Impact of Postural Adjustments on Upper Limb Function in Wheelchair Rugby Athletes

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ABSTRACT

The objective of this study was to evaluate the effects of sports on the static posture of the upper limbs of wheelchair rugby players. Twelve male players, between the ages of 20 and 45 years, were divided into two groups: Rugby Group (RG) with 6 individuals with neurological injuries (spinal cord injury C4/C7) who were wheelchair rugby players; Control Group (CG) with 6 individuals with neurological injuries (spinal cord injury C4/C7) who were not practicing rugby. The volunteers were submitted to postural evaluation by computerized biophotogrammetry in the following clinical conditions: Alignment of the right shoulder (ARS), alignment of the left shoulder (ALS), right shoulder abduction (RSA) left shoulder abduction (LSA), right inclination of the head (RIH), left inclination of the head (LIH), right elbow semiflexion (RES), left elbow semiflexion. These clinical conditions were used to diagnose the postural changes associated with the adapted sports biomechanics or the paraplegia habitual inactivity. The results obtained showed that the clinical conditions of RSE and LSE exhibited significant changes when both groups were compared. The study suggests that the sports gestures performed while rugby is being played had a positive effect on the static upper limb posture when the elbows were semiflexed.

KEYWORDS: Biophotogrammetry, Adapted Rugby, Body Posture, Elbow Semiflexion, Spinal Cord Injury.

I. INTRODUCTION

Individuals affected by spinal cord injury undergo physical and physiological adaptations that can radically change their everyday life. In the long run, the wheelchair user develops a poor sitting posture that can result in irreversible spinal and joint dysfunctions due to the contraction of muscles, tendons, ligaments, and fascia [1]. Benefits of sport and physical activity for the disabled give them an opportunity to test limits and potential, prevent secondary deformities, and promote social integration. The choice of activities depends on the disability, the social status, the opportunities, and the type of limitation, their sports preferences, transportation facilities, family support and professionals with experience to work with wheelchair players [2]. In light of these characteristics, the individuals with spinal cord injury (SCI) with greater motor impairment may participate in Wheelchair Rugby (WR). However, the adaptation to sport is very important and should be taken seriously, otherwise, it may produce postural complications, such as thoracic hyperkyphosis, forward head posture, and antalgic posture [3].
Thus, the objective of this study was to evaluate the effects of wheelchair rugby playing on the static posture of the upper limbs of wheelchair users.

II. MATERIALS AND METHODS

Sample characteristics

The research was approved by the Research Ethics Committee of the University Center - UNIFAFIBE (CAAE 56839716.0.0000.5387). All subjects were informed about the purpose and stages of the research and agreed to participate by providing their free and informed consent.
Initially the study sample included 16 male individuals aged 20 to 45 years, 12 with spinal cord injury, 3 with cerebral palsy and 1 with lower limb amputation at distal third of the femur. The exclusion criteria were determined as follows: Patients who presented age above or below the age group proposed; diagnosis of spinal cord injury (C4/C7), females; and those who were practicing other sports modalities. After applying the exclusion criteria, the 12 remaining subjects were divided into two groups: Rugby group (RG) with 6 individuals with spinal cord injury C4/C7, who were practicing WR; and Control group (CG) with 6 individuals with spinal cord injury C4/C7, who were not practicing any sports in the last 12 months. Those in RG had been playing rugby for the last 18 months, 3 times a week, 4 hours/daily. These individuals have been participating in a project called “Projeto Movimento Superação Bebedouro - SP” at the Centro Paula Souza- ETEC, Bebedouro-São Paulo. Six wheelchair

users from the Bebedouro community-SP and the city of Ribeirão Preto - SP, who were not practicing any sports activities in the last 12 months, were selected for the CG (Table 1).

Table 1 *– Individual demographic data.*

Participants (n = 12)	Group	Age (y) (20 – 45)	Lesion Level	Rugby class	Time since lesion
1	RG	31	C4/C5 INC	2.0	2 y
2	RG	32	C4/C7 INC	1.0	4 y
3	RG	30	C7 INC	1.5	3 y
4	RG	21	C6/C7 INC	1.5	6 y
5	RG	50	C4/C5 INC	0.5	1 y 8 m
6		39	C6 INC	1.0	1y 7 m
7	CG	28	C5 INC	-	2 y
8	CG	29	C4/C5 INC	-	1 y
9	CG	20	C6/C7 INC	-	3 y
10	CG	31	C6 INC	-	8 y
11	CG	21	C4 INC	-	7 y
12	CG	26	C7 INC	-	4 y

Rugby Group- RG; Control Group - CG; INC - Incomplete; y - years; m - months.

Postural assessment

The individuals were submitted to assessments using biophotogrammetry recording patterns. The paraplegic individuals were positioned in their respective wheelchair, making it possible to visualize postural changes in habitual position. Prior to setting the position, the wall-ground leveling was performed. A Sony Ciber Shot 14.1 megapixels was positioned on a tripod with a 3-meter distance between the focal lenses of the camera to the central area of the individual's body. This distance was marked on the ground with a gaffer tape for further evaluation. Another standardization measure was the tripod height, which remained at which remained at 50% of the individual sitting height. The passive markers (polystyrene balls) were positioned in the following segments: the auricular lobes, the acromion, the lateral epicondyle, and the styloid process of the radius. The images were obtained by a single evaluator without zoom and in three different planes: anterior and lateral (Right and Left). Postural assessment software (SAPO), version 0.68 was used for measuring body angles and distances.

Analysis of computerized biophotogrametry data and statistics

In the present analysis, the following clinical conditions were evaluated: shoulder alignment, shoulder abduction, head inclination, and elbow semiflexion. This evaluation allowed for the diagnosis of the postural changes associated with the adapted sports biomechanics or with the paraplegia habitual inactivity. The biophotogrametry data were tabulated and submitted to statistical analysis using SPSS version 21.0 for Windows (SPSS Inc.; Chicago, IL, USA) and analyzed statistically by a paired t-test.

III. RESULTS AND DISCUSSION

Results of biophotogrametry

For the clinical conditions of right and left shoulder alignment, right and left shoulder abduction and right and left head inclination, the results were not statistically significant. For the clinical condition of right and left elbow semiflexion, the results were statistically significant ($p \leq 0.05$), as shown in Table 2.

Table 2: Comparison of clinical conditions between groups

CONDICTIONS	GROUPS	*P* Value	MEANS	Standard Error
ARS	**RG**	**0.71^{ns}**	**121.53**	**±2.00**
	CG		**119.35**	**±5.32**
ALS	**RG**	**0.70^{ns}**	**120.05**	**±1.58**
	CG		**121.22**	**±2.53**
RSA	**RG**	**0.85^{ns}**	**102.20**	**±2.35**
	CG		**100.90**	**±6.07**
LSA	**RG**	**0.46^{ns}**	**99.03**	**±3.16**
	CG		**102.78**	**±3.68**
RIH	**RG**	**0.46^{ns}**	**69.83**	**±1.96**
	CG		**72.12**	**±2.22**
LIH	**RG**	**0.49^{ns}**	**70.82**	**±2.06**
	CG		**72.80**	**±1.84**
RES	**RG**	**0.04***	**133.90**	**±5.16**
	CG		**152.37**	**±5.93**
LES	**RG**	**0.01***	**136.02**	**±3.85**
	CG		**155.02**	**±4.73**

ns – Not significant * -
Statistically significant for p ≤0.05

The shoulder presents movements in the glenohumeral joint and any alterations in the biomechanics of gesture can lead to functional changes [4]. A study by Ninomyia et al., (2007) showed the presence of hypotonia in the rotator cuff of quadriplegics patients, causing some changes in the position of the humeral head in relation to the glenoid cavity, and consequently, altering the position of the shoulder while at rest [5].

For the clinical conditions of ARS, ALS, RSA, and LSA, there were no statistically significant differences between RG and CG. These results corroborate the claims that the postural impairments of all the participants will remain unchanged, regardless of the physical activity.

Marques et al., (2010) observed that to remain seated for long periods strongly influence functional changes of the spinal column [6]. This leads to inefficient muscle tone of the spinal trunk and induces abnormal muscle compensation. These changes were described by Pynt et al., (2001), who referred to thoracic hyperkyphosis as the cause of inward lumbar curvature, as well as the attenuation of cervical spine bending. Such changes were also observed in the participants of the present study, since the clinical conditions of RIH and LIH have not shown any significant results, reinforcing the postural habit as a compensation pattern, independent of the sports [7].

According to Sprigles et al., (2009), trunk control is an important factor affecting upper extremity function of wheelchair users. A stable pelvic and trunk can increase functional ranges of motion and also contribute to sports gestures. Conversely, changes in the spinal cord have negative effects on the functions of the upper limbs [8].

Individuals had incomplete, high level spinal cord injuries, and consequently, reduced trunk control and changes regarding the positioning of the upper limbs.

According to Mota (2013) observed that participation in sports improves physical performance, since it increases muscle strength, body awareness and balance [9]. These findings were in agreement with those found for the upper limb angles of RG compared to CG, where it was possible to observe significant results for the clinical conditions of RES and LES. The results obtained in the present study revealed that those who were playing rugby had increased their strength and upper limb awareness, as well as their improved static postural stability and coordination. Therefore, the sports gesture used to play rugby may potentiate the action of the upper limbs and reduce elbow semiflexion.

IV. CONCLUSION

The study suggests that the sports gestures used to play rugby had positive effects on the static upper limb posture when the elbow joint angle was analyzed at rest. However, further studies are necessary for a better understanding of this topic, which is still scarce in literature.

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