Treatment of Shoulder Dislocation Due to Rotator Cuff Syndrome: A Comparative Study Between A Manual Relocating Technique and A Shoulder Rehabilitation Device

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Abstract: Our objective is to introduce a new device designated to reduce shoulder dislocation (METHOD-2) compared to a manual technique (METHOD-1). Eighteen shoulders in 20 right-handed participants (22±5) were evaluated as non-traumatic posterior instability. Patients recorded scores ranging between 71.6 and 88.42% when performing the Japanese orthopaedic association shoulder scale (JOASS). Participants were divided into two groups of tens. A licensed physical therapist applied METHOD-1 on GROUP-1. As for GROUP-2, they completed two sets of 10 tractions and pulls using METHOD-2. Participants were asked to complete a relocating maneuver (METHOD-1 or METHOD-2) followed by a pain assessment (Borg-CR10) and a «Self-Assessment Manikin» (SAM). A retest was set 6 to 8 days later. The data collected were abduction, elevation, medial and lateral rotation goniometry, as well as, the scores obtained from the SAM and Borg-CR10 scales. A paired Student-T test was realized in order to compare test and retest results ($p<.05$). GROUP-1 procured a decrease in Borg-CR10 Scale (0.9) and an increase in the SAM scale (1.5). The gains of amplitude in GROUP-1 participants were significantly higher ($p<.05$) than those attained in GROUP-2 ($p>.05$). In conclusion, METHOD-2 had no shoulder relocating effects, but decreased the self-reported pain perception.

Keywords: Shoulder, Pain, Rehabilitation, Rotator cuff syndrome, New technique.

1. INTRODUCTION

Normal shoulder function is essential for everyday tasks and physical performance, and a slight dysfunction may cause an unbalanced everyday quality of life. Nearly 50% of patients who have shoulder pain and disability report limitation for 12 to 18 months [1]. Particularly, rotator cuff injury may evoke pain and glenohumeral (GH) disability even after surgery or conservative treatment [2]. Shoulder pain has been classified as the third leading musculoskeletal complaint seen by general practitioners. Often, postural deviations and muscular imbalances are the main causes leading to shoulder pain and instability. According to Horsley [3], shoulder instability will later convert into shoulder impingement. Primary shoulder impingement is frequently described as a mechanical compressor of the rotator cuff tendons, subacromial bursa and the long head of the biceps tendon against the acromion process and coracoacromial ligament. Secondary impingement occurs as a result of tight posterior capsule [4] and shoulder instability [3]. Physical therapy is generally the first approach in treating shoulder pain. It surrounds many forms of interventions, including exercise, functional training, manual therapy, physical agents and mechanical modalities. The main goal of this physical therapy treatment is to prevent impairment, enhance function, reduce risk, optimize overall health and, finally, enhance fitness and well being [1].

A perfect balance between mobility and stability is required to maintain the optimal function of the shoulder joint [5]. Because it affords large ranges of motion, the shoulder joint becomes unstable as a result of frequent high-demand usage or traumatic events. The pathophysiology of GH instability has been the focus of many studies and has been investigated since the time of Hippocrates [6]. Repeated high-magnitude stresses may compromise the structural load-bearing capacity of the capsuloligamentous stabilizers of the GH joint. Bankart was the first to emphasize the importance of detachement of the anteroinferior capsule from the glenoid (Bankart lesion) [7]. Neer hypothesized that repetitive microtrauma sustained during high-demand over-head sports activity could result in excessive capsule stretching, resulting in multidirectional instability. Patients are mostly consulted for recurrent dislocations. The GH tends more to dislocate in case of deficient stabilizers. This instability lead to painful shoulder conditions especially a dislocation of the shoulder. Partial dislocation is referred to as subluxation. In over 95% of shoulder dislocations, the humerus is displaced anteriorly, posteriorly caused by a rotator cuff imbalance or

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inferiorly in less than 1% of the cases. Based on a passive manipulation, the relocating techniques should be bearable reducing pain and instability. The purpose of this study was to introduce a new operator-dependent rotator cuff relocating device (Figure 1) to the treatment based on traction forces. We aimed to get the exact results of the manual treatment by relying only on the pull and push exercises performed by the patient

2. MATERIALS AND METHODS

2.1. Participants

A sample of twenty right-handed patients aged between 60 and 65 years volunteered to participate in this study. All were informed of the aims of the experiment before signing a written consent. The inclusion criteria included a diagnosis for shoulder dislocation as well as the ability to apply and perform the study instructions. Exclusion criteria were already-treated rotator cuff syndrome. The study was conducted in conformity with the Declaration of Helsinki 1975, revised Hong Kong 1989 and under the supervision of a physiotherapist.

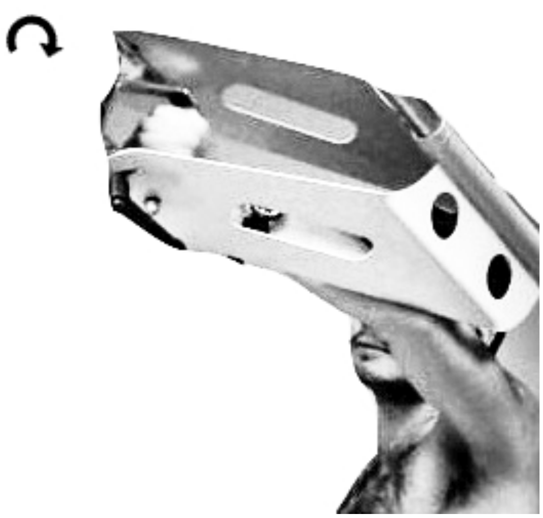

Figure 1: Illustration of an operator-independent device meant to help relocating the scapulohumeral joint during shoulder rehabilitation protocols.

2.2. Triple Point Test

Firstly, all patients had to undergo a global shoulder exploration through a "triple point test". This test is based on the ascertainment that a healthy patient is able to reach the dorsal facet of the contralateral scapula in three different ways:

1. The anterior contralateral passageway crossing the opposite side of the head
2. The anterior iposilateral passageway crossing the same side of the head
3. The posterior passageway crossing the back

The points reached with the fingertips for each of these passageways are designated within five stages. To evaluate the horizontal adduction of the shoulder, the patient begins with touching his mouth, his opposite ear, neck, trapezius muscle and finally his scapula. This underscores the anterior contralateral passage-way. As for the lateral rotation of the shoulder, the patient is asked to go through the same stages, but this time using his proper side. The anterior ipsilateral passageway is brought out. Finally, the posterior passageway appraises the medial rotation of the shoulder. The patient has to slide his hand starting by the sacral area in the back and going upward to the lumbar spine, the inferior angle of the scapula to reach the scapula. The result of the "triple point test" depends on the patient capacity to perform all given tasks; the slightest distress indicates a shoulder dislocation. The affected shoulder is designated for each patient to pursue the study.

2.3. Shoulder Score

For patients revealing shoulder disorder, shoulder function was assessed with the JOASS (Japanese Orthopedic Association Shoulder Score) derived from the ASES (American Shoulder and Elbow Surgeons evaluation form). A systematic literature review has been performed by Fayad *et al*. [8] to identify all available shoulder disability questionnaires; they suggested the use of ASES scale for evaluating shoulder function in the recreational athletes. The validity of the ASES is confirmed among fourteen scales. The JOASS is a clinician based outcome scale including five subscales and eight items. Items were scored on a 0 to variable maximum 5 to 30 points scale:

- Pain (30 points)
- Function (20 points)
- Range of motion (30 points)
- Joint stability (20 points)

Every patient had their own shoulder evaluation sheet indicating date, name, age, gender, dominant hand and affected shoulder. Firstly, the patient should denote the intensity of the affected shoulder's pain and the daily functions he could perform easily. Secondly, we apply a progressive resistance to quantify the patient's ability to accomplish shoulder abduction, and endurance when holding 1 kg.

Thirdly, the joint amplitude has been assessed with goniometry-based angle values [9]. The goniometer applied is a "Baseline Plastic 360 Degree ISOM" composed of two 12-inch branches connected to a common axis, and a calibrated scale indicating the angle values. Using the reference 0 method described by Roberts [10] then Brunner [11], we measured the elevation, abduction, external and internal rotation for each patient. To evaluate the elevation we adapted the R1 reference position where the patient is seated, bare-skinned; the patient is asked to perform an elevation in the sagittal plane. The elevation angle was formed by aligning the goniometer with the lateral epicondyle of the humerus, the middle of the glenoid fossa and a vertical line in the frontal plane. To assess the abduction range of motion, the patient remains seated and abducts his shoulder in the frontal plane. The abduction angle was formed by aligning the goniometer with the lateral epicondyle of the humerus, the middle of the posterior glenohumeral joint line, and a vertical line in the sagittal plane. As for the external and internal rotation, the position R3 designated the R1 position with 90° of elbow flexion and neutral forearm position. The external rotation angle was formed by aligning the goniometer with the ulna styloid process, the olecranon process of the ulna, and a horizontal line. The patient performs rotations in the horizontal plane. To have an accurate notion of the ranges of motion, the reference position was considered 0 when it didn't fit with the anatomical position, and was adapted for every measurement. The angle obtained is noted according to the form α= x ° and is considered as a reference value. Measurements are taken by the same physical therapist each time. In normal conditions, the patient should record: Elevation α=160° (±0.91); Abduction α=150° (±0.91); External rotation α= 50° (±0.91) and Internal rotation α=80° (±0.91). All patients with full ranges of motions will not pursue the study protocol.

2.4. Study Protocol

Before launching the experiments, we had to ensure that the patients' characteristics complied with the inclusion and exclusion criteria. The "triple point test" and the JOASS must be performed by a professional physiotherapist. The same person should perform all testing procedures so as to decrease to the maximum measuring errors. After confirming the affected shoulder and passageway using the "triple point test" for all patients, the population formed by a sample of twenty patients was randomly divided. Hence, two random groups of ten were formed to be treated with either manual-relocating technique or operator-independent device, and obtained data from both was compared. A testing stage was established to familiarize the patient with the study protocol, to loosen the glenohumeral joint and enhance the humeral head relocation in the labrum.

2.4.1. Testing Stage

The first group (GROUP 1) has to undergo Sohier [12] manual relocating technique: every patient is treated taking into account the considering his affected shoulder and passageway. In case of anterior dislocation, the patient is seated with bare-skinned thorax and upper limbs. The physical therapist from the front the patient's distressed shoulder and holds a backward thrust on the humeral epiphysis to detect the type of restriction and loosen it. For patients with posterior dislocation, they keep the initial seated position. The therapist places a hand on the anterior facet of the distressed shoulder, his other hand holding the patient's arm, which he later lifts to loosen the glenohumeral joint space. The first hand applies an anterior thrust to stimulate correction. Patients with inferior dislocation should be seated, their shoulder slightly abducted and elbow at 90° of flexion. The therapist applies a thrust on the humeral epiphysis to generate external rotation and loosens the forearm for internal rotation.

The second group (GROUP 2) will go through a shoulder adjustment technique using the proposed relocating device. The physical therapist should insure that the patient is seated correctly and bare handed. The arm support should be adjusted according to the arm's length and distressed shoulder (left or right). The handle adjustment is defined by the dislocation type. A measurement dial will indicate with a cursor the force of traction and thrust performed by the patient. As a first step, the patient raises his arm to hold the device's handle. The second step begins when the patient performs each 2 series of 10 tractions and 2 series of thrusts, traction or thrust lasting 2 seconds. The resting period lasts 1 minute between two series. Patients with anterior dislocation were asked to perform two series of tractions and thrusts while their arm was maintained anteriorly to help the humeral head to couple the labrum. Patients performed the same number of series while the glenohumeral joint is in slight internal rotation.

After achieving the shoulder-relocating program, we suggested a self-assessment measurement scale to evaluate the patient's perception of the testing program. The Self-Assessment Manikin (SAM), described by Bradley and Peter [13], is a non-verbal assessment technique measuring pleasure, arousal and dominance related to the person's affective reaction to a certain situation. The 5-step SAM scale was used. It is a nine-point scale starting with 1, indicating the discontent, to 9, indicating full satisfaction. Every patient has to assign an emoticon expressing his feeling during the testing procedure either for the manual technique of using the relocating device.

To assess shoulder pain, we employed the category ratio scale Borg CR-10 suggested by Borg [14]. It consists of a 15-grade scale starting with 0, indicating no pain, to 11, the extreme or maximum pain. Every patient has to indicate the closest number expressing his pain level when going through the testing procedure.

2.4.2. Retesting Stage

The retesting stage is considered as a sequence to the testing stage, where we can infer the effects of the two adjustment techniques. Between 5 to 7 days later, the patients of group one and two go through the exact same testing protocol. The first group was treated by the manual relocation technique and the second by the proposed device.

In the retesting stage, we measured the joint amplitude with goniometry-based angle values at the end of the treatment. These values will be noted and will represent the final angular values to compare with the initial range of motion. We assessed the elevation, abduction, external and internal rotation angular values. Afterwards the patients indicated their feeling using the self-assessment Manikin scale and their pain level with the Borg CR-10 scale. Within this stage, we expect that group one patients will be able to perform higher ranges of motion due to attenuated muscle stress. As for group two, they should be able to perform a higher traction due to their steady shoulder.

2.5. Outcome Measures

Patients' demographic after information including age, gender, history and physical activity, was collected at the entry into the study. Data on the type of dislocation was acquired using the "triple point test"; we linked them to the JOASS score results to indicate the affected shoulder and the final result of the assessment. The following patient-related measures of outcome such as angular values, SAM and Borg CR-10, results were collected at study entry level and 5 to 7 days later for testing and retesting stage.

2.6. Statistical Methods

Most epidemiological data are presented as descriptive data in table form. Comparison of the patient-related outcome scores of testing stage and retesting stage were analyzed using the software Statistica (version 7, Statsoft®, USA). For each group and each technique, the test and retest angular values have been compared for elevation, abduction, internal and external rotation using a paired Sample Student T test. The same test was also applied for the SAM and Borg CR-10 outcome measures comparison. Besides, the possible differences between the results of the manual and the device-assisted techniques have been evaluated using a Student T test for unpaired samples.

3. RESULTS

3.1. Epidemiological Data

The JOASS scores were collected and an average score of 83.4% for all twenty patients was obtained confirming the presence of shoulders instabilities.

3.2. Joint Amplitude

The angular values were delineated using a goniometer during the testing period of the manual relocating technique. The same measurements were taken after applying the manual technique in the retesting stage. The test and retest outcomes have been averaged and compared. Table **1** summarizes the four movement's range of motion (mean ±SD), namely, the elevation, adduction, internal and external rotation for both manual and device-assisted techniques. It was noticed that the angular values increase after applying the manual relocating techniques in the four main movements meaning that the manual technique help to improve the shoulder's function (from 4.8 to 16.8 %) ($p<.01$). The significant difference of the angular values of all movement shows the three types of dislocations were treated. This short-term improvement highlights the importance of the manual technique and the physical approach to the affected shoulder. For the shoulder relocation device, we noticed a slight increase

Table 1: Averages and Standard Deviation of Shoulder Range of Motion (°) During Test (TEST) and Retest (RETEST) after Applying Sohier's (2008) Technique. GROUP1 Refers to the Manual Technique Whereas GROUP2 Refers to Devise-Assisted Technique

	GROUP 1				GROUP 2			
	Elevation	**Abduction**	**IR**	**ER**	**Elevation**	**Abduction**	**IR**	**ER**
TEST	142.5 ±7.9	140.2 ±3.9	59.5 ±8.6	40.3 ±2.1	141.6 ±8	138.2 ±6.8	59.3 ±8.4	40.8 ±3.2
RETEST	150.9 ±7.4	147.3 ±2.8	67.9 ±8.5	47.1 ±2.8	143.6 ±8.1	140.1 ±7.0	60.4 ±6.9	42.1 ±2.5
Difference (%)	+ 5.5	+ 4.8	+ 12.3	+ 14.4	+ 1.3	+ 1.3	+ 1.8	+ 3.0
T value	*-16.83*	*-8.63*	*-8.20*	*-9.79*	*6.00*	*6.86*	*-1.67*	*-2.51*
p value	*.00*	*.00*	*.00*	*.00*	*.07*	*.06*	*.012*	*.00*

after the exercise in the four main movements going from 1.8 to 3 %, but only external rotation improvement was statistically significant (+3%) ($t=-2.51$; $p<.01$). Although gains in shoulder's amplitude after the exercise were expected, the results underline a limited short-term effectiveness of the shoulder's relocating device proposed in this study.

3.3. Manual vs. Device

The results of both manual and device-assisted techniques were averaged separately for test and retest sessions so as to avoid the possible between-session effects. Testing and retesting stage results were compared using an unpaired two samples Student T test. The results are presented in Table **2** as Mean ± Standard Deviation. None of the differences between techniques during both test and retest sessions were significantly different ($p>.05$); meaning that the four movements angles varied nearly the same within a same session independently of the technique.

3.4. Category Ratio (Cr-10 Borg) And Self-Assessment Manikin (Sam) Scales

The participants assigned an icon after applying the shoulder manual relocating techniques, indicating their feeling, and a number for the intensity of pain. This procedure was adapted in both testing and retesting stages to compare the feeling and the pain in both phases. Data are presented in Table **3** as Mean ±SD for both groups and both testing sessions. According to Table **3**, both CR-10 Borg and SAM values decreased between test and retest for both techniques meaning that pain is attenuated independently of the used technique. Regarding techniques, only SAM values were significantly different during the testing session (*i.e.* higher in the manual technique compared to device-assisted technique ($t =1$; $p< .01$)).

4. DISCUSSION

It was assumed that the closed kinetic chain traction work could allow an adjustment of the glenohumeral dislocation. The first set of measurements, including the ranges of motion for the elevation, abduction, internal and external rotation, revealed no significant differences between the initial values as well as after performing the exercise in order to adjust the shoulder's dislocation. The main idea behind the closed kinetic chain concept is to relocate the glenohumeral head in the labrum by applying traction forces to unbind the stiffed rotator cuff tendon and reinsure instability.

Table 2: Comparison of the two Techniques Effects on Elevation, Abduction, Internal and External Rotation During Both Test and Retest. GROUP1 Refers to the Manual Technique whereas GROUP2 Refers to Devise-Assisted Technique

	TEST					RETEST				
	GROUP 1	**GROUP2**	***Difference (%)***	***T value***	***p value***	**GROUP 1**	**GROUP2**	***Difference (%)***	***T value***	***p value***
ELEVATION	142.5 ±7.9	141.6 ±8	- 0.6	- 0.06	0.95	150.9 ±7.4	143.6 ±8.1	- 5	0.92	0.52
ABDUCTION	140.2 ±3.9	138.2 ±6.8	- 1.4	- 1.33	0.31	147.3 ±2.8	140.1 ±7.0	- 5.1	0.87	0.61
RI	59.5 ±8.6	59.3 ±8.4	- 0.3	- 0.96	0.43	67.9 ±8.5	60.4 ±6.9	- 12.4	0.34	0.75
RE	40.3 ±2.1	40.8 ±3.2	+ 1.2	0.19	0.87	47.1 ±2.8	42.1 ±2.5	- 11.8	0.92	0.40

Table 3: Test Retest Comparison of the CR-10 Borg and SAM Scales Scores in Both Groups.GROUP1 Refers to the Manual Technique whereas GROUP2 Refers to the Devise-Assisted Technique

	CR10 Borg					SAM				
	GROUP 1	**GROUP2**	*Difference (%)*	*T value*	*p value*	**GROUP 1**	**GROUP2**	*Difference (%)*	*T value*	*p value*
TEST	1.75 ±0.9	2.1 ±0.7	+ 16.6	0.60	0.70	6.6 ±0.9	6.3 ±0.9	- 4.7	*1*	*0,00*
RETEST	0.8 ±0.8	1.3 ±0.5	+ 38.4	0.5	0.67	7.8 ±0.9	7.1 ±0.8	- 9.8	*0.77*	*0.47*
Difference (%)	-54.2	-61.5				+15.3	+11.2			
T value	*8.14*	*5.58*				*-6*	*-3.21*			
p value	*0.00*	*0.00*				*0.00*	*0.01*			

However, the traction of the humerus to adjust dislocation should only be applied when there is a decrease of 25° in abduction. In addition, the initial position to allow relocation is abduction and not anterior traction [12]. The second set of measurement includes the category ratio CR-10 Borg and the self-assessment manikin scales. The significant values obtained for the CR-10 Borg and SAM scale demonstrate a reduction in the pain level and a feeling of satisfaction after using the shoulder relocating device. The muscles' relief after performing several tractions and compressions comparable to gym exercises could explain this finding. In addition, the active exercise performed by the patient is more likely an enhancement of the wellness feeling.

The second assumption is the effectiveness of the manual relocating technique on shoulder's adjustment. The first set of measurements, including the ranges of motion for the elevation, abduction, and internal and external rotation, showed significant differences between the testing and retesting stages especially for the shoulder's elevation. After identifying the affected passageway where the humeral head is locked [12], proposes to perform a passive manipulation to unbind it gradually. Afterwards, the full dislocation technique could be applied helping the overall wrap-around structures to respond positively. The rotator cuff injury could be one of the reasons creating shoulder dislocation, due to the tendon's stiffness. The results obtained in this study confirmed the short-termed effectiveness of the manual adjustment technique. The second set of measurements, including the CR-10 Borg and SAM scales, uncovered the pain reliever role of manual relocating technique. Created in 1955 and the most applied by physical therapists to treat shoulder diseases, passive manual techniques will always be the best technique to reduce instability. When touching the shoulder we can identify the stiffness and treat it gradually to achieve the best results.

Since the suggestion of the high authority of health and health ministry about the muscle strengthening to relocate the humeral head [15], the shoulder rehabilitation programs should obviously respect these recommendations The shoulder adjustment device proposed hereby can play a strengthening role since it would train several shoulder muscles that are important in maintaining the humeral head in the labrum. Further studies should be geared towards comparison of the shoulder adjustment device to standard shoulder strengthening technique. The results would illustrate positive effects on shoulder rotator strengthening enabling the integration of the device-assisted technique as a complement of the standard manual technique.

5. CONCLUSION

The glenohumeral joints are a complex articulation with a lack of stability. Static and dynamic stabilizers work as an important structure to maintain its stability. Based on a biomechanical and analytical function, these stabilizers try to compensate each other's action to avoid any sort of deficiency. When a glenohumeral dislocation is established, we have to trigger the origin and treat it gradually without influencing on other factors such as rotator cuff injuries or stiffness. When using the manual relocating technique, a physiotherapist can always identify the stages of distress. These techniques aim to treat the shoulder and avoid surgical intervention.

Introducing new rehabilitation techniques can always make the physiotherapist work easier and more efficient. A better in-depth comprehension of the rotator cuff mechanism and their efficacy on shoulder biomechanics can be examined later using the thermography techniques [16]. This study should be understood as a feasibility study requiring larger patients group and long-term effects investigations.

CONFLICT OF INTEREST

None.

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Received on 11-07-2014 Accepted on 27-07-2014 Published on 17-10-2014