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EFFECTIVENESS OF INDIVIDUALIZED APPROACH FOR PHYSIOTHERAPY OF CHRONIC SHOULDER PAIN AND PHYSICAL FUNCTIONING IN ELITE ATHLETES WITH PHYSICAL DISABILITIES

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ABSTRACT

Objective: To study the potential effectiveness of individual physiotherapy program for wheelchair athletes with shoulder girdle persistent pain and dysfunctions.

Materials and methods: Thirteen athletes, members of the Bulgarian National Teams in wheelchair basketball and track and field athletics, with mean age 40.6 ± 10.9 participated in the study. The studied athletes had had a history of persistent pain and shoulder girdle dysfunctions for more than 6 months. Individual physiotherapy programs were applied to the participants for a period of two weeks. The selection of techniques was based on the initial assessment and evaluation. The participants were evaluated before treatment, after the first week of treatment, and at the end of the period with the use of the following specific questionnaires and tests: Goniometry of shoulder flexion and horizontal adduction, Apley's Scratch test, Active compression test of O'Brien (ACT), Athletic shoulder outcome rating scale and Wheelchair User's Shoulder Pain Index (WUSPI).

Results: Post-treatment effects demonstrated a significant (p<.05) increase in shoulder flexion (14.6° for the right and 12.7° for the left) and horizontal adduction (21.9° for the right and 18.8° for the left). A corresponding increase in the scores for the Athletic shoulder outcome rating scale was found with 10.92 points difference to the initial score (p<.05). The WUSPI demonstrated a non-significant improvement of 0.69 points. The results of ACT and Apley scratch test showed a non-significant decrease of 23.1% for the right shoulder and, 15.4% decrease for the left shoulder after 7 days of treatment. Those results remained unchanged in post-treatment testing.

Conclusion: This study showed that the individual physiotherapy programs are effective in the management of wheelchair athletes with chronic shoulder pain. The involvement of Mulligan's manual therapy techniques combined with other types of exercises for the shoulder and the trunk are beneficial for wheelchair athletes with chronic shoulder pain.

Key words: *Wheelchair athletes, Pain, Physiotherapy, Shoulder, Shoulder girdle.*

INTRODUCTION

Shoulder disorders are a common problem in wheelchair users and many of them experience shoulder pain (Finley et al., 2004; Samuelson et al., 2004; Curtis et al., 1995; Curtis et al., 1999; Ballinger et al., 2000; Fullerton et al., 2003). Shoulder pain is caused by many factors, but most of the studies in the field report that increased shoulder load and the repetitive stress of everyday wheelchair handling and transfers are among the most prevalent ones (Fullerton et al., 2003; Nyland et al., 1997).

In elite wheelchair athletes, upper limb injuries are frequent, with shoulder injuries being the most common (Fairbairn et al., 2019; Tuakli-Wosornu et al., 2018). The cause of shoulder problems in wheelchair athletes is probably multifactorial and is difficult to identify (Heyward, 2017). Some authors concluded that there was a lack of knowledge of the cause of complaints and that further research should be performed to better understand mechanism and factors involved (Fullerton et al., 2003 Chung et al.,2012) The risk for shoulder pain further increases when wheelchair users also participate in different wheelchair sport activities (Crespo-Ruiz et al., 2011; Curtis et al., 1999; Pérez-Tejero et al., 2006). About 80% of wheelchair basketball players reported shoulder pain-related activities of daily living (ADL) or sports activities (Curtis et al., 1999; Pérez-Tejero et al., 2006). Overhead movements involved in many daily living activities and also many sports activities with even higher load may promote shoulder pain (Curtis et al., 1995; García-Gómez et al., 2017; Curtis et al., 1985).

According to some studies, elite wheelchair athletes experience many injuries including a high prevalence of rotator cuff pathology (Lim et al., 2014; De Witte et al., 2017; Tsunoda et al., 2016). Furthermore, it has been shown that encouraging shoulder stability and mobility are fundamental training contents to prevent postural changes (Garcia-Gomez et al, 2019). Often the pain is produced in the end range of elevation movements. They characterize the main part of the overhead sport activities. The full possible end range of upper limb elevation movements was found to be related to trunk mobility too (Requejo, 2008). Improvement in thoracic extension and rotation in able-bodied people is known to have the highest positive impact in the end range of shoulder flexion (Barrett et al., 2016). 15° improvement in thoracic extension resulted in improving shoulder function (Peek, 2015). However, it is relevant to note that no research, to our knowledge, has been carried out that deals with the impact of thoracic extension and rotation improvements to the shoulder range of motion of wheelchair users. In this regard, many studies have been developed to analyze wheelchair users and make the link between the existing pathologies and the reported rates of shoulder pain. Therefore, the majority of the studies focused on treatment programs and protocols are often based on structural changes found by imaging (Curtis et al., 1999; Mulroy et al., 2011; Van Straaten et al., 2014; Nawoczenski et al., 2006; Satyavanshi et al., 2017). This seems a bit controversial as recent studies show that nearly 60% of the investigated wheelchair users report shoulder pain but the imaging results do not identify any significant associations between pain and the prevalence of shoulder pathologies. In average, the pain is considered mild in intensity as evidenced by relatively low WUSPI scores for dominant and non-dominant shoulders (Divanoglou et al., 2018; Dyson-Hudson et al., 2004; Curtis et al., 1999; Morrow et al., 2014).

Muscle activity and changed kinematics is often associated with chronic pain in wheelchair users (Mulroy, 2011, Van Straaten, 2014). Articular receptors can influence the function of the muscles around the joint as explained by arthrokinematic reflex (Makofsky et al., 2007). Dysfunction, pain, and inflammation of the joints lead to neural inhibition of the surrounding muscles, which is known as arthrogenic muscle inhibition (Rice et al., 2010). This failure to activate the muscles was observed in the shoulder region as well (Diederichsen et al., 2009). Experimentally induced subacromial pain was found to reduce the force of contraction of infraspinatus muscle while performing an isometric external rotation (Stackhouse et al., 2013). However, by altering the peripheral input to the spinal centres the arthrogenic muscle inhibition can be reduced (Makofsky et al., 2007). Pain reduction in the shoulder joint was shown to improve the function of the surrounding muscles (Steenbrink et al., 2006). Joint mobilization can influence the efferent motor output to the surrounding muscles by increasing the afferent input through stimulation of mechanoreceptors of the joint. Mulligan's mobilization with movement (MWM) is a joint mobilization technique where an accessory glide is given manually to one of the joint surfaces while the participant performs the painful movement actively (Mulligan, 2019). One of the goals of MWM is to achieve immediate pain relief in the applied joints of the body (Neelapala, 2017). The mechanisms of action and effects of MWMs include manual correction at the joint and neurophysiological effects on the function of the surrounding muscles (Vicenzino et al., 2007, Dimitrova, 2006). A study reported a reduced muscle activity in the shoulder muscles during the application of MWM using a postero-lateral glide in asymptomatic individuals (Ribeiro et al., 2016). The positive instant results of the manual techniques are found to predispose patients to greater motivation and confidence (Teys al., 2008).

Consistent among several of the intervention studies for wheelchair athletes with shoulder pain to date is that the exercise protocols combine global strengthening of the scapular muscles with glenohumeral strengthening and stretching. In this study, we tested the efficacy of a series of therapeutic exercises in combination with individually selected Mulligan manual mobilisations designed to address shoulder pain in elite wheelchair athletes. In this regard, many studies have been developed to analyze wheelchair users (Curtis et al., 1999 Mulroy et al., 2011; Van Straaten et al., 2014; Nawoczenski et al., 2006; Satyavanshi et al., 2017). However, it is relevant to note that no research, to our knowledge, has investigated the impact of an exercise program on persistent shoulder pain of elite wheelchair basketball players and track and field athletes. The benefits of exercise were shown to be augmented when done in combination with several manual therapy techniques for able-bodied people with shoulder pain (Kuhn et al., 2009). Such findings were not reported in these individuals using MWM techniques. Regarding this, we could not find any research about the Mulligan manual mobilisations for wheelchair users with shoulder pain.

Therefore, the purpose of this study was to determine the effects of a 2-week intervention on shoulder pain and functional disability in elite wheelchair athletes with persistent symptoms of shoulder pain.

MATERIAL AND METHODS

This investigation was performed in accordance with the ethical standards of the Helsinki Declaration. All research procedures including testing protocol received approval from the Ethical board of the National Sports Academy. University-approved informed consent was obtained from the surveyed athletes.

Participants

Thirteen (11 male and 2 female) athletes with mean age 40.6±10.9 participated in the study. All participants were members of the Bulgarian National Teams in wheelchair basketball and track and field athletics (the disciplines of javelin throw and shot put) at the moment of the study. The studied athletes had had a history of persistent pain and shoulder girdle dysfunctions for more than 6 months.

Information including age, sex, date of SCI, total time of wheelchair dependence, previous operative procedures, and injuries of the upper extremities was obtained by interviewing and reviewing the medical records of all members of Bulgarian National Teams in wheelchair basketball and track and field athletics (the disciplines of javelin throw and shot put). These patients were asked to participate in this study. Inclusion criteria for the subjects included a current history of unilateral or bilateral shoulder pain lasting 6 months or longer and localized in the shoulder joint region; at least 2 of the following findings: painful arc on active scapular plane abduction and horizontal adduction, pain with shoulder motions (flexion, abduction, internal or external rotation), or painful palpation around the shoulder joint (anteriorly, posteriorly, or at greater and lesser tubercles); shoulder pain during training and sports activities; and shoulder pain during transfers and weight-relief raises. The exclusion criteria included history of fractures or dislocations in the shoulder from which the subject had not fully recovered, upper limb dysesthesia pain as a result of a syrinx or complex regional pain syndrome, and history of cardiovascular or cardiopulmonary disease. An informed consent was obtained from all the subjects before participation in this study. Of 36 wheelchair athletes, 13 met the inclusion criteria and were recruited for this study. A total of 13 patients with paraplegia (2 women and 11 men) were ultimately included in the study. Before enrollment patients gave their written informed consent to participate in the study. Four clinicians were involved in the evaluation procedure.

During the study, the physiotherapy interventions were conducted daily so that they did not interfere and limit the training activity of the participants. All participants were advised to continue their training regime, consisting of one training per day with average duration of one hour and 35min. There were no competitions in their schedule for the treatment period of the study.

Outcome measures

The participants were evaluated in the beginning, after the first week of treatment, and at the end of the period using the following specific questionnaires and tests:

Wheelchair User's Shoulder Pain Index (WUSPI) was specifically designed for patients with permanent disabilities, requiring the use of a wheelchair (Curtis et al., 1995). It covers general issues, related to a person's involvement and capacity, when performing everyday activities, including moving in the city, dressing, eating, etc. The Wheelchair User's Shoulder Pain Index (WUSPI) is a simple and effective self-report questionnaire for quickly measuring the functional cost of shoulder pain in wheelchair users. The WUSPI targets task-specific limitation resulting from shoulder pain (4 subsections), including wheelchair transfers, wheelchair mobility, self-care, and general activities. It is a 15-item self-report questionnaire in which patients are asked to rate, on a 10-cm visual analogue scale, the amount of pain they have experienced in their shoulder/s over the past week when performing everyday activities. The activities include transfers, mobilizing in a wheelchair, dressing and washing, sleeping, driving, performing household and other daily activities. The visual analogue scale is anchored at one end with 'no pain' and the other end with 'worst pain ever experienced'. The scores are tallied with the total score ranging from 0 to 150 points, where a higher score indicates more severe shoulder pain than a lower score. The score can be calculated by summing only the scores of questions that are relevant and answered. This score is then divided by the total number of questions that are answered and then multiplied by 15 to maintain the original scale (i.e., from 0 to 150 points) (Curtis et al., 1995; Curtis et al., 1999; Yildirim et al., 2010).

Athletic shoulder outcome rating scale (ASORS). This questionnaire was specifically designed for athletes with an accentuated predominant upper limb load. It provides information about the level of pain and performance of athletes during training activities and the performing of specific movements, required in their particular sports (Tibone et al, 1993; Magee, 2016). The questionnaire combines subjective and objective evaluations. The subjective evaluation is allocated 90 points, which include pain, strength/endurance, stability, intensity, and performance. The other 10 points are allocated for objective testing. The ASORS may be more sensitive for high-level athletes (Plancher et al., 2009). The overall results depending on the point allocation can be: *Excellent* - 90-100 points; *Good* - 70 - 89 points; *Fair* - 50 - 69 points and *Poor* - less than 50 points (Magee, 2016). Although this outcome assessment tool has not been validated in the literature, it was used because of its unique parameters for evaluation of outcome in the athletic shoulder (Reynolds et al., 2008). Typical shoulder outcome scales were developed for the general population and do not accurately assess outcomes in athletes. The subjective part of the Athletic Shoulder Outcome Rating Scale measures shoulder function in athletes based on pain, strength and endurance, stability, intensity, and performance. The individual categories are weighed according to the importance for the overall outcome with performance being weighed more than all the other categories combined (Reynolds et al., 2008).

Goniometry was used to assess the active pain free range of motion. Two specific directions of the movement were selected - flexion (elevation) and horizontal adduction of the shoulder because they were commonly limited due to pain for all the participants in the study. The point of the active range where participants reached pain was noted and recorded. All participants demonstrated pain limiting the active movement only in those two specified directions, flexion and horizontal adduction. The full possible active pain free range of motion was assessed to evaluate the patient's pain free active range of motion (Nitin, 2013). The goniometry procedure follows the guidelines of Van Ost (Van Ost, 2013).

Goniometry - flexion

The subject is positioned in sitting with the knees flexed to stabilize the lumbar spine. The elbow is extended, and the forearm is in mid position between supination and pronation. The shoulder should be in a position of maximal pain free flexion at the end of the movement. The elbow should be in extension and the forearm should be in a neutral position. The goniometric alignment is: Axis - Near the acromion process, through the humeral head; Stationary arm - Aligned with the midaxillary line of the trunk; Moving arm -Aligned with the lateral midline of the humerus siting the lateral epicondyle of the humerus. The scapula must be stabilized against a supporting surface to prevent elevation, upward rotation, and posterior tilting. The clinician uses his/her hand to stabilize the scapula. Common substitutions in an attempt to gain more shoulder flexion may include lumbar hyperextension, shoulder abduction, or scapular elevation. These substitutions may occur because of limitations at the glenohumeral joint or as a result of pain during testing.

Goniometry - horizontal adduction

The subject should be sitting with the shoulder in neutral rotation. The shoulder joint is flexed to 90 degrees and the elbow is flexed to 90 degrees. The shoulder should be in a position of maximal pain free horizontal adduction at the end of the movement.

Stationary arm - Aligned along the midline of the shoulder siting the base of the neck; Moving arm - Aligned along the midline of the humeral shaft, siting the lateral epicondyle of the humerus. The thorax must be stabilized against the back of a chair or supporting surface to prevent rotation.

Additional clinical information about the signs in the shoulder complex was obtained, by the application of two specialized tests - *Apley's Scratch test and Active compression test of O'Brien.* Both tests were randomly selected from the list of the most applied clinical tests for patients with shoulder pain (Magee, 2016). Both Apley and Active compression test of O'Brien were not used as selection criteria. The tests were applied at the beginning, after the 7th day and post treatment.

In *Apley's Scratch test* the patient is asked to put his/her arm above the head and drive it behind the neckline to touch his/her upper back. This test analyzes the rotation of upward, external and elevation (Anderson et al. 2011). During physical examination, if the patient is having pain provocation, then the physical assessment is marked positive (Magee, 2016).

Active compression test of O'Brien. The patient is placed in standing position with the arm forward flexed to 90° and the elbow fully extended. The arm is then horizontally adducted 10° to 15° (starting position) and medially rotated so the thumb faces downward. The examiner stands behind the patient and applies a downward eccentric force to the arm. The arm is returned to the starting position and the palm is supinated so the shoulder is laterally rotated, and the downward eccentric load is repeated. If pain on the joint line or painful clicking is produced inside the shoulder (not over the acromioclavicular joint) in the first part of the test and eliminated or decreased in the second part, the test is considered positive for labral abnormalities (Magee, 2016).

Intervention

All participants followed detailed individual programs consisting of two parts. The first part with protocol applied for all participants in the study including mobility and resistive (with elastic bands) exercises in the upper extremities (Curtis et al., 1999; Mulroy et al., 2011; Van Straaten et al., 2014; Nawoczenski et al., 2006; Satyavanshi et al., 2017). The second part of the program included specific Mulligan manual techniques, individually selected according to the symptoms of each participant. To assure the quality and consistency of the individual physiotherapy program, a qualitative analysis was developed based on the expert opinions of health and sports professionals, including a sports physician, physiotherapists and coaches (García-Gómez et al. 2017). The second part of the individual programs were individually selected by the physiotherapy team of 4 people. All of them where certified Mulligan manual therapy practitioners (CMP). The selection of the techniques followed all guidelines of the concept and was based on the pain location, movement limitation and movement restriction due to pain (Mulligan, 2019; McDowell et al. 2013).

Based on the information and evidence available in the previous literature, individual physiotherapy programs were developed. They focused on the pain management, mobility and activity improvement in wheelchair basketball players and track and field athletes (the disciplines of javelin throw and shot put) with chronic shoulder pain and limitations. The content validity of the first part of the treatment program was demonstrated in previous studies (Curtis et al., 1999; Mulroy et al., 2011; Van Straaten et al., 2014; Nawoczenski et al., 2006). The proposed first part of program included:

Five resistive exercises with an elastic band (Blue color Thera-band) performed for scapula retraction and depression, and shoulder rotation and adduction (two sets of ten repetitions, with 45 s of rest between sets). All exercises had to be performed without pain provocation. The detailed exercises were:

One hand horizontal rowing with accent for scapula retraction in the end position. Controlled protraction when going back to starting position in eccentric phase was required;

Shoulder internal and external rotation from starting position of the arm touching the unilateral side of the trunk and elbow in 90º;

Shoulder internal and external rotation from starting position 90º shoulder and elbow flexion;

Shoulder press (from 90º abduction of the shoulder) with an elastic band attached behind the patient on the level of the shoulder;

Shoulder press (from 90º abduction of the shoulder) with an elastic band attached in front of the patient on the level of the shoulder;

Mobility exercise for extension, rotation and lateral bending of the trunk from sitting position with back supported on the edge of the table (on the level of the inferior border of the scapulas) and hands behind the neck;

Mobility exercise for extension, rotation of the trunk from sitting position with back supported on the edge of the table (on the level of the inferior border of the scapulas) and hands holding a 300 gram, 1-meter long plastic bar placed on top of the shoulders and behind the neck.

Based on the information and evidence available in the literature, techniques for manual mobilization from the Mulligan concept were selected and applied. The techniques selected for the study were:

Mobilization with movement (MWM), lateral-posterior glide of the glenohumeral joint for limited and painful flexion (Mulligan, 2019). The technique was performed by a physiotherapist with a patient seated. The physiotherapist stood on the contralateral side of pain, stabilizing the scapula posteriorly with one hand. The head of the humerus was translated posteriorly and laterally with the other hand, along the plane of the glenoid fossa. While the glide was sustained, the patient actively elevated arm through the plane of movement. Three sets of ten repetitions, with 45 s of rest between sets were applied in each treatment session (Hing, 2015).

NAG's - natural apophyseal glides (Mulligan, 2019). The technique was performed by a physiotherapist with a patient seated and well supported in a chair. The physiotherapist stood facing the patient in step stance posture stabilizing the patient's shoulder/trunk. Painless oscillatory mid to end-range mobilization was applied in the plane of the facet joints on the spinous process or articular pillar. Mobilizations were applied 6 times on each level (working from cranial to caudal) and repeated 3 times (Hing, 2015).

Reverse NAG's for the cervicothoracic junction (Mulligan, 2019). The technique was performed by a physiotherapist with a patient seated and well supported in a chair. The physiotherapist stood facing the patient stabilizing the patient's shoulder girdle and upper trunk. Painless oscillatory mid to end-range mobilizations were applied in the plane of the facet joints on the articular pillars. Mobilizations were applied 6 times on each level (working from caudal to cranial) and repeated 3 times (Hing, 2015).

The exercises and techniques were selected, and the programs were developed based on previous literature and clinical experience (Curtis et al., 1999; Mulroy et al., 2011; Van Straaten et al., 2014; Nawoczenski et al., 2006).

The two-week-long intervention involved treatment sessions once daily, amounting to 14 sessions in total during a mid-season training camp. The exercise program was performed by each participant individually under the supervision of a physiotherapist who also applied the selected Mulligan's manual mobilizations throughout the study. All exercises and techniques were performed in a seated position.

Statistical analysis

The statistical analysis was performed with the Statistical Package for the Social Sciences (SPSS), version 23.0 for Windows (IBM corp. Inc., Chicago, IL, USA, 2015). The normality of all variables was tested with the Shapiro-Wilk normality test. Descriptive statistics (mean±-standard deviation) were computed. The categorical data were presented as a percentage. Student t-test for paired samples (two-tailed) was used to evaluate the changes in goniometry results over time. Additionally, Cohen's d effect size was used for quantitative measurement of the magnitude of the effect in the same variables. The McNemar test was conducted to determine the differences between proportions of positive answers in the *Appley* scratch test and *Active compression test.* The pre- and post-treatment differences in the scores of the *Athletic shoulder outcome rating scale* and *Wheelchair User's Shoulder Pain Index* were tested by Wilcoxon Signed-ranks Test. A probability level of $p < .05$ was used to establish the significance for all the procedures.

RESULTS

The changes in the range of motion in flexion and horizontal adduction are shown in Table 1, Figures 1 and 2.

The pre-treatment measurements for the range of flexion in both shoulder joints were 149.2±17.1° for the right shoulder and 146.2±23.0° for the left. After 7 days there was a tendency for increasing the range in both shoulder joints, respectively 158.9°±18.6° for the right and 154.2°±20.6° for the left. Post-treatment results for flexion reached an average of 164.6°±18.2° for the right and 160.0°±20.2° for the left shoulder. The differences between the test results were statistically significant (Table 1).

Table 1. *Range of motion in the shoulders – goniometry results (degrees)*

Variable	Pre-treatment A	After 7 days B	Post-treatment C	Mean Difference B-A	Mean Difference C-B	Mean Difference C-A	Cohen's d (C-A) 95% CI
Flexion – right shoulder	149.2±17.1	158.9±18.6	164.6±18.2	9.7 p=.004*	5.7 p=.01*	15.4 p=.007*	.87 -2.48 to .90
Flexion – left shoulder	146.2±23.0	154.2±20.6	160.0±20.2	8.0 p=.006*	5.8 p=.005*	13.8 p=.001*	.63 -1.71 to .53
Horizontal adduction – right shoulder	93.5±38.2	108.1±21.7	115.4±14.9	14.6 p=.02*	7.3 p=.01*	21.9 p=.01*	.41 -2.21 to .86
Horizontal adduction – left shoulder	96.9±39.0	109.6±20.9	115.8±15.8	12.7 p=.045*	6.15 p=.01*	18.8 p=.03*	.45 -2.21 to .86

Note: The values are presented as mean ± SD. The differences between means were calculated by paired sample *t*-test. *p<.05

For horizontal adduction, the pre-treatment measurements were an average of 93.5°±38.2° for the right shoulder and 96.9°±39.0° for the left one. There was an increase within the range of motion after 7 days with 14.6° for the right and 12.7° for the left shoulder. The post-treatment results for the right shoulder indicated that horizontal adduction range of motion significantly increased to 115.4°±14.9° ($p < .05$). The average left shoulder horizontal adduction significantly increased to 115.8° ± 15.8° ($p < .05$).

Cohen (1988) stated that d = .2, .5 and .8 correspond to "small", "medium" and "large" effects (Cohen, 1988). The effect size (Cohen's d) for the flexion of the right shoulder is .87 and .63 for the left one and that corresponds to a ‚strong' effect. For the horizontal adduction, the effect size is ‚medium' with .41 for the right shoulder and .45 for the left one.

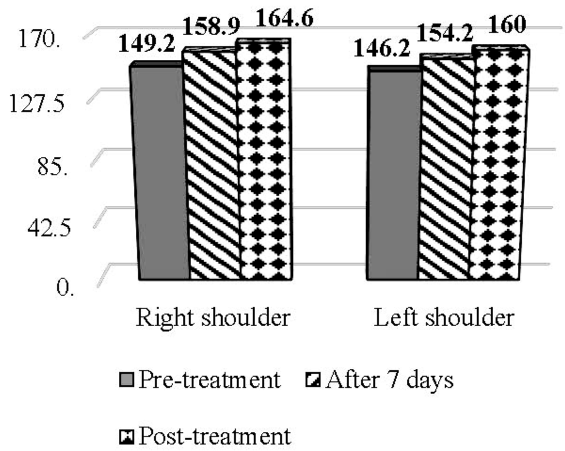

Figure 1. *Range of shoulders flexion (degrees)*

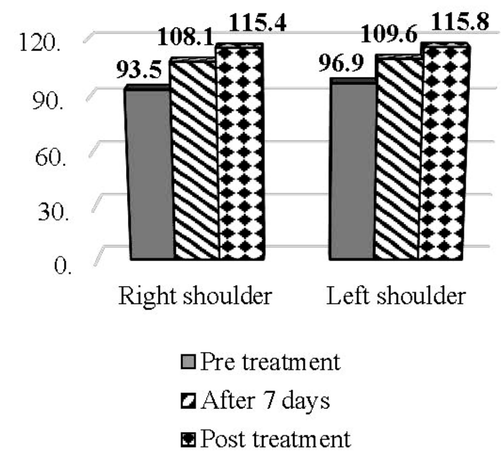

Figure 2. *Range of shoulders horizontal flexion (degrees)*

The percentages of positive cases in the Apley scratch test for the pre-treatment measures were the same for the right and the left shoulders 69.2% (Table 2). After 7 days of treatment, there was a reduction to 46.2% for the right shoulder (23.1% difference - Table 2).

Table 2. *Percentage of positive cases in the special tests*

Test/variable	Pre Treatment A	After 7 days B	Post Treatment C	%Difference B-A	%Difference C-B	%Difference C-A
Apley scratch test – right shoulder	69.2 % (9)	46.2% (6)	46.2% (6)	23.1% p=.25	15.4% p=.50	0 % p=1.00
Apley scratch test – left shoulder	69.2% (9)	58.3% (7)	46.2% (6)	15.4% p=.50	7.7% p=1.00	23.1% p=.25
Active compression test – right shoulder	53.8% (7)	30.8% (4)	30.8% (4)	23.1% p=.25	7.69% p=1.00	0 % p=1.00
Active compression test – left shoulder	38.5% (5)	23.1% (3)	23.1% (3)	15.4% p=.50	0% p=1.00	15.4% p=.50

Note: The values are presented as percent (number). The differences between proportions were calculated by McNemar Test. * $p<.05$

For the left shoulder, the difference after 7 days was 15.4% (58.3% positive cases - Table 2). Post-treatment those results remained the same: 46.2% positive cases for the right shoulder and 58.3% for the left one (Table 2).

The pre-treatment percentage of positive cases in the Active compression test of O'Brien for the right shoulder was 53.8% (Table 2). For the left one, it was 38.5% (Table 2). The testing after 7 days showed a non-significant decrease of 23.1% (30.8% positive cases) for the right shoulder and 15.4% (23.1% positive cases) decrease for the left shoulder. Those results remained unchanged in the post-treatment testing (Table 2).

The pre-treatment scores for the Athletic shoulder outcome rating scale (Table 3) were 70.31 ± 17.2. The post-treatment scores (81.23 ± 14.18) were significant with 10.92 difference to the initial score. The average pre-treatment score for the Wheelchair User's Shoulder Pain Index (WUSPI) was 35.31 ± 28.96. The post-treatment score was 34.62 ± 28.60 demonstrating non-significant improvement of 0.69 (p = .57).

Table 3. *Tests for complex function and activities: Athletic shoulder outcome rating scale (ASORS) and Wheelchair User's Shoulder Pain Index (WUSPI) (scores)*

Test/ Variable	Pretreatment	Post treatment	Difference	p
ASORS	70.31±17.2	81.23±14.18	10.92	.0015*
WUSPI	35.31±28.96	34.62±28.60	-0.69	.57

Note: The values are presented as mean±SD.
The differences between means were calculated by Wilcoxon Signed-ranks Test. * p<.05

DISCUSSION

The purpose of this study was to assess the effects of a 2-week individual physiotherapy programs on elite wheelchair basketball and track and field throwing disciplines athletes with chronic shoulder pain.

Following a 2-week intervention program, there was significant improvement in flexion and horizontal adduction ER ROM. The increases of 15.4° (R) and 13.8° (L) in flexion ROM and 21,9° (R) and 18.8° (L) in horizontal adduction ROM are also considered clinically significant improvements in ROM as they are increases greater than 5° (Boone et al., 1978). Manual therapy Mulligan techniques combined with active pain free movements in the symptomatic directions are most probably responsible for the increase in external rotation ROM. In addition, the resistive exercises that were included also provided a dynamic stress to the adjacent joint structures and have positive neurophysiological effect. There are no other published studies on the effects of those techniques on wheelchair users with persistent shoulder pain. However, these findings are consistent with studies with able-bodied people (Teys et al., 2008). The same tendency is demonstrated in studies conducted in other joints of the body that have shown similar effects with the MWM techniques (O'Brien et al., 1998; Abbott et al., 2001; Paungmali et al., 2003b; Collins et al., 2004, Vicenzino, 2007). Many studies proposed that manual therapy may provide sufficient sensory input to activate the endogenous pain inhibitory systems (Sterling et al., 2001; Paungmali et al., 2003a; Souvlis et al., 2005). The combination of active pain free MWM (mobilizations with movement), trunk mobility and strengthening exercises resulted in an improvement in previously restricted ROM in shoulder joint (due to pain) in the wheelchair athletes included in our study. The exercises of the trunk aimed to gain mobility in the area and possibly affect the end range of shoulder flexion (Barrett et al., 2016; Peak, 2015). They were applied in a manner based on the throwing kinematics and mechanic similar to the sports of the treated athletes. Overhead throwing motion is a complex activity, involving the shoulder, trunk, and spine, that is achieved through the activation of the kinetic chain, to allow the sequential transfer of forces and motion which requires good pain free mobility in both shoulder joint and thorax (Chu et al., 2016).

After the intervention, the participants reported a reduction in WUSPI scores; however, this change was not statistically significant. While evidence shows that wheelchair athletes are experiencing shoulder pain, explaining this occurrence has been much more difficult. Many studies have looked at correlations between athlete demographics and shoulder pain, but there are still discrepancies regarding the cause of the pain. The average WUSPI score of all participants in our study before the intervention, 35.31±28.96 (N=13) was high in comparison to studies of manual wheelchair users, averaging 23.08 but comparatively low in comparison to other wheelchair athletes (Brose et al., 2008). Post treatment scores in our study where 34.62±28.60. Byung-chun et. al. reported an average WUSPI score of 44.42 for adapted table-tennis athletes and 54.69 for adapted archery athletes (Byung-chun et al., 206). Hooper et al., 2018 reported 39.75 reported an average WUSPI score of 44.42 for adapted rugby athletes (Hooper et al., 2018).

Curtis and Black reported that the WUSPI score was 15.6 ± 20.5 in 46 female wheelchair basketball players (Curtis, 1999) which matches with the score of Ustunkaya et al. 21.59 ± 20.11 (Ustunkaya, 2007). It seems like wheelchair athletes, practicing overhead sports like wheelchair basketball and throwing disciplines (track and field athletics) report less shoulder pain than those who participate in competitive sports without so much overhead activities like wheelchair table tennis and wheelchair rugby.

The Athletic Shoulder Outcome Rating Scale demonstrated 'good' results (score >70) The pre-treatment scores were 70.31±17.2 and the post-treatment scores (81.23±14.18). This demonstrates a significant improvement with 10.92 difference to the initial score. However, it is relevant to address that no research, to our knowledge, has been carried out using the Athletic Shoulder Outcome Rating Scale for elite wheelchair athletes. We did believe it was important to determine scores for the Athletic Shoulder Outcome Rating Scale in addition to their current status mainly because of its unique parameters for evaluation of outcome in the athletic shoulder.

There were some limitations to this study. There was no treatment group assigned to a control condition or conventional physiotherapy intervention removing the ability to compare the individual physiotherapy with other treatment approaches. However, our results act as a basis for further investigation into reported shoulder pain by wheelchair athletes, specifically elite wheelchair basketball participants and track and field throwers.

Further analysis should be done with a larger sample of more diverse wheelchair athletes to determine more accurate the long-term effect of individual physiotherapy programs on shoulder pain. Future studies should also search for preventative measures to any associations found in comparative studies. The future studies should be more generalizable to wheelchair athletes participating in other wheelchair sports.

CONCLUSION

There is a lack of literature about the short- and long-term effect of manual mobilization techniques on wheelchair users with chronic shoulder pain. Specific to elite wheelchair basketball players and throwing disciplines athletes, the results from our study show potential possibility to decrease the level of pain. Clinical implications should include clinicians being more aware of the impact of shoulder pain of wheelchair users in their daily lives. This study shows that the individual physiotherapy program is effective in the management of wheelchair athletes with chronic shoulder pain. The involvement of manual therapy techniques, other types of exercises, such as scapular stability exercises, rotator cuff through range exercises, exercises for the anterior and posterior shoulder and trunk mobility exercises are beneficial for the studied elite wheelchair basketball players and track and field throwers with chronic shoulder pain.

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