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BIOMECHANICAL ASPECTS REGARDING RESTORATION OF SHOULDER STABILITY IN ATHLETES

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Abstract: *Although the recovery of the body after exertion or post-trauma is particularly important, in contemporary sports, for various reasons, it is often not given the necessary time. The main objective of the research was to study the biomechanical particularities of the shoulder that ensure mobility and stability in order to recover post-luxation. The research activity was carried out on two athletes, during 8 months, and we followed the restoration of muscle imbalances and the biomechanical analysis of the unstable shoulder. The objectives of the research were to select the most effective methods and means of physical therapy, by which to restore the stability of the post luxation shoulder, in athletes. As working methods we used exercises performed in a closed kinematic chain and neuromuscular and proprioceptive facilitation techniques, balancing the forces of the deep muscles. As conclusions, it can be said that isometric work in a closed kinematic chain and through neuromuscular and proprioceptive facilitation techniques, we can balance the stabilizing muscle forces at the level of the shoulder joint. Through the recovery sessions performed, the muscle imbalances were diminished by the considerable increase in the muscle strength of the per articular muscles.*

Key words: *physical therapy, stability, shoulder*

1. Introduction

The instability of the omo-humeral unit in spontaneous position is a result of bony, ligamentous and articular factors intrinsic to the three planes of space. This natural tendency towards instability of the homo-humeral unit in spontaneous position is physiologically compensated by osteo-articular factors, muscular factors, and spinal and scapular postural factors. The shoulder muscles originate on the scapula and insert on the upper extremity of the humerus arranged in several layers. The deepest layer called the rotator cuff is the most important and there are four muscles in number: the supraspinatus muscle responsible for shoulder

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abduction, the infraspinatus muscle, the small round responsible for external rotation, the muscle and the subscapularis muscle. They create a cone-shaped muscular mantle around the scapulohumeral joint with a role in shoulder stability and counteracting dynamic antagonistic muscles participating in various angles of movement.

Instability and pain from impingement syndrome are associated with the scapulothoracic stabilizing muscles (serratus anterior, rhomboids and trapezius) which can trigger rhythm disturbances [13]. Research shows that when these muscles lose muscle strength or overuse, stability in the humeral scapula joint is compromised and results in shoulder dysfunction [6]. In athletes, as a result of rising the shoulder during hyperflexion can trigger impingement syndrome [9]. Kibler, WB., 1998, states that dysfunctions of the scapulohumeral joint can be caused by the shortening of muscles such as the pectoralis minor, the latissimus dorsi and the levator scapulae, the shortening of the posterior joint capsule and/or the lack of coordination between the essential muscles such as the serratus anterior, trapezius and rotator cuff muscles [7].

2. Objective

The main objective of the research was to study the biomechanical particularities of the shoulder that ensure mobility and stability in order to recover post-luxation.

3. Materials and Methods

3.1. Research hypothesis

Starting from the idea that the effects of physical therapy affect the entire body of the human being, and thus also of the performance athlete, in the research carried out I established the following hypothesis:

- By applying static and dynamic stabilization techniques, we can help restore muscle imbalances at the shoulder level post-trauma.

3.2. Organization of the research

The research was carried out on 2 athletes, handball players, diagnosed with anterior scapulohumeral dislocation. The study was conducted for a period of 8 months, during 2021-2022. Physiotherapy sessions took place daily, for one hour, inside the strength room and the playing field. During the application of the tests and the intervention, I used a goniometer, elastic bands, balance boards, boss-ball.

In order to achieve the established objectives, a weekly intervention scheme was used, within which both proprioceptive neuromuscular facilitation techniques and closed kinematic chain exercises were used.

To combat the pain, Codman-type exercises were used to relieve muscle tension. Movements were performed in all directions for 20 repetitions of 3 series. Local and general massage was applied to reduce adhesions between muscle fibers, for general and local relaxation. Neuromuscular and proprioceptive facilitation techniques were used, techniques to promote strength and stability, and numerous exercises as varied as possible, which were run and combined so that each session differs in order to avoid the occurrence of muscle fatigue that can produce joint imbalances.

As part of the neuromuscular and proprioceptive facilitation techniques,

isometric contraction in the shortened area was used (repeated isometric contractions, interspersed with pauses, were performed in the area of muscle shortening, alternating isometrics (co-contraction of the rotator cuff and scapular muscles), rhythmic stabilization (isometric contractions were performed on the agonists and antagonists of each movement, without relaxation occurring).

These exercises were performed on the bossu ball from bilateral and unilateral support, once with support on the forearm and then with support on the hand. To increase the strength, the elastic band with progressive resistance was used and toning exercises for the muscles with the short lever arm, of strength, on the scapula-humeral joint (rotator cuff, anterior deltoid, supraspinatus, posterior deltoid) and at the level of the scapulothoracic muscles, the eccentric contraction was followed, phase where most handball-specific shoulder anomalies also occur [14]. Dynamic stabilizations were achieved using 3 main muscle chains. At the level of the glenohumeral joint, dynamic stabilizations were performed on the deltoid muscles and the rotator cuff. The scapulothoracic muscle chain was activated via the rhomboids, trapezius, serratus anterior, levator scapulae and thoracohumeral torque (pectoralis major and latissimus dorsi).

3.3. Assessment instruments

In order to evaluate the subjects, the following measurement methods were performed (exploration and evaluation): evaluation of the intensity of pain points, evaluation of mobility, strength and functional tests to evaluate shoulder stability. A system of manual examination techniques was performed to evaluate the strength of the muscle groups that perform the movements in the shoulder joint, respecting the general and specific rules of the technique, the positioning of the subjects and the examiner. Load and shift test – the subject in position sitting on a chair without a backrest, with a straight back, the examiner behind him stabilizes the clavicle and scapula with one hand, and with the other grasps the humeral head and pushes it anteriorly observing the degree of its mobility in relation to the position anatomical. It is appreciated by how much the center of the humeral head has moved with respect to the center of the glena in percentages and the type of laxity is established, as follows:

- 0-25% - normal laxity;
- 25-50% - first degree laxity;
- 50% - second degree laxity;
- >50% - grade III laxity.

Apprehension test – subject in supine position, examiner at the side of the limb to be tested and abducts the subject's arm to 90°, externally rotating it. The test is positive if the subject feels pain or a displacement of the shoulder, indicating previous instability.

Andrew's test for anterior instability – with the subject supine, with the arm abducted to 130° and externally rotated 90°, the examiner stabilizes the elbow with one hand and pushes the humeral head upward with the other. The test is positive if the subject feels pain during these maneuvers.

4. Results and Discussions

4.1. Results of the research

Initially, the subjects presented pain of strong to exacerbated intensity when

performing movements in the shoulder joint. Calculating the average of the progress recorded for each parameter, at the level of the two subjects, we notice that it corresponded to the objectives pursued, so that, both individually and at the group level, the pain was greatly reduced, or combated, joint mobility and muscle strength have improved, and the stability of the shoulder joint has increased (Table 1, Chart no. 1, 2).

Evaluated parameters Table 1

Evaluated parameters		**C.I.**		**D.F.**	
		TI	TF	TI	TF
Assessment of pain intensity		2	0	3	1
Testing articular	Flexion	150°	165°	145°	165°
	Extension	37°	43°	34°	41°
	Abduction	155°	172°	140°	168°
	Internal rotation	72°	83°	69°	78°
	External rotation	66°	80°	62°	77°
Testing muscular	Flexion	3++	4+++	3	4++
	Extension	4	5	4	5
	Abduction	3+	4++	3+	4+++
	Aduction	4+	5	4	5
	Internal rotation	4	5	4	5
	External rotation	3+	4++	3	4++
Testing funcțional	T. Load and Shift	30%	20%	30%	25%
	T. aprehensiunii	+	-	+	-
	T. lui Andrew	+	-	+	-
	T. Rockwood	+	-	+	-

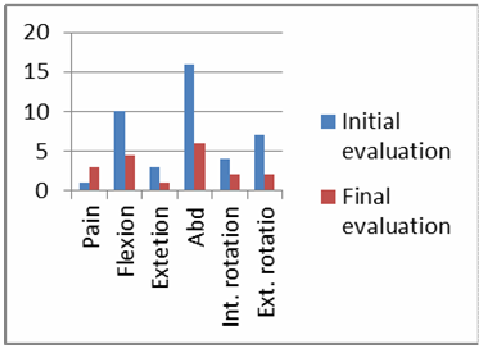

Fig. 1. *Means of progress in pain and mobility assessment*

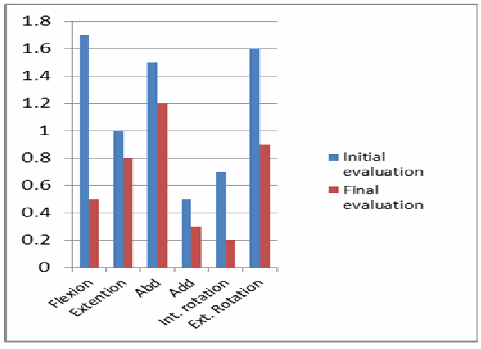

Fig. 2. *Progress averages for muscle testing*

Pleasing results were also recorded at the functional level, where initially the subjects presented pain and joint instability, the functional tests performed then showed themselves to be positive, while at the final tests they were recorded as negative, which demonstrates the effects proposed methods and means.

At the apprehension test, which indicated a previous instability of the shoulder, in both athletes, if initially it was positive, following the means applied, it was negative at the end. If initially the average of the two athletes was 35%, representing a first-degree laxity, at the end 15% were recorded, which means that they are within normal limits (Table no 1). Load and shift test – we assessed how much the center of the humeral head moved compared to the center of the glena in percentages, establishing the type of laxity (table 2).

Table 2

Functional test initial and final

	Load and Shift T.	**30%**	**15%**
Functional test	Apprehension T.	+	-
	Andrew T.	+	-
	Rockwood T.	+	-

Calculating the average of the progress recorded for each parameter, at the level of the two subjects, we notice that it corresponded to the objectives pursued, so that, both individually and at the group level, the pain was greatly reduced, or combated, joint mobility and muscle strength have improved, and the stability of the shoulder joint has increased. Exercises that involved submaximal eccentric contractions whose intensity increased progressively during training led to improved stability and pain relief.

4.2. Discussions

Shoulder pain is a cause of instability, because muscle tension is created as antalgic mechanisms that reduce mobility and muscle imbalances. Practicing different positions from which I followed shoulder discharges, by decocting it, I released muscle tension, which led to a rebalancing of the muscles.

The best muscle responses were obtained by working with elastic bands, through which eccentric stimulations were followed on the external rotators, a fact proven by the recorded results.

5. Conclusions

Full recovery of post-trauma athletes is particularly important in order to continue sports activity and achieve performance and high performance.

And in the game of handball, physical health along with mental health is the basis of performance. The fractionation of movements, maintaining in certain positions, with reduced dynamics in the shoulder joint, emphasizing the muscular play between the internal and external rotators, led to the improvement of shoulder stability. Too long muscle stretches should be avoided because the effective contraction decreases to completely oppose the translational force, especially if there is post-traumatic capsulo-ligamentous distension.

The results obtained from the final measurements highlighted the fact that by applying static and dynamic stabilization techniques, we can help restore muscle imbalances in the shoulders post-traumatic.

As conclusions, it can be said that isometric work in a closed kinematic chain and through neuromuscular and proprioceptive facilitation techniques, we can balance the stabilizing muscle forces at the level of the shoulder joint.

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