DIFFERENCES IN MAXIMAL ISOMETRIC MUSCULAR POTENTIAL OF LOWER EXTREMITIES

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Summary
Direct measurements of maximal generated human muscular strength have an important place in planning of force development training. The only valid and objective method of muscular force estimation is measurement by dynamometer. At Biomechanical laboratory of Faculty of sports and physical education, transversal research (which included 42 students of masculine sex) of lower extremities maximal isometric potential was performed. The results do not indicate some important differences in maximal muscular potential between left and right lower extremities.

Key words*: isometric muscular potential, dynamometry, lower extremities, differences.*

Introduction
As a result of contraction, due to abbreviation of muscular fibers, a certain tension appears there. Muscular tension is elementary physiologic characteristic of muscles. For example, three-heads muscle of lower-leg, during walking, develop tension which is four times larger than body weight, and if all human muscular fibers are excited and abbreviated in the same time (about 300 millions) and maximally, performing a drag in one direction, they could develop puissance of about 25 tones. Static tension represents muscular tension when muscular force confronts to external force and the result is inaction (relative inaction). There are two types of static muscular tensions: active and passive. Active static tension sets in when the muscle is contracted and in equilibrium with other forces, whereby the muscular attachments are always on the same distance. This kind of contraction is called isometric contraction. In this case, no work is committed, but because of the state of contraction, there is relatively large consummation of energetic reserves in the cells of muscular fibers. Since active static tension complicate circulation of substances and energy in the muscles, fatigue which arrives during and after the static active tension is even more present. This form of muscular contraction appears when the external load is equal or larger than muscular tension, but there aren't conditions for muscular stretching under the influence of external load. All holds on are characterized by static active tension. In the case of equilibrium of arbors, muscular force is the basic measurement under man's control where by precise dosage of force rotation momentum on the arbors is equal. Passive static tension is realized when muscular attachments are so distant, under the condition where muscles are relaxed, and the density of muscular tissue doesn't allow further alienation of muscular attachments. And that is the way to confront the external force which executed elongation of muscular attachments by passive muscular tension (Bubanj, 1997).

Methods
At the Faculty of sports and physical education in Niš, at Biomechanical laboratory there is piezo-electric emitter of force with appropriate amplifier and program support for tracking of force intensities changes per time component (Stanković, 2003). For estimation of muscular tension intensities, an instrument which consists of parts given in the following order was used:

- mechanical construction for insulation of desired movement (picture 1),
- force emitter (sonde of 600 kp, picture 2),
- analog-digital "AD" converter (picture 3) and
- hardware-software system for tracking, analyzing and accounting of data (pictures 4 & 5).

Examinees participated in measurements in the groups of ten. Measurement was realized by two persons, earlier educated for such research. An examinee took appropriate position for determined muscular region, and the segment of body which was submitted to testings was connected to mechanical construction and sonde by special belts. On the sign by the educated measurer, the examinee accomplished maximal muscular contraction by using examined muscular group.

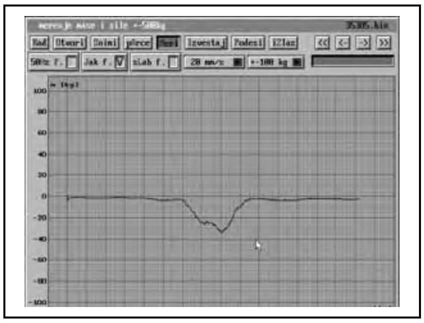
Electric dynamometer (sonde-force emitter) was constructed in „Technical-Development centre“ in Novi Sad: type: DSS/500, serial №: 98001 and sensitivity: 500kg of charge produce 2,2 mVN. Function of force emitter (sonde), is based on piezo-electric effect. Transmited electrycity has constant voltage during the passage through the semiconductor. Upon occasion of force activity which was produced by the examinee on the force emitter (semiconductor), voltage fluctuated depending on force intensity and was accounted by using device „AD“ converter and monitor of hardware-software system in kilograms with decimals. Total of 42 examinees of masculine sex, the students of Faculty of sports and physical education in Niš participated in this research. The right lower extremity is dominant among 37 of them, and the left lower extremity is dominant among five examinees. Measurements of maximal isometric muscular potential considered following variables: flexion in the right articulation of hip (FLDKUK), extension in the right articulation of hip (EKDKUK), adduction in the right articulation of hip (ADDKUK), abduction in the right articulation of hip (ABDKUK), flexion in the left articulation of hip (FLLKUK), extension in the left articulation of hip (EKLKUK), adduction in the left articulation of hip (ADLKUK), abduction in the left articulation of hip (ABLKUK).

Picture 1, Mechanical construction.

Picture 2, Force emitter.

Picture 3, “AD” converter

Picture 4, Software „Force Static“.



Results and discussion

Table 1, Kolmogorov - Smirnov One-Sample test (42 examinees).

Variables	FLDKUK	EKDKUK	ADDKUK	ABDKUK	FLLKUK	EKLKUK	ADLKUK	ABLKUK
Mean	34.48	32.91	34.94	29.51	36.12	33.72	35.46	31.52
Std. Deviation	9.08	8.29	8.25	9.02	10.06	8.69	8.07	9.67
Absolute	0.09	0.11	0.12	0.17	0.10	0.08	0.11	0.17
Positive	0.09	0.11	0.12	0.17	0.10	0.08	0.11	0.17
Negative	-0.06	-0.08	-0.10	-0.10	-0.05	-0.08	-0.09	-0.10
Kolmogorov-Smirnov Z	0.60	0.73	0.76	1.10	0.61	0.54	0.71	1.12
Asymp. Sig. (2-tailed)	0.87	0.67	0.60	0.18	0.85	0.93	0.69	0.16

Table 2, t-test for paired samples (42 examinees).

				95% Confidence				
Variables	Mean	Std.dev.	Std. error	Interval of the difference		t	df	Sig.
			mean	Lower	Upper			(2-tailed)
FLDKUK - FLLKUK	-1.64	7.25	1.12	-3.89	0.62	-1.46	41	0.15
EKDKUK - EKLKUK	-0.81	7.67	1.18	-3.20	1.58	-0.68	41	0.50
ADDKUK - ADLKUK	-0.52	6.14	0.95	-2.43	1.39	-0.55	41	0.59
ABDKUK - ABLKUK	-2.01	6.49	1.00	-4.03	0.01	-2.01	41	0.05

Table 3, Kolmogorov - Smirnov One-Sample test (37 examinees, right-footed).

Variables	FLDKUK	EKDKUK	ADDKUK	ABDKUK	FLLKUK	EKLKUK	ADLKUK	ABLKUK
Mean	35.50	33.45	35.88	29.85	35.97	34.10	35.74	31.85
Std. Deviation	8.69	8.05	7.97	9.38	9.93	9.04	7.91	9.76
Absolute	0.10	0.10	0.14	0.17	0.09	0.09	0.11	0.17
Positive	0.10	0.10	0.14	0.17	0.09	0.09	0.11	0.17
Negative	-0.07	-0.09	-0.08	-0.11	-0.05	-0.08	-0.09	-0.11
Kolmogorov-Smirnov Z	0.59	0.60	0.84	1.05	0.54	0.53	0.65	1.02
Asymp. Sig. (2-tailed)	0.88	0.87	0.48	0.23	0.94	0.94	0.79	0.25

Table 4, T test for paired samples (37 examinees, right-footed).

				95% Confidence				
Variables	Mean	Std.dev.	Std. error	Interval of the difference		t	df	Sig.
			mean	Lower	Upper			(2-tailed)
FLDKUK - FLLKUK	-0.47	6.79	1.12	-2.73	1.80	-0.42	36.00	0.68
EKDKUK - EKLKUK	-0.65	7.74	1.27	-3.23	1.93	-0.51	36.00	0.61
ADDKUK - ADLKUK	0.15	5.75	0.95	-1.77	2.06	0.15	36.00	0.88
ABDKUK - ABLKUK	-2.00	6.78	1.12	-4.26	0.27	-1.79	36.00	0.08

Table 5, Kolmogorov - Smirnov One-Sample test (5 examinees, left-footed).

Variables	FLDKUK	EKDKUK	ADDKUK	ABDKUK	FLLKUK	EKLKUK	ADLKUK	ABLKUK
Mean	26.92	28.92	27.96	26.98	37.20	30.92	33.40	29.09
Std. Deviation	9.25	9.91	7.54	5.71	12.14	5.35	9.94	9.69
Absolute	0.29	0.32	0.29	0.38	0.30	0.23	0.34	0.28
Positive	0.29	0.32	0.21	0.38	0.30	0.23	0.34	0.28
Negative	-0.21	-0.16	-0.29	-0.21	-0.19	-0.16	-0.19	-0.20
Kolmogorov-Smirnov Z	0.64	0.72	0.66	0.84	0.67	0.51	0.77	0.63
Asymp. Sig. (2-tailed)	0.81	0.68	0.78	0.48	0.76	0.96	0.60	0.82

Table 6, T test for paired samples (5 examinees, left-footed).

				95% Confidence				
Variables	Mean	Std.dev.	Std. error	Interval of the difference		t	df	Sig.
			mean	Lower	Upper			(2-tailed)
FLDKUK - FLLKUK	-10.28	4.16	1.86	-15.44	-5.11	-5.53	4.00	0.01
EKDKUK - EKLKUK	-2.00	7.90	3.53	-11.80	7.81	-0.57	4.00	0.60
ADDKUK - ADLKUK	-5.44	7.36	3.29	-14.58	3.71	-1.65	4.00	0.17
ABDKUK - ABLKUK	-2.10	4.18	1.87	-7.30	3.09	-1.13	4.00	0.32

To test existence of differences between muscular potentials of left and right extremities it was necessary, primarily, to adjust distribution values of examined variables, and based on these results to apply appropriate tests. By application of Kolmogorov - Smirnov test (table 1) the postulate about normal distribution of values at examineed variables was tested. Regarding the importances of Kolmogorov - Smirnov test (upon occasion of testing of normality of each variable) that are higher than minimum of importance which is 0.05 (FLDKUK=0.870, EKDKUK=0.666, ADDKUK=0.603, ABDKUK=0.179, FLLKUK=0.845, EKLKUK=0.930, ADLKUK=0.691, ABLKUK=0.163), the postulate about normal data distribution of all the tested variables was accepted.

Therefore, parametres tests were applied, i.e. t-test for paired samples. The results of t-test (table 2) indicate the existence of affable advantage in favor of the variables which relate to maximal isometric muscular contraction upon occasion of flexion in the right articulation of hip, because all differences of mean values are negative: FLDKUK – FLLKUK= -1.63571, EKDKUK – EKLKUK= -0.80857, ADDKUK – ADLKUK= -0.51881, ABDKUK – ABLKUK= -2.00810. However, based on significance of t-tests for paired samples (FLDKUK – FLLKUK=0.151, EKDKUK – EKLKUK=0.499, ADDKUK – ADLKUK=0.587, ABDKUK – ABLKUK=0.052) it may be concluded that differences between observed muscular potentials of the left and right lower extremities were not significant at any of the variables. Equivalently, it is also indicated by reliance intervals (95%) of mean values of differences at this research, which all contain zero. Upon occasion of rejecting the alternative hypothesis about existence of important differences, it is necessary to be careful at variable abduction of hip (ABDKUK-ABLKUK), because the importance of differences (p=0.052) is very close to the minimum of importance (α=0.05), so it is possible that the differences between the values of muscular forces described by this variable did not appear by haphazard, rather that a certain system factor is responsible for zero. By application of Kolmogorov - Smirnov test at sub-sample of 37 examinees with dominant right lower extremity (table 3), it was ascertained that there do not exist important aberrations in distributions of examined variables from normal distribution, i.e. all significances are higher than 0.05 (FLDKUK=0.876, EKDKUK=0.867, ADDKUK=0.483, ABDKUK=0.225, FLLKUK=0.935, EKLKUK=0.938, ADLKUK=0.789, ABLKUK=0.246). Therefore, parametres tests were applied. Based on significance of t-tests for Paired Samples at sub-sample of 37 examinees with dominant right lower extremity (table 4), the conclusion is that there do not exist important differences between examined muscular potentials of left and right lower extremities at all variables.

By application of Kolmogorov - Smirnov test at sub-sample of 5 examinees with dominant left lower extremity (table 5), it was ascertained that there do not exist important aberrations in distributions of examineed variables from normal distribution, i.e. all significances are higher than 0.05 (FLDKUK=0.811, EKDKUK=0.680, ADDKUK=0.780, ABDKUK=0.475, FLLKUK=0.763, EKLKUK=0.959, ADLKUK=0.599, ABLKUK=0.821). Therefore, parametres tests were applied.

Based on significance of t-tests for Paired Samples at sub-sample of 5 examinees with dominant left lower extremity (table 6), the conclusion is that there do not exist important differences between examined muscular potentials of left and right lower extremities at all variables, except at variable flexion of hip, where the significance is high (p=0.005).

Conclusion

This research gave results about topographic puissance of students from Faculty of sports and physical education in Niš. Non-existence of important differences in topographic puissance of lower extremities was ascertained, which gave a real insight in isometric muscular potential of examinees. Raciness is that all examinees had subjective sentiment that by using dominant in regard to non-dominant lower extremity, they could be able to achieve greater maximal isometric muscular force, which wasn't confirmed by this research. The applied methodology of work enabled accurate interpretations and explanations of established differences and necessary terms of reference from area of isometric muscular potential for further researches were defined.

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RAZLIKE U MAKSIMALNOM IZOMETRIJSKOM MIŠIĆNOM POTENCIJALU DONJIH EKSTREMITETA

Sažetak

Direktna mjerenja veličine maksimalne generirane sile mišića ljudskog tijela zauzimaju značajno mjesto u planiranju treninga razvoja snage. Jedini validni i objektivni način procjene sile mišića je mjerenje pomoću dinamometra. U okviru Biomehaničke laboratorije Fakulteta sporta i fizičkog vaspitanja izvršeno je transverzalno istraživanje maksimalnog izometrijskog mišićnog potencijala donjih ekstremiteta u kojemu je sudjelovalo 42 studenta muškog spola. Rezultati ne ukazuju na značajne razlike u maksimalnom mišićnom potencijalu lijevih i desnih donjih ekstremiteta.

Ključne riječi*: izometrijski mišićni potencijal, dinamometrija, donji ekstremiteti, razlike*

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