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Original Article

Comparison of the Effects of Stretching and Splinting in Improving the Range of Motion and Functional Status for Prevention of Post-Burn Axillary Contracture

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ABSTRACT

Background: Burn injuries often lead to severe complications, including axillary contractures, which can significantly restrict shoulder movement and impact quality of life. The rehabilitation strategies for managing post-burn axillary contractures, particularly stretching and splinting, have been the subject of much research, given their potential to improve shoulder range of motion and functional status.

Objective: This study aims to compare the effects of stretching combined with splinting versus splinting alone on the range of motion and functional status in patients with post-burn axillary contracture, to determine the most effective treatment modality for preventing the development of contractures.

Methods: A single-blinded randomized clinical trial was conducted at the Burn and Plastic Surgery Department of Mayo Hospital, Lahore, over six months. Forty patients aged 20-50 years with Type 1 to Type 3 axillary contractures and shoulder abduction ranging from 20 to 100 degrees were enrolled. Participants were randomly assigned to either Group A (stretching plus splinting) or Group B (splinting alone). Outcomes were measured using the Disabilities of Arm, Shoulder, and Hand (DASH) questionnaire and goniometry for shoulder motion range, before and after the interventions. Statistical analysis was performed using SPSS version 25, with paired and independent T-tests applied for within and between-group comparisons, respectively.

Results: The stretching group demonstrated significant improvements in shoulder motion ranges: flexion (91.00 ± 19.97 to 98.75 ± 19.75, p<0.000), extension (34.50 ± 12.13 to 41.85 ± 12.70, p<0.000), abduction (94.50 ± 26.84 to 103.50 ± 25.97, p<0.000), external rotation (34.15 ± 18.79 to 42.85 ± 18.87, p<0.000), and internal rotation (33.95 ± 11.05 to 42.90 ± 11.03, p<0.000). The DASH scores improved from 21.35 ± 3.58 to 31.30 ± 3.48 (p<0.000). Similar improvements were noted in the splinting group but were more pronounced in the stretching group. Between-group analysis revealed significant differences in favor of the stretching group for all measures of shoulder motion and DASH scores.

Conclusion: The study concluded that stretching, when combined with splinting, is more effective than splinting alone in improving shoulder range of motion and functional status in patients with post-burn axillary contracture. These findings suggest that incorporating stretching into the rehabilitation protocols for burn survivors could significantly enhance recovery outcomes.

Keywords: Axillary contracture, Burn injuries, Rehabilitation, Stretching, Splinting, Shoulder range of motion, Functional status.

Journal of Health and Rehabilitation Research 2791-156X JHRR

INTRODUCTION

Burn injuries result in severe cellular damage by transmitting unbearable external harmful energy into the body, initiating both physiological and pathophysiological responses (1). These injuries lead to ischemia, reperfusion injuries, skin necrosis, and the subsequent development of hypertrophic scars, keloids, and contractures (2). Studies have shown that approximately one-third of adult burn patients develop at least one joint contracture following their injury, with large joints such as the shoulder, elbow, hip, and knee being commonly affected. Specifically, 38% of these contractures occur in the axilla and shoulder, significantly restricting the normal range of motion of the shoulder joint (4, 5). Axillary contracture (AC) is particularly prevalent among young males in lower and middle-income countries, where burn injuries result in the deaths of 200,000 to 300,000 individuals annually. In comparison, about 20.9% of burn patients in high-income countries develop contractures (6).

The causes of axillary contractures can vary, including frictional injuries, thermal burns, cold or frostbite burns, radiation, chemical, and electrical burns (1). The severity of the burn, especially in cases of deep or full-thickness burns, leads to the destruction of the epidermal appendages and the reticular layer of the dermis, resulting in the formation of hypertrophic scarring (7). The major risk factors for contracture formation include delayed healing, excessive proliferation of scar tissue, the depth and extent of the burn, as well as the cause and area of the injury. Secondary risk factors include genetic predisposition, race, skin color, age, gender, and the nutritional status of the patient both before and after the injury. The choice of treatment and the timing of wound closure, as well as the condition of the wound bed and the chosen preventive method, also play significant roles in the development of contractures (8-10).

Contractures are classified by Kurtzman and Stern into three categories, with Type 1 involving the anterior or posterior axillary fold, Type 2 sparing the axillary dome but involving both folds, and Type 3 including the axillary dome in addition to both folds (11). Achauer's classification further divides contractures based on the involvement of the axillary folds and the presence of scarring, with four types ranging from minimal scarring without hairy area involvement to extensive scarring including the hairy area (12). The severity of post-burn contractures is categorized into mild, moderate, and severe based on the degree of shoulder abduction achievable, with severe contracture significantly limiting shoulder movement to no more than 30 degrees (13).

The treatment of burn and contracture patients employs a variety of approaches, with the primary goal being the prevention of axillary contracture through positioning, splinting, serial casting, exercises, the use of paraffin and ultrasound, and surgical correction. Recent studies have highlighted the effectiveness of stretching in enhancing the range of motion, particularly in flexion and abduction among upper limb burn patients, thereby reducing the incidence of axillary contracture (4, 14, 15). Conversely, other research emphasizes the benefits of positioning patients in airplane splints to provide abduction support, which not only improves the range of motion in the shoulder but also enhances patient mobility and functional status (5, 16, 17). This comparative analysis aims to elucidate the relative impacts of stretching and splinting in improving shoulder range of motion in post-burn axillary contracture patients, with the ultimate goal of decreasing the development of contracture and enhancing the recovery rate and functional status of these individuals.

MATERIAL AND METHODS

The study was designed as a single-blinded randomized clinical trial (RCT) conducted in the Burn and Plastic Surgery Department of Mayo Hospital, Lahore, over a span of six months. Ethical approval for the research was granted by the Ethical Committee of Johar Institute of Professional Studies, under the reference number JIPS/SPT-23/39. The trial enrolled 40 patients, inclusive of both genders, utilizing a convenience sampling technique. Eligible participants were aged 20-50 years, both male and female, who had shoulder abduction ranging from 20 to 100 degrees and were diagnosed with Type 1 to Type 3 Axillary contracture (4, 18). Individuals with open wounds, a history of mental illness such as dementia, cancer, heterotrophic ossification, and those who were paraplegic or tetraplegic, were excluded from the study (4, 14).

Randomization of participants into two groups was achieved through a lottery method, wherein participants selected a chit with an alphabet indicating their group assignment: Group A (stretching along with splinting) or Group B (splinting alone).

The primary outcomes measured were the range of shoulder motion, disability, and severity of post-burn shoulder contracture, assessed using the Disabilities of Arm, Shoulder, and Hand (DASH) questionnaire and goniometry. These assessments were conducted in either a sitting or supine position. In Group A, the treatment protocol included stretching with splinting. Patients underwent ultrasound therapy in a circular motion at a frequency of 3 MHz and intensity of 0.50-0.80 W/cm^2 for 5-10 minutes in pulsed cycle mode (19). This was followed by passive and assisted exercises focusing on abduction and flexion of the shoulder joint, performed by therapists in three sets of 15-second repetitions. Subsequently, a passive sustained stretch was applied to the shoulder joint for one minute in both abduction and externally rotated positions, and flexion positions, with approximately 3 sets of 5-10

Journal of Health and Rehabilitation Research 2791-156X JHRR

repetitions over a duration of 20 minutes (4, 14). The session concluded with the application of an Airplane splint to the affected shoulder. Conversely, Group B participants underwent a similar initial procedure but were subsequently placed in an airplane splint at an 80° abduction angle for a period ranging from 40 minutes to 2 hours, repeated 2-3 times within a single day (20).

Data collection adhered strictly to ethical guidelines, including the Declaration of Helsinki, ensuring informed consent was obtained from all participants prior to inclusion in the study. Data were analyzed using SPSS version 25. Descriptive statistics, including mean and standard deviation, were used to summarize the demographic data of the patients. The normality of the data was assessed using the Shapiro-Wilk test, which indicated a p-value greater than 0.05, thereby justifying the use of parametric tests for analysis. Within and across group comparisons were conducted using Paired T-tests and Independent T-tests, respectively, to evaluate the effectiveness of the interventions on the outcome measures.

RESULTS

In the conducted single-blinded randomized clinical trial, demographic characteristics of the participants revealed a slight age difference between the two groups, with the stretching group averaging 41.80 years (SD = 7.93) and the splinting group 43.00 years (SD = 6.98). Gender distribution was relatively balanced, with the stretching group comprising 60% males and 40% females, compared to the splinting group's 55% males and 45% females. The cause of burn injuries among participants varied, including flame burns (40% in the stretching group vs. 35% in the splinting group), scald burns (30% in both groups), electricity burns (25% in both groups), and chemical burns (5% in the stretching group vs. 10% in the splinting group). Axillary contracture types across the groups were also documented, showing a distribution across Type 1A, 1B, Type 2, and Type 3, with Type 1B being the most common in both groups (35%) (Table 1).

The within-group analysis revealed significant improvements in both groups post-intervention. For the stretching group, the ranges of affected shoulder movements showed significant enhancements in flexion (from 91.00 ± 19.97 to 98.75 ± 19.75, p<0.000), extension (from 34.50 ± 12.13 to 41.85 ± 12.70, p<0.000), abduction (from 94.50 ± 26.84 to 103.50 ± 25.97, p<0.000), external rotation (from 34.15 ± 18.79 to 42.85 ± 18.87, p<0.000), and internal rotation (from 33.95 ± 11.05 to 42.90 ± 11.03, p<0.000). The DASH scores also indicated significant improvements (from 21.35 ± 3.58 to 31.30 ± 3.48, p<0.000). Similar trends were observed in the splinting group, with improvements in flexion, extension, abduction, external rotation, and internal rotation, as well as DASH scores, indicating enhanced functional status post-intervention (Table 2).

Table 1 Demographic Characteristics of Participants in Group A (Stretching) and Group B (Splinting

Variable	Stretching Group	Splinting Group
Age (years)	41.80 ± 7.93	43.00 ± 6.98
Gender		
Male	12 (60%)	11 (55%)
Female	8 (40%)	9 (45%)
Cause of Burn		
Flame Burn	8 (40%)	7 (35%)
Scald Burn	6 (30%)	6 (30%)
Electricity Burn	5 (25%)	5 (25%)
Chemical Burn	1 (5%)	2 (10%)
Axillary Contracture Type		
Type 1A	6 (30%)	6 (30%)
Type 1B	7 (35%)	7 (35%)
Type 2	4 (20%)	5 (25%)
Type 3	3 (15%)	2 (10%)

Table 2 Within-Group Analysis of Ranges of Affected Shoulder and DASH Scores

Variable	Stretching Group (Pre)	Stretching Group (Post)	p-value	Splinting Group (Pre)	Splinting Group (Post)	p-value
Flexion	91.00 ± 19.97	98.75 ± 19.75	0.000	103.25 ± 26.37	105.9 ± 26.39	0.000
Extension	34.50 ± 12.13	41.85 ± 12.70	0.000	35.50 ± 17.01	38.45 ± 16.99	0.000
Abduction	94.50 ± 26.84	103.50 ± 25.97	0.000	106.50 ± 25.6	113.10 ± 25.86	0.000

Journal of Health and Rehabilitation Research 2791-156X JHRR

Variable	Stretching Group (Pre)	Stretching Group (Post)	p-value	Splinting Group (Pre)	Splinting Group (Post)	p-value
External Rotation	34.15 ± 18.79	42.85 ± 18.87	0.000	35.75 ± 18.51	38.85 ± 18.33	0.000
Internal Rotation	33.95 ± 11.05	42.90 ± 11.03	0.000	32.55 ± 12.03	35.75 ± 11.95	0.000
DASH	21.35 ± 3.58	31.30 ± 3.48	0.000	21.20 ± 3.98	25.15 ± 3.95	0.000

Table 3 Between-Group Analysis of Post-Intervention Ranges of Affected Shoulder and DASH Scores

Variable	Stretching Group (Post)	Splinting Group (Post)	p-value
Flexion	98.75 ± 19.75	105.9 ± 26.39	0.00
Extension	41.85 ± 12.70	38.45 ± 16.99	0.001
Abduction	103.50 ± 25.97	113.10 ± 25.86	0.004
External Rotation	42.85 ± 18.87	38.85 ± 18.33	0.001
Internal Rotation	42.90 ± 11.03	35.75 ± 11.95	0.005
DASH	31.30 ± 3.48	25.15 ± 3.95	0.000

Between-group analysis post-intervention highlighted the differential impacts of the two treatment modalities. The stretching group demonstrated significant improvements in flexion, extension, abduction, external rotation, and internal rotation compared to the splinting group. Specifically, flexion improved more significantly in the splinting group (105.9 ± 26.39) compared to the stretching group (98.75 ± 19.75), yet, for extension, abduction, external rotation, and internal rotation, the stretching group showed more significant improvements. The DASH scores further emphasized the difference in functional recovery post-treatment, with the stretching group showing a higher score (31.30 ± 3.48) compared to the splinting group (25.15 ± 3.95), indicating a more substantial improvement in the disability, arm, shoulder, and hand functions in the stretching group (Table 3).

DISCUSSION

In the investigation of the effects of stretching and splinting on the prevention and management of post-burn axillary contracture, the Disabilities of Arm, Shoulder, and Hand (DASH) questionnaire and goniometry were employed as reliable and valid tools for measuring the range of motion and disability in affected shoulders. The findings underscored the beneficial roles of both interventions in enhancing the functional abilities and maintaining or improving the shoulder range of motions among burn patients. Specifically, splinting was highlighted for its capacity to reduce disability by maintaining the burned area in an adequate position, thereby lessening tension on the skin and underlying tissues, and preventing contracture deformity (21). This aligns with Aghajanzade's (2019) affirmation of splinting's utility in minimizing disability among burn contracture patients. The integration of splinting with active exercises has also been shown to effectively prevent contractures by improving DASH scores (20, 21).

Further supporting the efficacy of these interventions, Perera et al. (2017) discussed how stretching maintains the flexibility and strength of the pectoralis major and latissimus dorsi muscles, crucial for preserving the axillary space and the functional level of the shoulder joint (14). Stretching's mechanism involves inhibiting the Golgi tendon organs, which decreases neuronal discharge from the motor area of the spinal cord, thus relaxing musculotendinous unit tension, and alleviating pain and disability among contracture patients (22). This is corroborated by findings from Phadkhe (2016) and further elaborated by Tahreem (2022), who noted that physical therapy techniques such as positioning, splinting, and stretching are pivotal in treating and preventing burn contractures, with stretching identified as particularly effective in restoring muscle flexibility and enhancing motion range (23).

Wang (2021) reported that stretching not only reduces myofibroblasts and inflammatory cells but also diminishes type I collagen and α-smooth muscle actin expression, thereby increasing joint mobility and the range of motion in contracted regions (24). Zhang (2017) and Tokuyama (2015) added that stretching reduces tension on healing scars, tendons, and muscles, which, combined with increased levels of ground matrix, helps to prevent scar contracture formation and improves the pliability of the burn area (25, 26). However, Goverman (2017) pointed out that while splinting is a traditional physical therapy protocol for preventing contracture among shoulder burn patients, static splinting can increase scar tension, leading to hypertrophic scarring and contracture development, which adversely affects recovery (10).

The study's strengths include its rigorous methodological approach and the utilization of validated outcome measures to assess the effectiveness of stretching and splinting in managing post-burn axillary contracture. Nevertheless, the study is not without limitations. The sample size, though adequate to demonstrate significant findings, limits the generalizability of the results to broader

Journal of Health and Rehabilitation Research 2791-156X JHRR

populations. Furthermore, the study's duration, restricted to six months, may not capture the long-term outcomes of these interventions. Future research could benefit from larger sample sizes, longer follow-up periods, and the inclusion of additional outcome measures to provide a more comprehensive understanding of these interventions' efficacy.

CONCLUSION

In conclusion, the investigation reaffirmed the importance of both stretching and splinting in managing post-burn axillary contracture, with stretching showing superior effectiveness in improving range of motion and functional status. These findings suggest that an integrated approach incorporating both techniques may offer the most benefits to patients. Recommendations for clinical practice include the adoption of combined stretching and splinting protocols to maximize recovery outcomes in individuals suffering from post-burn axillary contractures. Further research is warranted to explore these interventions' long-term effects and to identify optimal protocols for their implementation.

REFERENCE

1. Jeschke MG, van Baar ME, Choudhry MA, Chung KK, Gibran NS, Logsetty SJNRDP. Burn injury. 2020;6(1):11.
2. Oosterwijk AM, Mouton LJ, Schouten H, Disseldorp LM, van der Schans CP, Nieuwenhuis MKJB. Prevalence of scar contractures after burn: a systematic review. 2017;43(1):41-9.
3. Goverman J, Mathews K, Goldstein R, Holavanahalli R, Kowalske K, Esselman P, et al. Adult contractures in burn injury: a burn model system national database study. 2017;38(1):e328-e36.
4. Holavanahalli RK, Helm PA, Kowalske KJ, Hynan LSJAopm, rehabilitation. Effectiveness of paraffin and sustained stretch in treatment of shoulder contractures following a burn injury. 2020;101(1):S42-S9.
5. Gorka R, Gupta AK, Prakash S, Bakthavachel I, Lamba S, Gohil AJJBO. Simple, self-adjustable airplane splint for axillary contractures. 2017;1(2):54-8.
6. Botman M, Hendriks TC, de Haas LE, Mtui GS, Nuwass EQ, Jaspers ME, et al. The effectiveness of burn scar contracture release surgery in low-and middle-income countries. 2020;8(7).
7. Goel A, Shrivastava PJIjopsopotAoPSoI. Post-burn scars and scar contractures. 2010;43(Suppl):S63.
8. Tredget EE, Levi B, Donelan MBJSC. Biology and principles of scar management and burn reconstruction. 2014;94(4):793-815.
9. Ladak A, Tredget EEJCips. Pathophysiology and management of the burn scar. 2009;36(4):661-74.
10. Goverman J, Mathews K, Goldstein R, Holavanahalli R, Kowalske K, Esselman P, et al. Pediatric contractures in burn injury: a burn model system national database study. 2017;38(1):e192-e9.
11. Ndiaye L, Sankale A, Ndiaye A, Foba M, Coulibaly NJBO. Management of axillary burn contracture: A summary of 67 cases. 2018;2(3):109-13.
12. Karki D, Narayan RPJWJoPS. Role of square flap in post burn axillary contractures. 2017;6(3):285.
13. Kumaran S, Nambi G, Beck B, Paul MK, Gupta AK, Dhanraj PJOpotNAoB-I. A clinical study of post burn contracture of axilla & its management. 2008.
14. Perera AD, Perera C, Karunanayake A. Effectiveness of early stretching exercises for range of motion in the shoulder joint and quality of functional recovery in patients with burns-a randomized control trial. 2017.
15. Ashraf U, Maqbool S, Fatima T, Asghar HMU, Anwar M, Baig FJPJoM, et al. Comparison of the effect of Range of Motion exercises versus stretching techniques in prevention of burn contractures of upper limb; RCT-A Randomized clinical trial. 2022;16(05):54-.
16. Thomas R, Wicks S, Toose C, Pacey VJJoBC, Research. Outcomes of early use of an end of range axilla orthotic in children following burn injury. 2019;40(5):678-88.
17. Greiser C, Lorello D, Lyons D, Richey KJ, Murray D, Foster KNJJoBC, et al. 639 Maximizing Safe Positioning of Upper Extremities after Axillary Burn Injuries to Prevent Contractures and Maintain Function. 2021;42(Supplement_1):S175-S6.
18. Karki D, Mehta N, Narayan RPJIJoPS. Post-burn axillary contracture: A therapeutic challenge! 2014;47(03):375-80.
19. Riaz HM, Cheema SAJIJoB, Trauma. Paraffin wax bath therapy versus therapeutic ultrasound in management of post burn contractures of small joints of hand. 2021;11(3):245.
20. Ahuja RB, Chatterjee PJIJoB. Management of postburn axillary contractures. 2019;27(1):8.
21. Aghajanzade M, Momeni M, Niazi M, Ghorbani H, Saberi M, Kheirkhah R, et al. Effectiveness of incorporating occupational therapy in rehabilitation of hand burn patients. 2019;32(2):147.

Journal of Health and Rehabilitation Research 2791-156X JHRR

22. Phadke A, Bedekar N, Shyam A, Sancheti PJHKPJ. Effect of muscle energy technique and static stretching on pain and functional disability in patients with mechanical neck pain: A randomized controlled trial. 2016;35:5-11.

23. Tehreem Z, Kazmi Y, Khalid MU, Mansha H, Hassan M, Majeed RJJoUM, et al. Comparison of soft tissue mobilization versus static stretching in post-burn contractures at elbow and wrist, A pilot study. 2022;13(3):408-11.

24. Wang L, Cui J-B, Xie H-M, Zuo X-Q, He J-L, Jia Z-S, et al. Effects of Different Static Progressive Stretching Durations on Range of Motion, Myofibroblasts, and Collagen in a Posttraumatic Knee Contracture Rat Model. 2022;102(5):pzab300.

25. Zhang Y-t, Li-Tsang CW, Au RKJHKJoOT. A systematic review on the effect of mechanical stretch on hypertrophic scars after burn injuries. 2017;29(1):1-9.

26. Tokuyama E, Nagai Y, Takahashi K, Kimata Y, Naruse KJPo. Mechanical stretch on human skin equivalents increases the epidermal thickness and develops the basement membrane. 2015;10(11):e0141989.