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BIOMECHANICAL SIMILARITY OF COMPLEX EXERCISES FROM INITIAL POSITION LYING ON THE SIDE FOR CORRECTION AND TREATMENT OF SCOLIOSIS

Notes

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Abstract

The aim of this research was to find an ideal model of a set of exercises from an initial position lying on the side-lateral position, that would be used for the prevention and correction of a functional stage and the first stage of scoliosis as the most frequent health and sociable issue among children in development that have this deformity as a result of various external and internal factors affecting their growth and development. The research is conducted on 11 entities (exercises) for establishing their homogeneity as well as their connectivity the method of qualitative mechanical analysis was applied. The results of the biomechanical analysis from the binary matrix were processed by algorithm ALPROBI HERACLIT and SPSS 18.0. All the provided condensed data. The proposed complex of exercises has a coefficient of full biomechanical similarity (CFBS= .750). The greatest values were obtained at the exercises. No 10. Raising of the lower part of the torso with the hand laterally raised to 90 degrees (RLOWPTORHAND LATR90) No9. Raising of the lower part of the torso with one hand behind the back (RLOWPTORHANDBBACK) and No 11. Raising of the lower part of the torso while slightly pressing the hand on the hip (RLOWPTORPRESSHHIP). For the effect as well as the improvement of muscle contraction in the future the electromyographic method would be applied through which we would have a concise preview of the efficiency of the exercises from the suggested set of exercises and particularly the exercises that showed the highest coefficient of force of connectivity that would be frequently repeated in the treatment.

Keywords*: scoliosis prevention & correction, spine biomechanical analysis*

INTRODUCTION

Scoliosis represents the curving of the spine either on the left or on the right side in the shape of the letter C or on both sides in the shape of the letter S. In most cases the reason for this is unknown and it is called idiopathic scoliosis, so its progress is unpredictable, which makes the curing treatment more difficult. (Lowe, T. G., Edgar, M., Margulies, J. Y., Miller, N. H., Raso, V. J., Reinker, K. A., & Rivard, C. H. 2000). It could appear in the earliest stages of life, in the adolescent period or in the ending period of the growth and development. (Konieczny MR, Senyurt H, Krauspe R.,.J Child Orthop 2013) If in certain cases, one of the parents has a spine deformity the probability that their offspring would have such deformity is great.(Park WW, Suh KT, Kim JI, Kim SJ, Lee JS, 2009). In such cases, the development of the spine should be traced from the earliest age and to react to every change accordingly. (Gorman KF, Julien C, Moreau A, 2012). The presence of any issues related to the joints and the muscles after the birth of the child and in the course of the first year (inwardly rotated feet-in-toeing or outwardly rotated feet-out-toeing), torticollis, dislocated hips in the further development of the child could cause a deformity of the spine. (Schultz AB, Sörensen SE, Andersson GB, 1984). Thus, it is very important for parents to observe the process of growing up attentively and to pay special attention to certain signs of spine deformities. It would be desirable for every change that occurs the specialist to be informed the orthopedist and the exercise therapist in order for a detailed examination of the spine to be conducted. (Gorman KF, Julien C, Moreau A, 2012). The examination is conducted through observation so that the child is without clothing and is standing a meter or two in front of the examiners. (Weiss H, Moramarco M, Moramarco K, 2013). The first thing to be examined is the shoulders' height. There is a possibility one of the shoulders to be higher than the other and also the scapula would be in a lower position than usual and a little more detached from the spine in comparison with the other scapula. If we palpate the vertebrae of the spine, it could be deduced that they are not aligned appropriately. The asymmetry of the triangle that is shaped when the hand touches the hip should be a symmetrical triangle on the left and on the right side. In case if they are not symmetrical there is a deformity. (Pugacheva N,2012). During the examination, it is very important to recognize the rib arches when the child attempts to bend forward in order for the fingers to touch the feet. Every hump on the back on a level of the ribs is an alarming sign of the potential existence of scoliosis. After that, by use of a scoliometer applied to the patient placed in the same position, the degree of scoliosis is determined. Besides the well-known reasons for scoliosis as genetics, coalescence, and incorrect sedentary posture, in a great number of cases, the real reason for scoliosis cannot be determined. Therefore, the treatment of this deformity is

difficult, unpredictable and long-termed. (Ameri E, Behtash H, Mobini B, Bouzari B, Tari V, 2008). Because of the duration of the treatment process, orthopedic corsets are necessary, but when the exercises and the corsets are impossible to apply, surgery takes place. (Longworth B, Fary R, Hopper D,2014). Contrary to the other spine deformities where there is a possibility the exercises suggested by the exercise therapist could be conducted at home, the exercises for scoliosis require an individual approach especially when the Schroth method is applied. (Schreiber S, Parent EC, Hedden DM, Hill D, Moreau MJ, Lou E, Watkins EM, Southon SC, 2015). In this case, it is very important for the parents to cooperate with the rest of the medical team. The corrective exercises for scoliosis are conducted by the exercise therapist in the presence of the parents if the child is younger. (Negrini S, Negrini A, Romano M, Verzini N, Parzini S, 2006). For successful application of the exercises by the therapist, the exercises should be well planned, and programmed including an approximately ideal model should be made that would be efficient and would shorten the period of scoliosis treatment.

This study it would be presented the method of qualitative biomechanical analysis through which we could attempt to find an approximately ideal method of exercises that would be used by therapists and sports teachers in order for more efficient prevention and correction of the functional and first stage of scoliosis to be prevented. (Aliu.D,2022).

METHODOLOGY

Sample of entities

The exercises from the initial position lying on the side-lateral position of the body (Scoliosis)

1. Raising of the head on the side-lateral head raising (RHEADSLATHEADR)
2. Raising of the head and the shoulders laterally (RHEADSHOULAT)
3. Raising of the head with bent elbow laterally RHEADBELBLAT)
4. Raising of the torso laterally with one arm stretched above the head while the other is behind the back (RTORLATONEARMSTRHEADBBACK)
5. Raising of the thoracic part of the spine with the hands behind the nape (RTHOPSHANDBN)
6. Raising of the lower part of the torso laterally with the arm placed beside the torso (RLOWTORLATAPLBTOR)
7. Raising of the lower part of the torso with the hands behind the nape (RLOWPTORHANDBN)
8. Raising of the lower part of the torso with one hand behind the back (RLOWPTORHANDBBACK)
9. Raising of the lower part of the torso with the hand stretched above the head (RLOWPTORHANDSTRAHEAD)
10. Raising of the lower part of the torso with the hand laterally raised to 90 degrees(RLOWPTORHAND LATR90)
11. Raising of the lower part of the torso while slightly pressing the hand on the hip (RLOWPTORPRESSHHIP)

The basic motor stereotypes are analyzed by the method of qualitative biomechanical analysis, while the results will be given in an ordinary matrix that provides information about the basic biomechanical characteristics of each entity (exercise). The entity represents a vector, where the numeric value 1 indicates the possessiveness of a biomechanical characteristic, and 0 indicates the non-possessiveness of a biomechanical characteristic in that entity. The rows represent the vectors of the entities while the columns represent the vectors of the biomechanical variables. From the basic matrix, primarily, the coefficients of biomechanical similarity are determined among the analyzed entities. Then full biomechanical similarity is determined i.e. homogeneity as well as the force of the biomechanical similarity among the entities. This procedure is described in the ALPROBI Heraclitus algorithms and SPSS 18.0.

RESULTS

Table1. Biomechanical characteristics of a sample of complex exercises from an initial position lying on the side-lateral position (scoliosis)

СКОЛИОЗА

5.2 Примерок на комплекс вежби

5.2.2 Комплекс на вежби за превенција и корекција на лошото сколиотично држење на телото (функционален стадиум) и прв степен (**сколиоза**)

5.2.2.2 Комплекс на вежби од почетна положба **ЛЕЖЕЊЕ БОЧНО**

Примерок на варијабли

			Целни движења			Почетна положба				Завршна положба			
			ИСТЕГ	ЈАКНЕ	ИЗДРЖ	ППЛЕЖГРА	ППЛЕЖБОК	ППОКЛЕК	ППСПР-РЕК	ЗПЛЕГРАД	ЗПЛЕЖБОК	ЗПОКЛЕК	ЗПСПР-РЕК
			1	2	3	1	2	3	4	1	2	3	4
1	Подигнување на главата со отпор на десната рака	(ПОДГОТПДР)		1				1				1	
2	Подигнување на главата и рамениот појас со свиткани раце на гради	(ПОДГРПСВРГ)		1				1				1	
3	Подигнување на главата и лактот	(ПОДГЛ)		1				1				1	
4	Подигнување на горниот дел од рбетниот столб со испружена рака и другата во задрачување	(ПОДГОРРСИСПРЗАДР)		1				1				1	
5	Подигнување на горниот дел од рбетниот столб со свиткани раце зад тил	(ПОДГОРРССВР)		1				1				1	
6	Подигнување на долниот дел од трупот со рака во дорачување	(ПОДДОЛТРРДОР)		1				1				1	
7	Подигнување на долниот дел од телото раце зад тил	(ПОДДОЛТРТИЛ)		1				1				1	
8	Подигнување на долниот дел на телото со рака во задрачување	(ПОДДОЛТРРАЗАД)		1				1				1	
9	Подигнување на долниот дел од трупот со рака во предрачување	(ПОДДОЛТРРПРЕД)		1				1				1	
10	Подигнување долниот дел од трупот со рака во одрачување	(ПОДОДЛТРРОД)		1				1				1	
11	Подигнување на долниот дел на трупот со потисок на шаката врз карлица	(ПОДДОЛТРПОТШ)		1				1				1	

Варијабли за одредување на анатомско-функционалната структура на движењата

	ИКЕРСВД	ИКЛФРСВД	ККЛФРСВДЦП	ИКЛФРССГД	ККЛФРССГДЦП	ККЛФРССГДПП	ИКФЗПРША	ИКФЗПРШС	ИКЕЗПРША	ИКЕЗПРШС	ИКФЗША	ИКФЗШС	ИКЕЗША	ИКЕЗШС	ИКФЗЛА	ИКФЗЛС	ККФЗЛППА
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
(ПОДГОТПДР)	1		1				1				1				1		
(ПОДГРПСВРГ)	1		1		1					1				1		1	
(ПОДГЛ)	1	1				1		1				1			1		1
(ПОДГОРРСИСПРЗАДР)	1		1			1	1		1		1		1				
(ПОДГОРРССВР)	1		1			1		1				1				1	
(ПОДДОЛТРРДОР)	1	1			1		1		1		1		1		1		
(ПОДДОЛТРТИЛ)	1	1			1			1				1				1	
(ПОДДОЛТРРАЗАД)	1	1			1		1		1		1		1		1		
(ПОДДОЛТРРПРЕД)	1	1			1		1		1		1		1		1		
(ПОДОДЛТРРОД)	1	1			1		1		1		1		1		1		
(ПОДДОЛТРПОТШ)	1	1		1			1				1				1		

	ИКЕЗЛА	ИКЕЗЛС	ИКАФЗРА	ИКРФЗРА	ИКХЕЗРА	ИКХЕЗРС	ИКАДДВРА	ИКАДДВРС	ИКАББЗРА	ИКАББЗРС	ККАББЗРЦПА	ККАББЗРППА	ИКЕЗКНС	ИКЕЗККС	ИКАДДВККС	ККАДДЗККЦПА	ККАББЗККЦПА
	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
(ПОДГОТПДР)									1				1	1	1		
(ПОДГРПСВРГ)								1					1	1	1		
(ПОДГЛ)									1			1	1	1	1		
(ПОДГОРРСИСПРЗАДР)		1					1				1		1	1	1		
(ПОДГОРРССВР)						1				1			1	1	1		
(ПОДДОЛТРРДОР)	1		1						1				1	1		1	1
(ПОДДОЛТРТИЛ)						1				1			1	1		1	1
(ПОДДОЛТРРАЗАД)	1			1	1		1		1				1	1		1	1
(ПОДДОЛТРРПРЕД)	1		1		1		1		1				1	1		1	1
(ПОДОДЛТРРОД)	1				1		1		1				1	1		1	1
(ПОДДОЛТРПОТШ)	1						1		1				1	1		1	1

Варијабли за одредување на механичката структура на движењата

	ГОЛПОТПОВ	НИСНИТТ	ЛАБРП	ОТКИНСИПТР	ДВИФРОРАМ	КУСТРААТ	КРИТРААТ	МАЛБРЗ	УМЕМНАР	УМЕМНАН	УМЕМНАТ
	1	2	3	4	5	6	7	8	9	10	11
(ПОДГОТПДР)	1	1	1	1	1	1	1	1	1		1
(ПОДГРПСВРГ)	1	1	1	1	1	1	1	1			1
(ПОДГЛ)	1	1	1	1	1	1	1	1	1		1
(ПОДГОРРСИСПРЗАДР)	1	1	1	1	1	1	1	1	1		1
(ПОДГОРРССВР)	1	1	1	1	1	1	1	1	1		1
(ПОДДОЛТРРДОР)	1	1	1	1	1	1	1	1		1	1
(ПОДДОЛТРТИЛ)	1	1	1	1	1	1	1	1	1	1	1
(ПОДДОЛТРРАЗАД)	1	1	1	1	1	1	1	1		1	1
(ПОДДОЛТРРПРЕД)	1	1	1	1	1	1	1	1	1	1	1
(ПОДОДЛТРРОД)	1	1	1	1	1	1	1	1	1	1	1
(ПОДДОЛТРПОТШ)	1	1	1	1	1	1	1	1	1	1	1

Table 2. Normed measures of biomechanical similarity (inter-similarity), coefficient of full biomechanical similarity and coefficients of biomechanical connection force of a sample of complex exercises from an initial position lying on the side-lateral position (scoliosis)

	Cosine of Vectors of Values										
	(ПОДГОТПДР)	(ПОДГРПСВРГ)	(ПОДГЛ)	(ПОДГОРРСИСПРЗАДР)	(ПОДГОРРССВР)	(ПОДДОЛТРРДОР)	(ПОДДОЛТРТИЛ)	(ПОДДОЛТРРАЗАД)	(ПОДДОЛТРРПРЕД)	(ПОДОДЛТРРОД)	(ПОДДОЛТРПОТШ)
(ПОДГОТПДР)	1.000	.773	.810	.836	.783	.766	.669	.740	.766	.778	.821
(ПОДГРПСВРГ)	.773	1.000	.682	.711	.783	.645	.711	.623	.613	.623	.615
(ПОДГЛ)	.810	.682	1.000	.706	.816	.680	.745	.657	.683	.694	.731
(ПОДГОРРСИСПРЗАДР)	.836	.711	.706	1.000	.761	.704	.615	.716	.740	.752	.717
(ПОДГОРРССВР)	.783	.783	.816	.761	1.000	.579	.841	.559	.587	.596	.629
(ПОДДОЛТРРДОР)	.766	.645	.680	.704	.579	1.000	.741	.932	.950	.932	.873
(ПОДДОЛТРТИЛ)	.669	.711	.745	.615	.841	.741	1.000	.716	.740	.752	.755
(ПОДДОЛТРРАЗАД)	.740	.623	.657	.716	.559	.932	.716	1.000	.951	.967	.878
(ПОДДОЛТРРПРЕД)	.766	.613	.683	.740	.587	.950	.740	.951	1.000	.984	.899
(ПОДОДЛТРРОД)	.778	.623	.694	.752	.596	.932	.752	.967	.984	1.000	.914
(ПОДДОЛТРПОТШ)	.821	.615	.731	.717	.629	.873	.755	.878	.899	.914	1.000
КЦБС	.750										
	(ПОДГОТПДР)	(ПОДГРПСВРГ)	(ПОДГЛ)	(ПОДГОРРСИСПРЗАДР)	(ПОДГОРРССВР)	(ПОДДОЛТРРДОР)	(ПОДДОЛТРТИЛ)	(ПОДДОЛТРРАЗАД)	(ПОДДОЛТРРПРЕД)	(ПОДОДЛТРРОД)	(ПОДДОЛТРПОТШ)
КСБП	.774	.678	.721	.726	.693	.780	.728	.774	.791	.799	.783
	5	11	9	8	10	4	7	6	2	1	3

DISCUSSION

From the analysis of the obtained results in the inter-similarity matrix from Tab. 2., it can be determined that the greatest similarity is observed between exercises No. 9 Raising of the lower part of the torso with the hand stretched above the head (RLOWPTORHANDSTRAHEAD) and No 10. Raising the lower part of the torso with the hand laterally raised to 90 degrees (RLOWPTORHAND LATR90) with a coefficient of .984. The largest similarity coefficients range from .914 to .984. The smallest similarity is present between exercises No 5 thoracic part of the spine with the hands behind the nape (RTHOPSHANDBN) and No 8. Raising the lower part of the torso with one hand behind the back (RLOWPTORHANDBBACK) with a coefficient of .596.The smallest similarity coefficients range from .559 to .596. The coefficient of full biomechanical similarity is CFBS=.750. According to the obtained results, the highest values of the CBCF coefficient of biomechanical connection force of one exercise with all other highest values were obtained in exercise No 10. Raising of the lower part of the torso with the hand laterally raised to 90 degrees (RLOWPTORHAND LATR90) with a coefficient.799, and No. 9 Raising of the lower part of the torso with the hand laterally raised to 90 degrees (RLOWPTORHAND LATR90) with a coefficient .791, and No.11 Raising of the lower part of the torso while slightly pressing the hand on the hip (RLOWPTORPRESSHHIP with a coefficient of .783.

CONCLUSION

Analysis of the data provided directly towards the statement that the suggested exercises possess great homogeneity. According to the obtained results the highest values of one exercise with all the other exercises (CBCF), the highest values of are obtained in the following exercises No.10 Raising of the lower part of the torso with the hand laterally raised to 90 degrees (RLOWPTORHAND LATR90), No.9 Raising of the lower part of the torso with the hand laterally raised to 90 degrees(RLOWPTORHAND LATR90) and. No.11 Raising of the lower part of the torso while slightly pressing the hand on the hip (RLOWPTORPRESSHHIP). The obtained results from the research are a quality example of the planning and programming that would be used in the prevention and correction of kyphosis (functional stadium and the first stage). For the establishing of the effect of the above-mentioned exercises on the postural muscles in an individual as well as in groups that have the functional and the first stage of kyphosis, not excluding the ones that are in a more serious phase of malformation. In the future, the electromyographic method would be applied that would precisely define the effect of the chosen exercises as well as the duration of the improvement of the muscle contraction. By application of these exercises in one treatment by physicians who more efficiently and for less time would contribute to solving the issues referring to this deformity including the possibility of this to be applied in the exercises which are used for different deformities of the spine.

REFERENCES

Ameri, E., Behtash, H., Mobini, B., Bouzari, B., & Tari, V. (2008). Patient satisfaction after scoliosis surgery. *Med J Islam Repub Iran* 21(4), 177–84.

Aliu.D, Biomechanical status of exercises for prevention and treatment of scoliotic body posture. *Research in Physical Education, Sport and Health*, *11*(1), 43-47.

Gorman KF, Julien C, Moreau A. The genetic epidemiology of idiopathic scoliosis. *Eur Spine J*, 21(10), 1905–1919.

Konieczny MR, Senyurt H, Krauspe R. Epidemiology of adolescent idiopathic scoliosis. *J Child Orthop,7*(1),3-9.

Longworth, B., Fary, R., & Hopper, D. ()Prevalence and predictors of adolescent idiopathic scoliosis in adolescent ballet dancers. Arch Phys Med Rehabil 2014; 95(9): 1725-30

Negrini S, Negrini A, Romano M, Verzini N, Parzini S. A controlled prospective study on the efficacy of SEAS.02 exercises in preventing progression and bracing in mild idiopathic scoliosis. Stud Health Technol Inform. 2006;123:523–6.

Negrini S, Negrini F, Fusco C, Zaina F. Idiopathic scoliosis patients with curves more than 45 Cobb degrees refusing surgery can be effectively treated through bracing with curve improvements. The Spinal Journal 2011;11:369–380.

Pugacheva N. Corrective exercises in multimodality therapy of idiopathic scoliosis in children - analysis of six weeks efficiency-pilot study. Stud Health Technol Inform. 2012;176:365–71.

Park WW, Suh KT, Kim JI, Kim SJ, Lee JS. Decreased osteogenic differentiation of mesenchymal stem cells and reduced bone mineral density in patients with adolescent idiopathic scoliosis. *Eur Spine J* 2009; 18:1920–1926. doi: 10.1007/s00586-009-1129-z.

Schultz AB, Sörensen SE, Andersson GB. Measurement of spine morphology in children, ages 10-16. Spine 1984; 9(1): 70-3.

Schreiber S, Parent EC, Hedden DM, Hill D, Moreau MJ, Lou E, Watkins EM, Southon SC. The effect of Schroth exercises added to the standard of care on the quality of life and muscle endurance in adolescents with idiopathic scoliosis—an assessor and statistician blinded randomized controlled trial: "SOSORT 2015 Award Winner" *Scoliosis.* 2015;**10**:24. doi: 10.1186/s13013-015-0048-5.

Weiss H, Moramarco M, Moramarco K. Risks and long-term complications of adolescent idiopathic scoliosis surgery vs. non-operative and natural history outcomes. *Hard Tissue.* 2013;**2**(3):27. doi: 10.13172/2050-2303-2-3-498.

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