

THE EFFECT OF AMERICAN FOOTBALL TRAINING ON THE ANGLES OF SPINAL CURVATURES AND SEGMENTAL MOBILITY OF THE SPINE

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Summary

Aim. To verify the effect of long-term American football training on the physiological curvatures and mobility of the spine.

Material and methods. The study included 35 men (21-23 years of age) who practiced American football in teams from the Polish Top League, and 35 healthy controls of similar age who did not practice any sport discipline. The functional spinal parameters were determined with an aid of Penny & Giles tensometric electrogoniometer.

Results. The analyzed groups differed significantly in terms of the angles of cervical and lumbar lordosis which proved greater in football players, by 1.1° and 2.2°, respectively. A significant reduction of the lumbar spine mobility: anteroflexion (by 6%), extension (by 21.3%), left and right lateral flexion (by 9.3% and 8.7%), and rotation to the left and right (by 17.7% and 14.7%), was revealed in football players, along with an increased mobility of the thoracic segment: anteroflexion (by 5.3%), extension (by 8.3%), and rotation to the right (by 5.6%). No significant differences in the mobility of cervical spine were documented.

Discussion. According to literature, football players are characterized by increased lumbar lordosis and mobility of lumbar spine. Our partially contradictory findings may result from the fact that previous studies involved players from more experienced American league. Significantly reduced mobility of lumbar spine reflects greater compression forces generated in this segment.

Conclusions. Tailored bioregeneration should constitute a vital component of the training programs as it could counterbalance the alterations of functional parameters resulting from the specifics of American football.

Key words: spine, electrogoniometry, football, mobility range

INTRODUCTION

Functional parameters of the spine change throughout the entire life. This can be associated with an array of factors, such as age, gender, body weight, or physical activity. Spondylometric parameters, especially reduced segmental mobility, and increased or decreased spinal curvatures, constitute a sensitive indicator of pathological changes (1-3).

A number of published studies dealt with the relationships between practicing various sport disciplines and functional parameters of the spine (2, 4-7). To the best of our knowledge, the number of published studies on changes in the segmental mobility of the spine and the angles of spinal curvatures in American football players is sparse (8).

AIM

The aim of this study was to verify the effect of long-term American football training on the physiological curvatures and segmental mobility of the spine.

MATERIAL AND METHODS

The study included 35 men between 21 and 23 years of age, who practiced American football in teams from the Top League of the Polish American Football Association. Mean training history of the players was 6 years.

The control group comprised 35 healthy men aged between 21 and 23 years, who did not practice any sport discipline. The protocol of the study was approved by the Local Bioethical Committee, and all the subjects gave their written informed consent to participate in the project.

We examined the segmental mobility of the cervical, thoracic, and lumbar spine and determined the angles of physiological spinal curvatures. All the measurements were taken in the same baseline position (standing freely with arms alongside the trunk, equal pressure applied on both feet, and head in the horizontal Frankfurt plane). The spinal mobility was determined in three planes: sagittal, coronal, and transverse. All the measurements were taken in the same room, with air temperature between

22°C and 24°C. Each participant was examined at the same time of the day; the day was free from any other physical exercise and training.

We used the system of Penny & Giles tensometric electrogoniometers, modified according to Boocock in order to eliminate potential measurement bias associated with shifting skin and soft tissues in relation to bones (9). The measurements were taken according to Lewandowski (3). Sensors of the electrogoniometer were placed alongside the long axis of participant's body and fixed to the skin with an aid of double-sided medical adhesive tape.

Basic statistical characteristics of studied variables: arithmetic means, standard deviations, and minimum and maximum values were determined. As the normal distribution of the studied material was confirmed by means of the Shapiro-Wilk test, the parametric Student t-test was used to verify the significance of intergroup differences. The results documented in our participants were compared with the age-adjusted reference values reported by Lewandowski (3).

RESULTS

The analyzed groups differed significantly in terms of the angles of cervical and lumbar lordosis. The average cervical lordosis in football players was 1.1° greater than in the controls. The increased cervical lordosis of the athletes was confirmed on comparison with the respective reference values. The intergroup differences in the angles of thoracic kyphosis did not prove significant. The most pronounced intergroup differences pertained to lumbar lordosis. Football players were characterized by an increased angle of this curvature, by 2° on average, as compared to the controls and normative values (tab. 1, 2).

The differences in the mobility of cervical spine were not significant. An increased mobility of the thoracic segment: anteroflexion (by 5.3%), extension (by 8.3%), and rotation to the right (by 5.6%), was documented in football players, along with a significant reduction of the lumbar spine mobility: anteroflexion (by 6%), extension (by 21.3%), left and right lateral flexion (by 9.3% and 8.7%), and rotation to the left and right (by 17.7% and 14.7%) (tab. 3, 4, 5).

Comparison with the reference values published by Lewandowski revealed reduced mobility in all spinal segments. The reduction was most pronounced in the lumbar segment, in the case of which the deviation from normative value ranged between 3.9° and 5.8° (tab 3, 6).

DISCUSSION

Strains the athlete is exposed to can affect the lordosis or kyphosis. An increase or decrease in spinal curvatures can exert a negative effect on the vertebrae, intervertebral discs, ligaments, and some muscle groups. Maintenance of physiological curvatures in all spinal segments is vital for the normal balance of the musculo-skeletal system strain (4, 10).

Nyland analyzed the effect of football training on the lordosis and mobility of the cervical spine in athletes from two age categories. He observed increased cervical lordosis in older athletes, and attributed this finding to adaptive changes associated with the involvement in football training or matches (8). The more intensive the athletic training is, the larger are the spinal curvatures (6). The increase in the cervical and lumbar lordosis was documented in our study as well. The training program of football players includes many athletic components, which could be reflected by larger angles of these curvatures (11). Nyland analyzed solely the mobility of cervical spine and revealed its improvement in football players. In contrast, we did not observe significant changes in the cervical mobility. However, Nyland analyzed players from much more experienced American league. Perhaps, also the methods of training these players were more elaborated, which was reflected by their improved spinal mobility (8).

Table. 2. Reference values of the physiological spinal curvatures in 22-year-old men, according to J. Lewandowski (3).

Curvature	\bar{x} (°)	SD
Cervical lordosis	36.52	5.21
Thoracic kyphosis	32.43	4.15
Lumbar lordosis	36.06	4.97

Table. 1. Basic statistical characteristics of the physiological spinal curvatures in American football players and in the controls (*p < 0.05).

Curvature	Football players			Controls			Student t-test		
	N	\bar{x} (°)	SD	N	\bar{x} (°)	SD	t	df	p
Cervical lordosis	35	36.89	2.36	35	35.77	1.86	2.19	68	0.032*
Thoracic kyphosis	35	31.60	2.34	35	31.20	1.95	0.78	68	0.440
Lumbar lordosis	35	37.91	2.89	35	35.49	2.23	3.93	68	0.000*

t – values read from respective distribution tables; df – degrees of freedom; p – level of statistical significance

Table 3. Basic statistical characteristics of the functional parameters of three spinal segments in American football players.

Spinal segment	Mobility	N	\bar{x} (°)	SD	Min (o)	Max (o)
Cervical	Flexion	35	61.46	3.04	53	70
	Extension		57.31	3.98	50	71
	Left lateral flexion		50.03	8.17	48	56
	Right lateral flexion		51.11	2.65	46	56
	Rotation to the left		83.66	2.80	79	89
	Rotation to the right		83.94	2.87	79	89
Thoracic	Flexion	35	26.89	2.76	20	31
	Extension		22.89	2.34	13	27
	Left lateral flexion		29.74	3.37	17	34
	Right lateral flexion		30.46	3.35	18	34
	Rotation to the left		31.40	2.94	21	36
	Rotation to the right		31.43	3.01	26	35
Lumbar	Flexion	35	62.63	4.71	54	76
	Extension		28.34	2.95	24	29
	Left lateral flexion		27.74	3.57	17	35
	Right lateral flexion		28.00	3.67	15	34
	Rotation to the left		7.46	2.47	4	12
	Rotation to the right		7.43	2.44	3	13

Table 4. Basic statistical characteristics of the functional parameters of three spinal segments in the controls.

Spinal segment	Mobility	N	\bar{x} (°)	SD	Min (o)	Max (o)
Cervical	Flexion	35	61.71	4.01	50	69
	Extension		58.66	4.21	45	72
	Left lateral flexion		51.40	2.35	47	56
	Right lateral flexion		51.06	2.33	46	55
	Rotation to the left		84.11	2.63	79	88
	Rotation to the right		83.83	2.41	79	89
Thoracic	Flexion	35	25.54	2.39	19	30
	Extension		21.14	2.50	11	30
	Left lateral flexion		29.00	2.74	15	34
	Right lateral flexion		29.71	2.82	17	33
	Rotation to the left		30.17	2.18	24	35
	Rotation to the right		29.86	2.53	22	35
Lumbar	Flexion	35	66.63	3.16	61	78
	Extension		36.03	3.68	28	45
	Left lateral flexion		30.57	1.87	28	36
	Right lateral flexion		30.66	2.18	25	40
	Rotation to the left		9.06	1.53	5	13
	Rotation to the right		8.71	1.60	4	13

Table. 5. Significance of differences in the mobility of various spinal segments in American football players and in the controls (*p < 0.05).

Spinal segment	Mobility	N	Student t-test		
			t	df	p
Cervical	Flexion	35	-0.30	68	0.763
	Extension		-1.37	68	0.174
	Left lateral flexion		-0.95	68	0.343
	Right lateral flexion		0.10	68	0.924
	Rotation to the left		-0.70	68	0.484
	Rotation to the right		0.18	68	0.857
Thoracic	Flexion	35	2.17	68	0.033*
	Extension		3.01	68	0.004*
	Left lateral flexion		1.01	68	0.316
	Right lateral flexion		1.00	68	0.319
	Rotation to the left		1.99	68	0.051
	Rotation to the right		2.36	68	0.021*
Lumbar	Flexion	35	-4.17	68	0.000*
	Extension		-9.65	68	0.000*
	Left lateral flexion		-4.16	68	0.000*
	Right lateral flexion		-3.68	68	0.000*
	Rotation to the left		-3.26	68	0.002*
	Rotation to the right		-2.61	68	0.011*

Table. 6. Reference values of the mobility of three spinal segments in 22-year-old men, according to J. Lewandowski (3).

Spinal segment	Mobility	N	(o)	SD	Min (o)	Max (o)
Cervical	Flexion	35	64.06	5.33	47	74
	Extension		60.29	5.26	50	75
	Left lateral flexion		52.88	3.30	45	63
	Right lateral flexion		53.09	3.17	46	62
	Rotation to the left		86.37	3.73	77	97
	Rotation to the right		86.38	3.70	77	96
Thoracic	Flexion	35	27.71	3.36	21	39
	Extension		23.37	2.14	19	29
	Left lateral flexion		31.51	3.54	25	40
	Right lateral flexion		31.43	3.32	24	40
	Rotation to the left		31.75	3.79	24	40
	Rotation to the right		31.61	3.68	25	40
Lumbar	Flexion	35	68.41	6.36	59	90
	Extension		32.22	4.76	20	46
	Left lateral flexion		32.20	2.74	27	40
	Right lateral flexion		32.26	2.71	26	40
	Rotation to the left		11.46	1.12	9	14
	Rotation to the right		11.56	1.13	9	15

The greatest reduction of spinal mobility pertained the lumbar segment, which can result from excessive tone of its stabilizing muscles. During a blocking maneuver, the L₅-S₁ spinal segment is exposed to huge compression forces, up to 8679 N. Such strain can enforce adaptive changes in the musculoskeletal system (12).

Szulg analyzed the spondylometric parameters of 20 rugby players (7). The comparative analysis of football and rugby players suggests that the latter are characterized by greater reduction of spinal mobility and increased curvatures in all segments (fig. 1, 2, 3). The greatest differences in the mobility pertained to the rotatory movements of cervical spine. Compared to the football players, the rugby players showed reduced rotation to the left and right (by 52.2% and 52.8%, respec-

tively; fig. 1). Football players are equipped with pads and helmet, which can attenuate strains specific for this discipline. The lack of helmet and the resultant micro-injuries can be reflected by markedly reduced rotation of cervical spine in rugby players. Furthermore, the lack of protective equipment can be associated with greater axial strain, which negatively affects intervertebral joints, ligaments, and muscles (7, 13, 14).

We postulate the important role of balanced muscle tone. Bioregeneration should constitute an important component of the training program, which should be enhanced by relaxation techniques and tailored strengthening exercises. Particular attention should be paid to the muscle groups that are responsible for increased lumbar and cervical lordosis (7, 15).

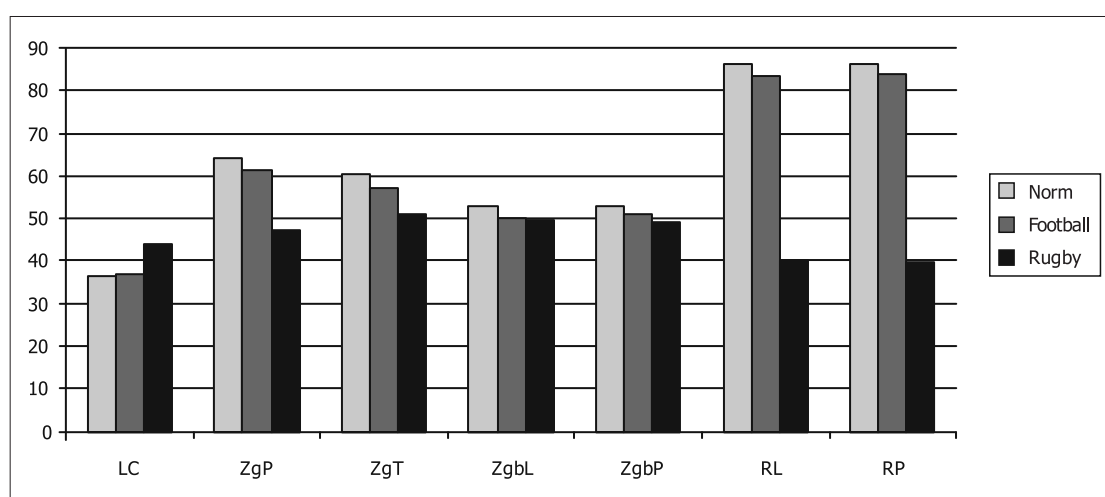


Fig. 1. Comparison between the functional parameters of cervical spine in American football players, controls, and respective reference values (°).

LC – cervical lordosis; ZgP – anteroflexion; ZgT – posterior flexion (extension); ZgbL – left lateral flexion; ZgbP – right lateral flexion; RL – rotation to the left; RP – rotation to the right

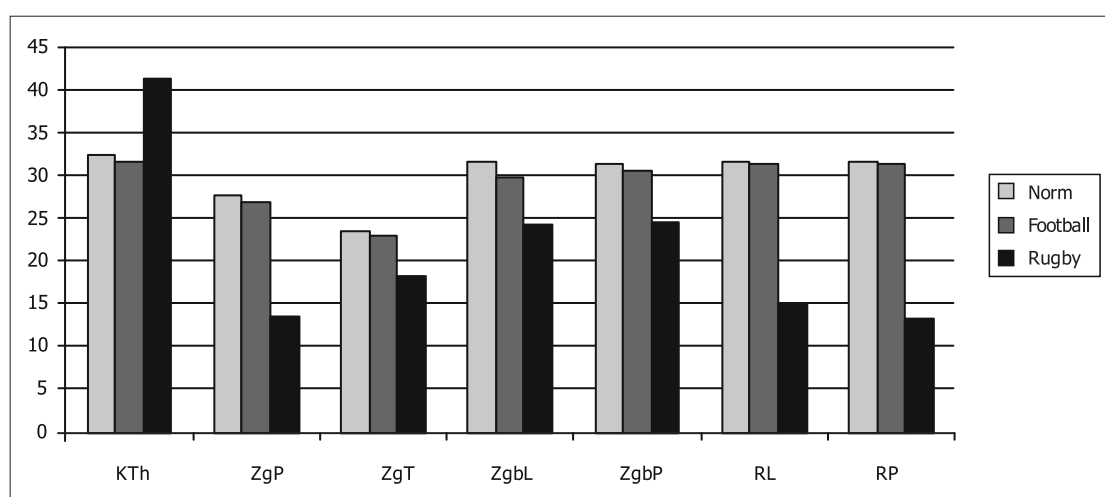


Fig. 2. Comparison between the functional parameters of thoracic spine in American football players, controls, and respective reference values (°).

KTh – thoracic kyphosis; ZgP – anteroflexion; ZgT – posterior flexion (extension); ZgbL – left lateral flexion; ZgbP – right lateral flexion; RL – rotation to the left; RP – rotation to the right

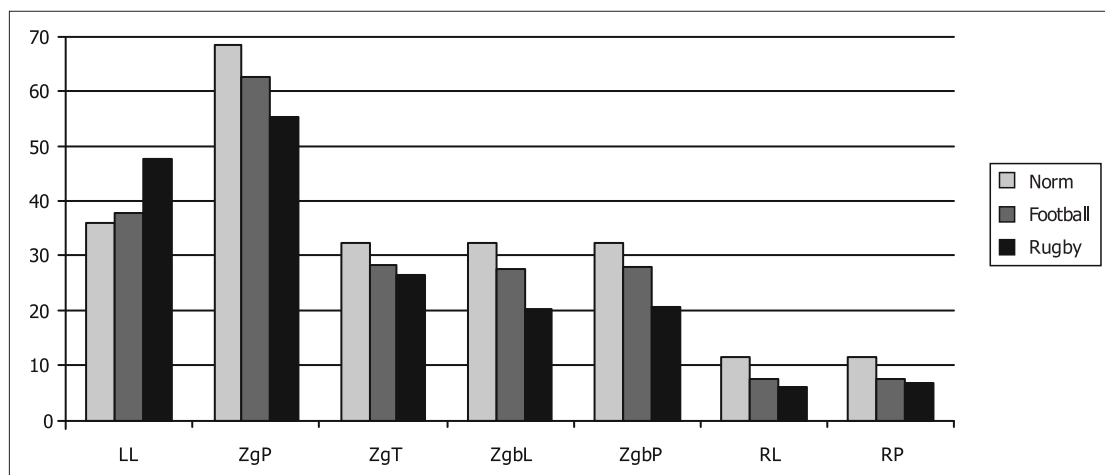


Fig. 3. Comparison between the functional parameters of lumbar spine in American football players, controls, and respective reference values (°).

LL – lumbar lordosis; ZgP – anteroflexion; ZgT – posterior flexion (extension); ZgBL – left lateral flexion; ZgBP – right

CONCLUSIONS

Due to its athletic components, American football training can result in increased lumbar and cervical lordosis.

The greatest reduction of mobility in the lumbar spine can correspond to the magnitude of strain of this spinal segment.

Comparison with literature data suggests that American football is associated with smaller deficits in the functional parameters of the spine than rugby.

Tailored bioregeneration should constitute a vital component of the training programs for football players as it could counterbalance the alterations of functional parameters resulting from the specifics of this discipline. □

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