 0.001$), and MEPS ($p = 0.015$) were statistically significant.

CONCLUSION: Functional bracing offers: pain relief, performance, function in shoulder and elbow, better than sling immobilization. Conservative treatment with functional bracing is recommended as the best option for the appropriate patient with humeral shaft fracture.

INTRODUCTION

A fracture of the humeral shaft is one of the most prevalent fractures of the long bones of the upper arm and represents about 1-3% of all fractures and nearly 20% of lesions of the humerus. They may happen following a high energy trauma (such as road traffic accidents, sporting injuries in younger people or low energy falls in older people). The fractures of the humeral shaft are an extremely common injury that may produce severe pain, functional deficits, decreased mobility and impaired activities of daily living. It is therefore important to provide adequate treatment to facilitate fracture union, function of the upper limb and quality of life.

In the past, the standard approach to most uncomplicated humeral shaft fractures has been conservative treatment because of the excellent ability of the humerus to heal and its good blood supply. The non-operative treatment options are designed to stabilize the fracture, but reduce the risks of surgery. The conservative treatment options include sling immobilization and functional bracing which are the most frequently used.

A sling is often used in the acute stage of the injury to help minimize pain and help support the affected limb. Easy, cheap and readily available. But, if it becomes a chronic state of immobility, the shoulder and elbow can become stiff, weak, range of motion is limited, and recovery may be delayed. These restrictions may have a negative impact on patient's return to their routine activities and occupational duties.

Functional bracing was first introduced by Sarmiento and colleagues and is now accepted as a successful conservative treatment of fractures of the humeral shaft. Functional braces offer a circumferential compression to the soft tissue and allow for controlled motion of the adjacent joints whilst ensuring acceptable fracture alignment. This approach allows for callus formation to aid secondary bone healing and allows early mobilization of the shoulder and elbow. Early movement helps to prevent stiffness at the joint, helps to preserve muscle strength and helps recovery to be quicker. Good union rates, acceptable functional results and high patient satisfaction have been reported for functional bracing in previous studies.

There have been several studies that have compared operative vs non-operative treatment for humeral shaft fractures, and some have examined the efficacy of functional bracing alone. There is, however, not much available evidence to compare functional bracing with sling immobilization as conservative treatment options. In addition, the differences in pain relief, shoulder function, elbow function and functional ability in ADLs between these two interventions have not been adequately studied, especially in developing countries where conservative treatment is still widely used due to limited healthcare resources.

For this reason, the present study was performed to compare the clinical efficacy of functional bracing with sling immobilization in patients with humeral shaft fractures. The study examined pain using the Numeric Rating Scale (NRS), upper limb disability with the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire, shoulder function with the Constant-Murley Score (CMS) and elbow function with the Mayo Elbow Performance Score (MEPS). The results of this study could be factors in evidence-based decisions and choosing the most effective conservative treatment for humeral shaft fracture patients.

Methodology :

Study Design: Quasi-experimental study.

Study Sites: LLRC Lahore and Aziz Fatima Hospital Faisalabad.

Sample Size: Forty patients with humeral shaft fractures.

Groups:

Group A: Functional Brace (n=20)

Group B: Sling Immobilization (n=20)

Inclusion Criteria:

- Age 18–60 years
- Both genders
- Closed humeral shaft fractures

Exclusion Criteria:

- Open fractures
- Neurological disorders
- Associated musculoskeletal conditions

Outcome Measures:

- DASH Score
- Numeric Rating Scale (NRS)
- Constant-Murley Score (CMS)
- Mayo Elbow Performance Score (MEPS)

DATA COLLECTION PROCEDURE:

After obtaining a permission letter from the Head of the Department of Orthotics and Prosthetics, Government College University, Faisalabad, we visited LLRC to collect samples for our research study through the procedure approved by the Departmental Committee of Orthotics and Prosthetics. Written informed consent was obtained from all participants prior to their enrollment in the study. Patients diagnosed with humeral shaft fractures and fulfilling the inclusion criteria were recruited from the Orthopedics Department of the study hospital. Baseline demographic and clinical data, including age, gender, mechanism of injury, fracture pattern, side involved, comorbidities, pain score, shoulder function, elbow function, and daily activities, were recorded before the initiation of treatment.

After the baseline assessment, the patients were allocated into two groups based on the conservative treatment method used:

Group A: Functional bracing

Group B: Sling immobilization

Patients were then managed according to standard departmental protocols. A follow-up assessment was conducted after 6–8 weeks of treatment. During the follow-up visit, clinical examination and evaluation were performed, and the outcome measures, including pain, shoulder function, elbow

function, and daily activities, were reassessed to determine the effectiveness of functional bracing and sling immobilization.

Statistical Analysis:

Data were analyzed using SPSS. Wilcoxon Signed-Rank Test and Mann-Whitney U Test were applied. Significance level was set at $p < 0.05$.

Results:

In this study, a total of 40 participants had been included, comprising 20 patients who had been treated with a sling and 20 patients who had been treated with a functional brace. Before and after application of both treatment, follow up assessments had been done. Patients who had received the two different treatment options had observed positive outcomes; however, been treated with the functional brace had demonstrated better recovery outcomes. There was evidence of improvements in range of motion, pain and mobility. The average age of the participants had been obtained and follow-up evaluations, it had been found that there was a significant increase in the mean range of motion from pre-treatment values. These results had indicated that the functional brace was more effective than the sling in improving functional recovery among patients with humeral shaft fractures.

Table 1. Demographic Characteristics

Variable	Frequency	Percentage
Male	24	60%
Female	16	40%
Age 25-35 years	21	53.3%
Age 36-45 years	19	46.7%

A total of **40 participants** were included in the study. Among them, **24 (60%) were male** and **16 (40%) were female**, indicating that humeral shaft fractures were more common among males than females in the study population. Regarding age distribution, **21 participants (53.3%)** were in the 25–35 years age group, while **19 participants (46.7%)** were in the 36–45 years age group. This

suggests that the majority of participants were young adults aged 25–35 years, with both age groups being relatively well represented in the study.

Table 2: Descriptive Statistics of Outcome Measures

Outcome Measure	Brace Group (Mean ± SD)	Sling Group (Mean ± SD)
DASH Change	-47.76 ± 9.67	-35.17 ± 8.52
NRS Change	-35.17 ± 8.52	-16.35 ± 4.72
CMS Change	25.90 ± 5.97	18.50 ± 6.05
MEPS Change	58.00 ± 10.81	49.90 ± 9.39

Both brace group and the sling group showed improvement however the brace group had more improvement in all the outcome measures. The descriptive statistics showed that patients treated with the brace had an increased overall functional recovery and reduction in pain compared to the patients treated with the sling. The brace group had a greater mean improvement in the DASH score (mean -47.76 ± 9.67) than the sling group (mean -35.17 ± 8.52), indicating more improvement in upper limb function and less disability. Likewise, the brace group reported a larger NRS change (25.90 ± 5.97) compared to the others (18.50 ± 6.05), which indicated better pain relief. Additionally, there was greater improvement in elbow function as measured by the MEPS in the brace group (58.00 ± 10.81) compared with the sling group (49.90 ± 9.39), showing better restoration of elbow function. In general, the results of this study indicate that functional bracing yielded better functional results, less pain and better recovery than sling immobilization with humeral shaft fractures.

Table 3:

Within-Group Comparison (Brace Group) Using Wilcoxon Signed-Rank Test

Outcome Measure	Z Value	p-value
DASH	-3.921	<0.001*
NRS	-3.928	<0.001*

CMS	-3.924	<0.001*
MEPS	-3.930	<0.001*

The within-group comparison using the Wilcoxon Signed-Rank Test demonstrated statistically significant improvements in all outcome measures for patients in the brace group after treatment. Significant reductions were observed in the DASH and NRS scores ($Z = -3.921$ and -3.928 , respectively; $p < 0.001$), indicating marked improvement in upper limb function and pain relief. Likewise, significant increases in the CMS and MEPS scores ($Z = -3.924$ and -3.930 , respectively; $p < 0.001$) reflected substantial improvements in shoulder and elbow function following treatment. Since all p-values were less than 0.001, the improvements were highly statistically significant, suggesting that functional bracing was effective in enhancing clinical and functional outcomes in patients with humeral shaft fractures.

Table 4: Within-Group Comparison (Sling Group) Using Wilcoxon Signed-Rank Test

Outcome measure	Z value	P value
DASH	-3.921	<0.001
NRS	-3.931	<0.001
CMS	-3.934	<0.001
MEPS	-3.946	<0.001

Significant at $p < 0.05$

All outcome responses were found to be significantly improved in patients after the sling group when compared within the group by the Wilcoxon Signed-Rank Test. DASH and NRS scores were significantly decreased ($Z = -3.921$, -3.931 , respectively, $p < 0.001$), reflecting the improvement in the function of the upper limbs and the decrease in pain. Likewise, similar improvements in shoulder and elbow function were seen with significant increases in the CMS and MEPS scores of $Z = -3.934$ and -3.946 respectively ($p < 0.001$). All p values were < 0.001 and the changes were highly statistically significant, suggesting that sling treatment was effective in improving pain and functional outcomes.

The results, however, only show the improvement for the sling group, and not whether it is more effective than the brace group.

Table 5: Wilcoxon Signed-Rank Test (Sling Group)

Variable	N	Median (Pre)	Median (Post)	Median Difference	W	Z	P
DASH	20	65.4	20.0	-45.83	0.000	-3.920	<0.001
NRS	20	34.0	9.0	-23.0	0.000	-3.920	<0.001
CMS	20	4.0	32.5	27.5	0.000	-3.920	<0.001
MEPS	20	27.5	85.0	60.0	0.000	-3.920	<0.001

All clinical and functional outcome measures showed statistically significant improvement in the sling group after treatment with Wilcoxon Signed-Rank Test. The median difference between the DASH scores before and after treatment was -45.83 ($Z = -3.920$, $p < 0.001$), meaning that there was a significant improvement in upper limb disability. In the same way the median NRS decreased from 34.0 to 9.0, with a median difference of -23.0 ($Z = -3.920$, $p < 0.001$), and this was also significant, indicating good pain relief. In contrast, the median CMS increased from 4.0 to 32.5 (median difference = 27.5, $Z = -3.920$, $p < 0.001$), and the median MEPS increased from 27.5 to 85.0 (median difference = 60.0, $Z = -3.920$, $p < 0.001$), demonstrating marked improvements in shoulder and elbow function. In general, the data revealed that there was a significant functional recovery and reduction of pain from baseline in the sling treatment group.

Table 6: Wilcoxon Signed-Rank Test (Brace Group)

Variable	N	Median (Pre)	Median (Post)	Median Difference	W	Z	P
DASH	20	82.5	46.7	-35.4	0.000	-3.920	<0.001
NRS	20	38.0	20.5	-16.0	0.000	-3.920	<0.001
CMS	20	2.0	20.0	17.0	0.000	-3.920	<0.001
MEPS	20	15.0	67.5	50.0	0.000	-3.920	<0.001

All outcome measures were found to improve statistically significantly in the brace group after treatment; Wilcoxon Signed-Rank Test. The median DASH score was reduced from baseline to after treatment with a median difference of -35.4 ($Z = -3.920$, $p < 0.001$), showing a significant decrease in upper limb disability. Likewise, there was a significant reduction in median NRS scores, from 38.0 to 20.5, with a difference of -16.0 ($Z = -3.920$, $p < 0.001$). The median CMS increased from 2.0 to 20.0 (median difference = 17.0, $Z = -3.920$, $p < 0.001$), while the median MEPS increased from 15.0 to 67.5 (median difference = 50.0, $Z = -3.920$, $p < 0.001$), demonstrating significant improvements in shoulder and elbow function. Overall, these results showed that the brace treatment significantly improved pain, functional ability, and joint function, compared to the baseline level.

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improvements in shoulder and elbow function. Overall, these results showed that the brace treatment significantly improved pain, functional ability, and joint function, compared to the baseline level.

Discussion

There was less disability and greater functional independence with functional bracing vs with sling immobilization. Patients who wore a sling had a higher percentage of surgical intervention, indicating that functional bracing promotes earlier return of functional use of the upper limb and successful return to normal daily activities. It also led to better shoulder and elbow mobility, as well as pain relief and positive DASH scores, possibly because of the controlled stabilization effect it had. Functional bracing has been shown to have positive effects in other studies around the world, with good functional recovery and quality of life seen in humeral shaft fractures (Matsunaga et al., 2017; Westrick et al., 2017). These findings agree with the biomechanics principle given by Sarmiento et al. (1977) that the brace offers stability of the fracture by the compression of soft tissues and muscular forces, while allowing controlled motion, which facilitates callus formation and secondary bone healing without prolonged immobilisation. This facilitates keeping the fracture reduced and maintains joint mobility, which was observed in the functional bracing group of the present study. Sling immobilization is still useful for pain management in the acute phase, but may have a negative effect on functional recovery when used long term. Patients treated with slings had a relatively poor outcome in elbow and shoulder function and in performance of daily activities. The complications of prolonged immobility include joint stiffness, muscle weakness, decreased range of motion and delayed rehabilitation (Pal, 2015). Thus, slings can be helpful for short-term support, but might not be as effective as functional bracing for long-term treatment.

In line with recent literature that supports conservative treatment, focusing on early mobilization (Van Bergen et al., 2023), the present results support these conservative treatment approaches. Likewise, Nshimiyimana et al. (2024) found that functional bracing provided an improvement in alignment, recovery time and functional outcomes when compared with less restrictive

immobilization methods. In summary, the results of this study confirm the findings of the previous studies, and support the use of functional bracing for a selected patient population. Satisfactory results for functional bracing can be explained by better fracture stabilization, maintenance of shoulder and elbow mobility, patient compliance, and as a result of controlled loading, better biological bone healing. Moreover, functional bracing is low cost, non-invasive, and especially appropriate in the developing world, thus a possible treatment in resource-poor areas.

Overall, functional bracing was seen to have a better clinical outcome than sling immobilization in humeral shaft fractures. Patients who had received treatment with functional braces had more pain relief, more shoulder/elbow range of motion, more upper limb function, and more independence in ADLs.

This study is in agreement with other studies that suggest functional bracing is a useful conservative treatment for humeral shaft fractures. Sling immobilization may be appropriate during the early post-injury phase for pain management and initial management, however, functional bracing may be better for achieving functional recovery and overall patient clinical outcomes in the long run.

CONCLUSION:

This study compared the effectiveness of functional bracing and sling immobilization in the conservative treatment of humeral shaft fractures. Both treatment methods significantly improved pain, upper limb function, and overall clinical outcomes. However, the functional brace demonstrated greater improvement in DASH, NRS, CMS, and MEPS scores compared with the sling group, indicating better functional recovery and pain relief. Therefore, functional bracing appears to be a more effective conservative treatment option than sling immobilization for patients with humeral shaft fractures. Further studies with larger sample sizes and longer follow-up are recommended to confirm these findings.

LIMITATIONS

There are few limitations in this study. The size of the sample was not large. The findings may not be generalizable, due to the small number of participants (n = 40).

The post-follow up period was also short and doesn't allow for a complete evaluation of long term effects like fractures union, patient satisfaction and late complications.

The study mainly had a focus on clinical outcomes and did not evaluate clinical factors like radiological healing, quality of life or cost effectiveness. Furthermore, not all the individual factors such as following rehabilitation program, occupation and lifestyle, were fully controlled, and could have influenced outcomes of recovery.

RECOMMENDATIONS

Further studies with larger numbers of patients and longer follow-up duration are needed to improve the evidence on the effectiveness of functional bracing and sling. in humeral shaft fractures, immobilization is indicated, and future studies should also evaluate radiological healing to provide a more comprehensive understanding of treatment outcomes, including quality of life, patient satisfaction, and cost-effectiveness.

Additionally, factors such as age, gender, fracture type, and the influence of rehabilitation compliance should be explored as potential determinants of recovery. Patient education and adherence to rehabilitation programs remain essential for achieving optimal outcome.

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