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SCAPULAR KINEMATICS AND MUSCULAR ACTIVITY LEVEL ASSESSED BEFORE AND AFTER A SCAPULAR EXERCISES PROGRAM

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1 INTRODUCTION

Shoulder pain is a major musculoskeletal complaint [1]. Among different contributing factors for chronic conditions, the scapular adaptations have been identified as a relevant one [2]. This association seems to be expressed through neurophysiological and biomechanical scapular parameters. However, there are some conflicting findings about this association between scapular adaptations and chronic shoulder pain, as well as about the effectiveness of a first line recommended intervention for shoulder pain's rehabilitation - therapeutic exercise [3].

2 MAIN OBJECTIVE

Based on biomechanical and neurophysiological parameters essential for characterizing participants with chronic shoulder pain founded in our previous studies, the main objective of this study was to measure changes in scapular kinematics and related surface electromyographic activity after a scapular-based therapeutic exercises program.

3 METHODS

A pre-post single group design study, involving a total of 18 subjects with chronic shoulder pain, was performed. During the drinking task, inertial sensors and a model of four degrees of freedom to represent the scapulothoracic motion as well as surface electromyography (EMG) assessed scapular 3D kinematics [abduction (+), elevation (+), upward rotation (+) and winging (+, raise of the scapula's medial border and inferior angle)] and muscular activity level of the trapezius portions and serratus anterior, respectively, as in a previous study [4]. The task was performed at a self-paced rhythm and, for analysis, was subdivided into 5 phases: I) reach the bottle positioned at 90° of shoulder elevation in the scapular plane, II) forward transport of the bottle to the mouth, III) drink a sip of water, IV) backward transport of the bottle to the initial position, V) return of the upper limb. The results obtained pre- and post-intervention were compared between each other and with a reference (asymptomatic subjects [4]). Subjects with chronic shoulder pain also rated their shoulder pain intensity (NRS) and function (SPADI), before (M0) and after (M1) intervention. A monitored and progressive scapular exercise program was performed 3 times/week for 8 weeks. The program included preparatory, warm-up, neuromotor/ strengthening (selected according to exercises' ability to recruit scapular muscles) and stretching exercises.

4 RESULTS

After the scapular exercises program, it was observed a decreased in middle (MT, in forward transport and return phase) and lower trapezius (LT, in return phase) and serratus anterior (SA, in return phase) activity level, which approximate the participants to the reference (Table 1). About the scapular motions, it was also observed: a) decreased upward rotation (backward transport phase), making these participants similar to the reference; b) increased winging (return phase), like the reference values; and c) increased downward rotation (return phase), revealing higher values than the reference (Table 1). It was also observed a significant improvement in shoulder function ($p<0.0001$, mean difference of 23.55 points) and a reduction in shoulder pain ($p<0.0001$, median difference of 4.5 points) of the participants, at post-intervention (M1).

Table 1 – Scapular 3D kinematics (3D motion) and scapular muscular activity level from the reference (asymptomatic subjects) and from symptomatic participants with chronic shoulder pain at M0 and M1

Drinking Phase	% EMG	REF (mean or md ± SD or IR)	M0 (mean or md ± SD or IR)	M1 (mean or md ± SD or IR)	M0vsM1	REFvsM0	REFvsM1
Reaching	**UT**	16.6±11.6	14.2±23.7	23.0±17.3	p>0.05	p>0.05	p>0.05
	MT	8.0±4.7	15.1±7.1	12.8±7.7	p>0.05	**p<0.0001**	**p=0.006**
	LT	9.7±4.9	16.8±6.9	16.3±8.6	p>0.05	**p<0.0001**	**p=0.004**
	SA	19.0±22.6	13.1±8.8	15.6±30.9	p>0.05	p>0.05	p>0.05
Forward Transp.	**UT**	23.0±96	22.2±14.7	27.2±11.9	p>0.05	p>0.05	p>0.05
	MT	4.8±3.2	10.7±7.7	6.1±5.7	**p<0.0001**	**p<0.0001**	p>0.05
	LT	7.8±5.5	15.1±7.1	13.4±6.9	p>0.05	**p=0.005**	**p=0.044**
	SA	13.5±16.2	13.8±9.6	7.5±22.6	p>0.05	p>0.05	p>0.05
Drink	**UT**	27.8±11.9	25.7±12.7	28.1±10.8	p>0.05	p>0.05	p>0.05
	MT	3.4±2.2	6.9±3.3	4.6±4.5	p>0.05	**p<0.0001**	**p=0.044**
	LT	8.4±4.3	12.4±9.1	10.7±9.1	p>0.05	p>0.05	p>0.05
	SA	16.9±19.8	9.1±8.9	12.4±30.9	p>0.05	**p=0.047**	p>0.05
Backward Transport	**UT**	22.3±9.3	21.9±11.9	24.7±9.9	p>0.05	p>0.05	p>0.05
	MT	7.5±3.9	10.6±5.8	10.6±5.8	p>0.05	**p<0.0001**	**p=0.013**
	LT	10.5±5.3	14.5±9.8	11.3±11.1	p>0.05	**p=0.022**	p>0.05
	SA	16.5±15.3	15.2±11.1	15.3±30.9	p>0.05	p>0.05	p>0.05
Return	**UT**	12.8±7.5	13.0±16.8	14.0±8.7	p>0.05	p>0.05	p>0.05
	MT	5.8±2.6	14.7±5.8	6.3±3.1	**p<0.0001**	**p<0.0001**	p>0.05
	LT	6.4±5.0	16.1±9.4	4.9±2.8	**p=0.003**	**p=0.002**	p>0.05
	SA	9.6±15.1	15.2±6.3	5.3±10.3	**p=0.035**	p>0.05	p>0.05

3D motion (°)	REF (mean or md ± SD or IR)	M0 (mean or md ± SD or IR)	M1 (mean or md ± SD or IR)	M0vsM1	REFvsM0	REFvsM1
Ab/Ad	13.6±7.8	10.5±6.7	11.4±5.1	p>0.05	p>0.05	p>0.05
El/Dep	2.1±3.2	1.9±3.3	2.1±2.5	p>0.05	p>0.05	p>0.05
Ur/Dr	20.7±6.8	20.7±5.0	19.1±4.4	p>0.05	p>0.05	p>0.05
Wing	-7.3±3.0	-7.4±2.3	-6.3±2.1	p>0.05	p>0.05	p>0.05
Ab/Ad	-6.5±2.7	-6.7±2.6	-7.9±3.2	p>0.05	p>0.05	p>0.05
El/Dep	-3.5±4.8	-3.9±2.7	-4.3±3.5	p>0.05	p>0.05	p>0.05
Ur/Dr	-8.3±3.5	-9.6±3.5	-8.9±2.8	p>0.05	p>0.05	p>0.05
Wing	2.5±2.5	3.2±1.4	3.1±1.9	p>0.05	p>0.05	p>0.05
Ab/Ad	10.0±3.7	9.2±3.3	10.1±4.3	p>0.05	p>0.05	p>0.05
El/Dep	4.5±4.7	2.8±2.6	3.8±4.9	p>0.05	p>0.05	p>0.05
Ur/Dr	9.4±2.3	8.1±3.8	8.9±3.4	p>0.05	p>0.05	p>0.05
Wing	-4.0±1.3	-3.1±1.3	-3.8±1.9	p>0.05	**p=0.013**	p>0.05
Ab/Ad	0.0±0.6	0.1±0.4	0.3±1.8	p>0.05	p>0.05	p>0.05
El/Dep	1.1±1.4	0.9±1.2	0.9±1.7	p>0.05	p>0.05	p>0.05
Ur/Dr	1.5±1.9	3.7±3.6	2.1±2.4	**p=0.03**	**p=0.004**	p>0.05
Wing	0.0±0.7	-0.7±1.4	-0.3±0.7	p>0.05	**p=0.005**	p>0.05
Ab/Ad	-18.2±6.1	-15.7±3.3	-17.5±4.3	p>0.05	p>0.05	p>0.05
El/Dep	-5.3±1.2	-3.9±3.2	-4.6±3.0	p>0.05	p>0.05	p>0.05
Ur/Dr	-16.7±5.9	-14.4±5.5	-20.3±3.7	**p<0.0001**	p>0.05	**p=0.017**
Wing	7.2±3.4	5.9±3.7	7.8±1.8	**p<0.0001**	p>0.05	p>0.05

Ab/Ad – abduction/adduction; El/dep – elevation/depression; IR – interquartile range; Md – median; REF – reference; SD – standard deviation; UR/DR – upward/downward rotation; UT – upper trapezius

5 CONCLUSIONS

After a program of scapular therapeutic exercises, the observed modifications in scapular motions, the reduced muscular activity level of MT, LT and SA and shoulder pain intensity, as well as the increased shoulder function can be highlighted. The motor adaptations observed after the exercise program, particularly if in agreement with the reference, could demonstrate the effect of scapular exercises on these outcomes during chronic shoulder pain's rehabilitation. However, motor adaptations do not seem to be the only reason explaining changes in shoulder pain and function.

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