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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

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ABSTRACT

Background: This study evaluated the effects of an early stretching exercises programme on the range of motion of the shoulder joint and functional recovery in patients with burns.

Methods: A randomized controlled study was conducted. Patients from 15 to 55 years of age with a total burn injury surface area (TBSA) of 10% to 45% involving the shoulder joint including axilla were eligible. Participants were randomized into two groups; intervention and a usual care control group, with 110 patients in each group. A standardized protocol was used in the management of intervention group for 14 days. The control group was subjected to usual protocol currently used. The range of Motion (ROM) was measured, and Functional recovery (FR) was assessed with the Quick DASH questionnaire and the Abduction Ladder. Data were obtained before and after the intervention phase and at 3, 6 and 12 months of post-burn period.

Results: The mean (SD) age of intervention group and control group were 29.76 [9.81] and 30.31 [9.45] respectively. The mean (SD) TBSA% of intervention group and control group was 26.15[9.45] and 24.60[9.56] respectively. There is a significant beneficial difference (p=<0.0001) in ROM and FR between the intervention group and the control group.

Conclusion: This study demonstrated that an early sustained stretching exercise regime significantly improved the ROM and functional recovery of the shoulder joint after a severe burn involving the axilla.

Keywords: Range of Motion (ROM), Stretching exercises, Axillary burn, Functional recovery.

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INTRODUCTION

Burns are responsible for significant mortality and morbidity worldwide [1-4]. Burnt survivors have many physical, functional and psychological difficulties [2]. The majority of patients with burns have an upper limb injury [5-8]. Upper limb functions are vital for the performance of activities of daily living, occupation, and sports [9,10]. Therapists involved in rehabilitation, including physiotherapists, must aim to restore functional range of motion, (ROM) effectively and strength [11]. Contractures after axillary burns often result in limited ROM of the arm and thus loss of function [11].

The depth and severity of the burn and complications of the burn injury influence the outcome of the burnt upper extremity. Inadequate physiotherapy is one key factor that may be responsible for poor recovery after a burn injury [12, 13].

Scar contracture in the axillary region has to be treated surgically if conservative treatment fails to improve the range of movement of shoulder joint [13]. The most important aims of rehabilitation for burn victims are the restitution and improvement of joint mobility, muscular endurance, and strength [12, 13]. Baldwin et al. (2013) reported that significant loss of shoulder joint range of motion is a frustrating complication of burn injury and an aggressive therapy programme can minimize contracture formation [14]. According to Spires et al. (2007), in physical therapy, the muscles are stretched to either maintain or regain their normal resting length and flexibility [15]. Law et al. (2009) stated that active stretching increases active flexibility by strengthening the agonistic muscles. Techniques such as slow relax stretching is useful in relieving spasms in muscles that are healing after an injury [15, 16].

To assess the outcomes of functional recovery, specific subjective and objective assessments are needed. The Quick DASH (Disabilities of the Arm Shoulder and Hand) is a patient self-rated questionnaire and is a useful tool for assessment of the functional recovery [17, 18].

There is very limited evidence in the literature regarding the incorporation of stretching exercises and range of motion (ROM) exercises in rehabilitation programmes and comparing the quality of recovery in severely burnt patients. Wu et al. & Jarrett et al. (2007, 2008) reported that there is only a limited amount of research documenting functional ability, physical fitness, and health-related quality of life after a burnt injury. Even these studies have only proven that stretching exercises are beneficial to improve ROM for patients recovering from burn injury.

There is no study determining the association between patient outcome measurements and early stretching exercises provided to burnt patients was found. Hence, this is the unique study designed to evaluate the outcomes such as range of movement of the shoulder joint and the quality of functional recovery of burn patients after implementing stretching exercise protocol. This study aim was to evaluate the potential benefits of early stretching exercises programme on the ROM of the shoulder joint and functional recovery following a major burn injury involving the axilla with a control group.

METHODOLOGY

This study was approved by the Ethical Review Committee of the Faculty of Medicine, University of Kelaniya (P047/06/2010) and The National Hospital of Sri Lanka (AA/ETH/2010). Registration in the Sri Lanka Clinical Trial Registry was obtained before the study starts (SLCTR/2012/001, on 27/01/2012). Written informed consent was obtained from the patients who took part in the study.

Study design, setting, and population

A randomized controlled experimental single-center study was conducted at the Burns and Reconstructive Surgical unit, National Hospital of Sri Lanka (NHSL) over a period of one year (February 2012 to September 2013). For the intervention group, patients were selected from the burns and reconstructive surgical unit. For the control group, patients were selected from the surgical wards of NHSL. Two registers were maintained for all shoulder, and axillary burnt patients admitted to the NHSL, one for the patients who are in the surgical wards and the other for the patients in the burns and reconstructive surgical unit. Blue numbers were given to these patients (who were eligible for the study). (E.g., for the intervention group, Patient no.1 documented as I1and for the control group patient no.1 as C1, etc.) After considering exclusion criteria, red numbers were given to the patients who were in the two groups in the same manner described above. According to the random numbers which had been created form the software package; 125 patients were included in each group by using the patient's numbers (red) in each register initially. On admission to the burns unit, the ward staff was requested to provide information about the study to all burn admissions with the involvement of the shoulder joint and axilla.

Inclusion criteria: The following factors were considered as inclusion criteria for the study: 1) Involvement of the shoulder joint with axilla as a result of the burn injury; 2) Age range15 to55 years ; 3) Total burn surface area TBS 10% to 45%; 4) Mentally competent to actively participate in the rehabilitation programme. Even the patients with both arms burnt eligible to be included in the study, and they were managed as per the study rehabilitation protocol, and dominant hand was noted.

Exclusion criteria: The following patients were excluded from the study: 1) Pre-burn shoulder pathology, other major trauma such as fractures involving the arm and shoulder girdle at admission to hospital, 2) Pre-existing conditions such as tetraplegia, hemiplegia and other neurological and muscular disorders. 3) People who indicated that they would not be able to return to the Burns unit for any follow-up appointments, 4) Patients suffering from mental retardation or and any known psychological

disorder. 5) Patients were withdrawn from the study if death occurred before discharge from the hospital and during the follow-up period.

According to the CONSORT statement, a participant flow diagram was formed as in Figure 4.

This flowchart describes the process of selection of the patients for the study.

Study protocol

Before starting the stretching, exercises patients were provided with adequate pain relief by medications such as Paracetamol (NSAIDS) and morphine by a staff nurse. The stretching exercises were commenced within 48-72 hours post burn injury in superficial and partial thickness burns. In full thickness burns stretching was commenced on the 5th day after the skin grafting was done. These stretching exercises were performed within the pain tolerable limits according to the Visual Analog Scale. The numbers of repetitions were increased gradually over three days starting with five repetitions and progressing to 10, and then 20 and continued for fourteen days (Annex 1; Figure 1.1b).

The control group followed the protocol that is normally used in the unit. This includes active mobilization exercises, passive mobilization exercises, active assisted exercises, muscle strengthening exercises and activities of daily living. These exercises were also started within 48-72 hours post burn injury as mentioned in the intervention group (Annex 1; Figure 1.1a, Figure 1.1b).

For the experimental group additional stretching exercises were introduced (normally in the morning).

These included:

1) **Passive stretching exercises;** while the patient was in a supine lying position
   - The patient's shoulder was abducted to the limit of the patient's abduction range and held in that position for 1 minute.
   - The Patient's shoulder was flexed to the limited of the patient's flexion range and held in that position for1 minute.

2) **Active stretching exercises**
   - The patient held the bed head bar while in the supine lying position for 1 minute (The patient's arm moved up from thigh region towards the head while maintaining the flexion position in the sagittal plane) (figure 2).
   - The patient held the saline stand placed by the side of affected arm while him/her in sitting position for 1 minute (The patient's arm moved up with maintaining the abduction position in frontal plane) (figure 3).

     In addition to that, advice was given to both groups by the therapists to follow the instructions regarding scar management, nutrition, skin care, infection control procedures, etc. in the unit.

Figure 2: The patient held the bed head bar while in the supine lying position. Active stretching exercise Shoulder flexion

Figure 3: The patient held the saline stand while in the sitting position. Active stretching exercise - shoulder abduction

Data collection method

Shoulder joint Range of motion (ROM) measurement

The Shoulder ROM measurements (flexion, extension, abduction, internal rotation and external rotation) were taken by two physiotherapists each experienced in managing patients with burns before starting the study protocol for the intervention group and the control group; before starting the normal rehabilitation protocol. After that, the measurements were taken after two weeks, three months, six months and twelve months after the burn injury. Each participant (either an intervention group or control group) was randomly allocated to one of the two trained physiotherapists. To ensure accuracy and reliability of the data, the same person took the measurements of that subject throughout the study period under the overall supervision of the principal investigator. In each movement, three measurements were taken, and the mean value was noted.

Data analysis

Analysis of the data was conducted using the SPSS (version16) statistical software package. The independent sample T-tests were used for between-group comparison

at baseline and following the exercises intervention at each stage (two groups had been selected randomly and independently, and the hypothesis of difference had been tested). All values are presented as the mean ± standard deviation (SD), and the level of significance was set at p= 0.05. Logistic regression was carried out to determine whether there was any significant association between age, sex, BMI, TBSA and DM on the range of movement of the shoulder joint in both groups.

RESULTS

The 362 patients were assessed for eligibility, and 94 were excluded according to the selection criteria. From 268 patients, 125 were selected for two groups even though the sample size was 110 in each to account for withdrawals from the study (according to the non-published data; dropout rate was about 5% at the unit). During the study period, three participants from the intervention group and four participants from the control group did not follow-up the treatment (Figure 4 - lost to follow-up). Finally, there were 116 and 114 patients in the intervention group and the control group respectively. For the data analysis, 110 from each group was allocated (Figure 4).

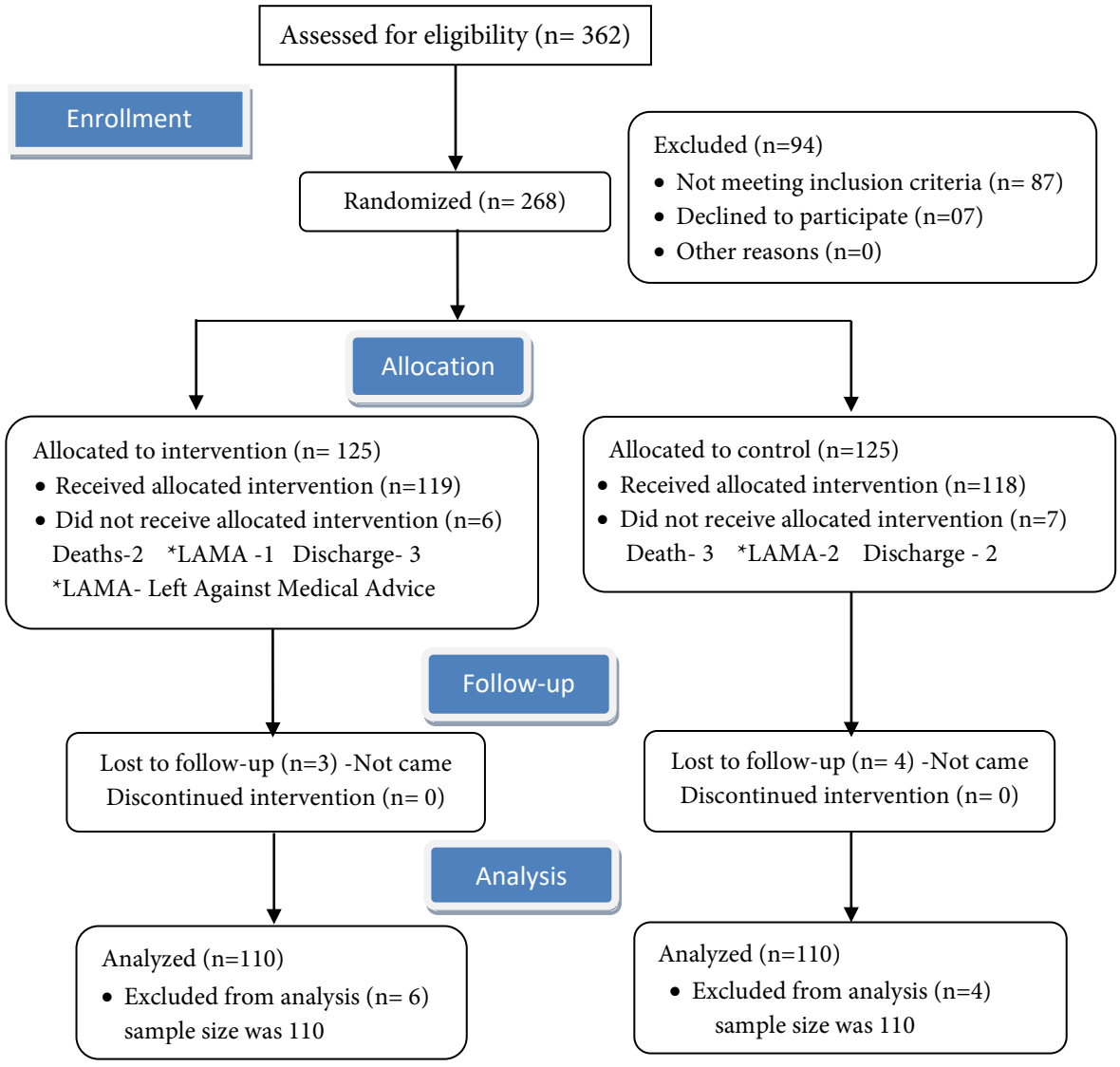

Figure 4: Sequence of allocation and implementation (CONSORT2010 Flow Diagram)

Intervention group

There were 110 patients in this group. 49 were males, and 61 were females. Among all participants, there were 14 (05 males and 09 female) patients with High Blood sugar (a co-morbid disease with burns) though out the hospitalization period. Mean (SD) of Age was 29.76(9.81), Mean (SD) of TBSA was 26.15 (9.45) and Mean (SD) of BMI was 26.15(9.45) (Table 1).

Figure 5 shows; the active ROM of all shoulder movements (mean values) has dramatically increased after the intervention period; this was almost double of the initial values. After that movement was gradually increased. Shoulder flexion and abduction were reached its maximum level. All the shoulder movements were achieved almost equal values (mean) of standard ROM of the shoulder joint (Table 2) and functional joint ROM after 12 months of period.

Table 1: Descriptive statistical analysis (N=110) Intervention group and control group

Demographic Characteristics	Intervention group Mean(SD)	Control group Mean(SD)
Age	29.76(9.81)	30.31(9.45)
*BMI	22.56(3.35)	22.84(3.08)
*TBSA%	26.15(9.45)	24.60(9.56)

Table 2: Mean Range of Motion of the shoulder joint of Sri Lankan healthy adults (*N-24) N*- Number of participants

ROM	Mean(SD)
Flexion	173.89 (4.48)
Extension	59.33 (4.36)
Abduction	175.00 (4.95)
Medial rotation	86.48 (3.71)
Lateral rotation	92.22 (7.04)

*BMI - Body Mass Index
*TBSA - Total Burn Surface Area

Control group

There were 110 patients in this group. 47 males and 63 females. Among all participants there were 11 (04 male and 07 female) patients with High Blood sugar level though out the hospitalization period. Mean (SD) of Age was 30.31 (9.45), Mean (SD) of TBSA was 24.60(9.56) and Mean (SD) of BMI was 22.84 (3.08) (Table 1).

Figure 6 shows; the active ROM of all shoulder movements (mean values) gradually increased during the study period, but compared with the intervention group the rate was low and did not achieve the standard ROM of shoulder joint except shoulder extension after 12 months of period (Table 3). Even though gained ROM were not in standard level, functional activates can be perfumed by the participants with available joint ranges.

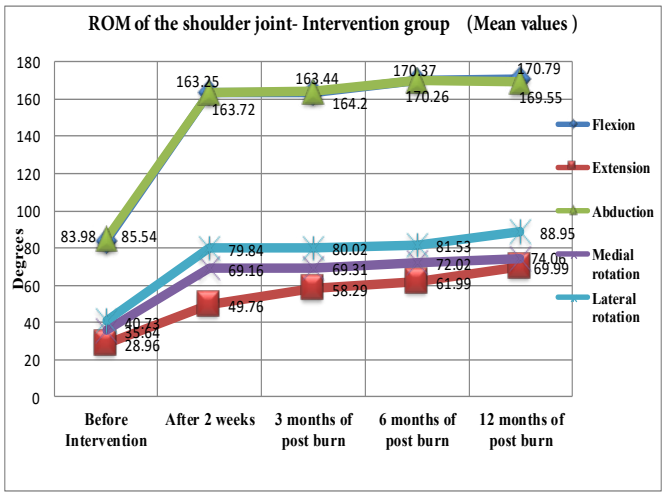

Figure 5: Intervention group- Mean values of ROM of the shoulder joint

Table 3: Mean values of ROM of the shoulder joint of the intervention group and the control group - after 12 months of intervention

ROM	Std*value	Inter:* group	Control group
Flexion	173.89 (4.48)	170.79(4.54)	120.55(11.96)
Extension	59.33 (4.36)	59.99(2.79)	57.71(3.19)
Abduction	175.00 (4.95)	169.55(4.61)	132.76(12.56)
Medial rotation	86.48 (3.71)	74.06 (4.39)	49.61(6.54)
Lateral rotation	92.22 (7.04)	88.95(4.39)	54.68(7.37)

Std* - Standard value of the shoulder movement
Inter:* - Intervention

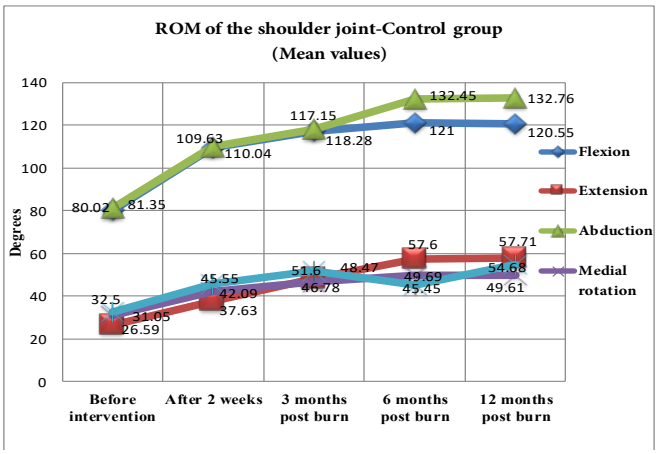

Figure 6: Control group- Mean values of ROM of the shoulder joint

The overall ROM scores (before the intervention) of shoulder joint computed were observed, and probability plots (Normal Q-Q plot) appear reasonably normally distributed.

Demographic characteristics (age, TBSA%, and BMI) of both control and the intervention groups were similar. There was no significant difference in ROM of the shoulder joint before the intervention, but after the intervention, after three months, six months and 12 months there was a significant difference between the intervention group and the control group; it was ($P = 0.0001$). In this study; it was found that relationship between Age, Sex, BMI, TBSA, and DM with ROM of shoulder abduction was insignificant ($p > 0.05$). Also, there were no significant correlations among any of the predictor variables with the ROM of the shoulder joint in both groups.

T-Test

Independent sample T-test was used to compare the mean scores of all the shoulder joint motion and the mean score of the QDASH of the intervention group and the control. The mean scores of all the shoulder joint motion in the intervention group reached to its highest level over the study period, and the mean score of the QDASH in the intervention group appeared to reduce over the study period (Figure 7). There was a significant difference in ROM ($p=0.001$) of the shoulder joint (Annex 2; Table 4) and the QDASH score ($p=0.001$) in the intervention group at 3months 6 months and 12 months study period in

compared to control group (Annex 2; Table 5).

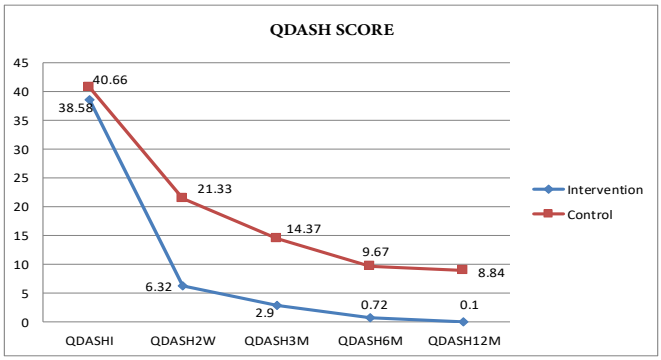

Figure 7: Mean values of Quick DASH Score of two groups

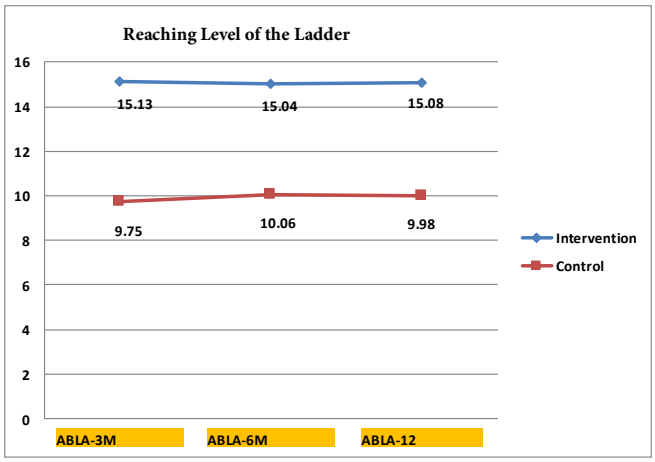

Figure 8: Mean values of reaching level of the Abduction Ladder

Figure 7 showed the mean values of Q-DASH Score of two groups after 12 months of the period decreased in both groups; more in the intervention group over the study period, indicating improvement in upper limb function. In the intervention group, it was all most 0 (mean) level wherein the control group it stopped at 8.84 (mean). Mean values of the reaching level of the Abduction Ladder did not change much in both groups, but in the intervention group, it was higher than compared to control group (Figure 8).

DISCUSSION

The study aimed to find the effectiveness of early stretching exercise technique in patients with shoulder and axillary burns. This study compared the outcomes of the shoulder joints as a range of motion and the quality of functional recovery of the upper limb with a control group which involved only protocol currently used in the unit (active exercises, passive exercises, muscle strengthening exercises).

Previous studies that have shown the beneficial relationship between the therapeutic exercises and the range of movement of the shoulder joint and the health-related quality of life of the burn victims are descriptive cross-sectional studies. Those studies do not mention a specific protocol that can be included in an early stretching exercise programme to improve the range of movement and shoulder functions of burn victims.

There was significant difference found in two groups. The Main attention was focused on the hold time of the stretching exercises in this study. The one-minute stretching hold time was decided based on the previous studies, previous studies emphasized sustain stretching for the burn scars are effective, but there was controversy about the hold time. Even though most of the researchers agree with 30 -60 seconds, Godleski (2013) recommended that it should be more than 3 minutes and additional study is needed to determine what duration is optimal. Longer hold times were considered as being potentially more beneficial, but there was concern that therapist fatigue during a prolonged stretch might affect the consistency of the intervention and lack of patient tolerance [19].

The two muscles that bound the axillary space, pectoralis major and lattisimus dorsi, maintain the axilla. The axillary space is what contracts at rest but stretches in full extension. The effectiveness of stretching maintains the length and power of the muscles. The stretched axillary space contributes to the prevention of axillary contracture.

According to our study findings, the intervention group improved significantly compared to the control group due to the stretching protocol. The stretching protocol consistently improved ROM significantly in rehabilitation patients with burn injury during the intervention period. It is additionally important to note that the program produced ROM gains despite the anticipated active negative effect of ongoing scar formation, and not using alternative contracture treatment strategies such as splinting and positioning and casting. We attempted measuring pain (using Visual Analog scale) scores during protocol; at pre-stretch, during the stretch, and post stretch to ensure optimal pain control which required producing an effective stretch. Active ROM may be more functionally applicable but felt to be more difficult to accurately record because of day-to-day changes in patient fatigue and local pain.

Our findings support thus of Godleski et al. (2013) who showed that intensive stretching yielded significant improvements in joint range of motion for patients with burn-associated joint contractures. Ward (2006) stated that passive ROM exercises are useful when soft tissue resistance affect the motion and the patient does not have the strength and endurance to overcome the force produced by the soft tissues. This passive ROM exercises are also useful when the patient is suffering from a painful condition. He also mentioned that these passive ROM should be performed slowly enough so that there is enough time for tissue elongation. Ward (2006) concluded that the stretch should be held for at least 30-60 seconds [20]. Our study findings agree with the findings of Ward (2006) and Godeski et al., (2013).

Strengths of the study: This is the first adequately powered RCT that has specifically evaluated the effectiveness of early stretching exercises for the quality of recovery, specifically applied to shoulder and axillary regions of people with burnt injuries. Our results demonstrated that the early stretching exercises of shoulder region improve

the function and self-rated change in symptoms in the intervention group significantly (p=0.001) compared with the control at short, medium, or longer-term follow-up. Before the intervention, there was no significant difference (p= 0.524) between the functional level of the upper limb in participants of both groups.

According to the results of the present study, the mean Quick DASH scores showed a trend towards the pre-injury score over time and therefore pre-admission upper limb functional level such as; doing heavy house hold chores, washing back, recreational activities with taking some force through arm were improved. Furthermore, very good response toward the psycho- social, work, sport and recreational activities were observed as above. Also, maximum achievement of Abduction Ladder was also demonstrated in the intervention group but not the control. Continues stretching was used to elongate the muscle and to give maximum ROM of the joint. Due to the stretching technique used in our study shoulder movements improved significantly compared to the control group. This improvement in shoulder ROM contributed to improved upper limb functional level.

It was noted that this stretching exercises regime has a beneficial effect on the axillary scars and as a result, the patients had functional and cosmetic benefits.

Study limitation- As mention above this study has done with the participants who can speak and understand the Sinhala language only.

CONCLUSION

The present study is the first adequately powered randomized controlled clinical trial that has demonstrated a sustained stretching protocol which has significant benefits with regard to improving the range of movements of the shoulder joint, functional activities of a shoulder joint of burnt victims. This study also demonstrates that this sustained stretching technique can be practiced using easily available equipment found in most of the hospitals in developing countries. However, more studies are required to further refine the use of stretching and other contracture treatment techniques in the field of burn rehabilitation.

Abbreviations

NHSL: National Hospital of Sri Lanka
DASH: Disability of the Arm, Shoulder, and Hand
QDASH: Quick DASH
TBSA: Total Burn Surface Area
ROM: Range of Motion
VSS: Vancouver Scar Scale
FR: Functional Recovery

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Annex 1

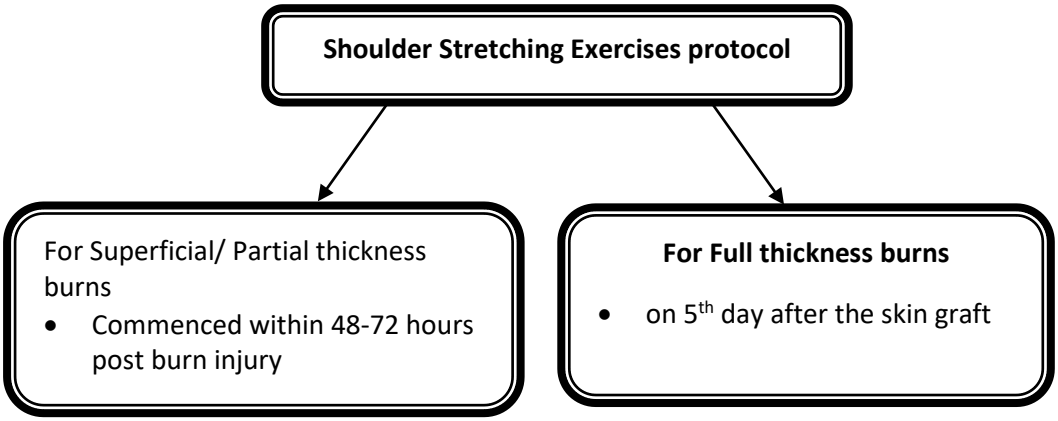

Figure 1.1 a Stretching Exercises protocol

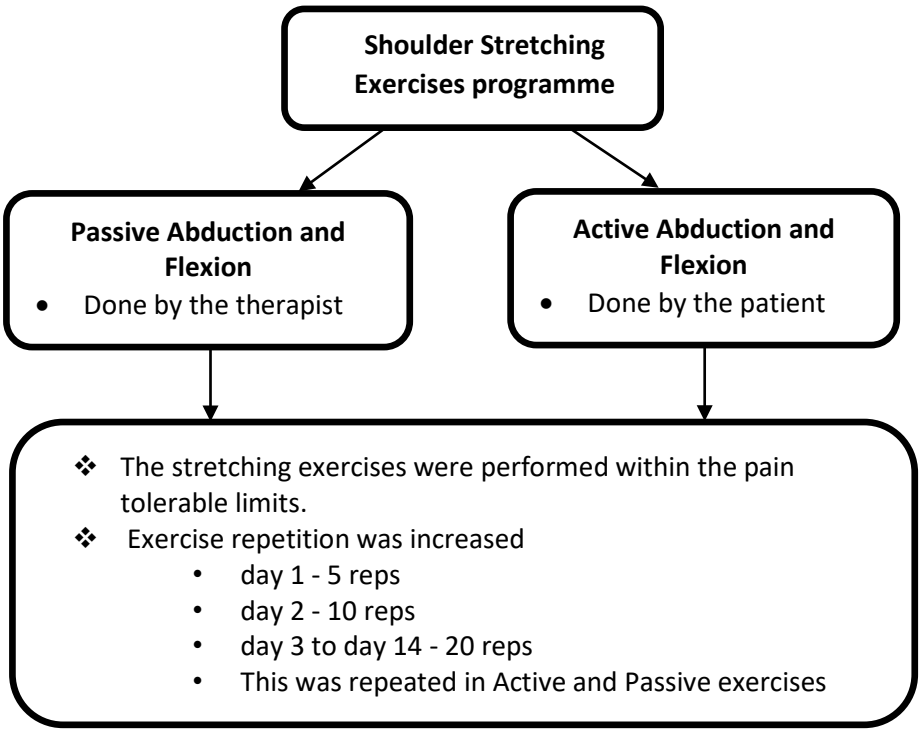

Figure 1.1 b: Shoulder Stretching Exercises procedure

Annex 2

Table 4: Independent samples T-test- 12 months (*ROM mean score)

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2-tailed)
Flexion2	46.89	0.000	-40.171	218	0.000
			-40.171	137.979	0.000
Extension2	0.000	0.997	-10.586	218	0.000
			-10.586	214.015	0.000
Abduction2	49.59	0000	-36.682	218	0.000
			-36.682	137.886	0.000
MeRotation2	9.65	0.002	-32.543	218	0.000
			-32.543	190.703	0.000
LaRotation2	38.48	0.000	-43,539	218	0.000
			-43.539	161.154	0.000

Table 5: Independent sample T-test- Group Statistics (Quick DASH mean score)

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2-tailed)
QDASH	110.14	0.000	9.278	218	0.000
2Weeks			9.278	127.082	0.000
QDASH	61.70	0.00	9.525	218	0.000
3 months			9.525	134.092	0.000
QDASH	52.720	0.00	9.178	218	0.000
6 months			9.178	116.331	0.000
QDASH	61.596	0.00	9.668	218	0.000
12 months			9.668	109.782	0.000