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Original Article

Monitoring the muscle training by evaluation of viscoelastic parameters

POPESCU RODICA[1], DORINA ORTANESCU[2], ELIANA LICA[3], GERMINA COSMA[4], LIGIA RUSU[5]
[1]Kt.drd.UNEFS Bucuresti
[2,3,4,5]University of Craiova

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Abstract: Problems statement: The muscle training is based on muscle parameters like muscle tone, elasticity, stiffness that need to be evaluate. One of the method is myotonometry help us to monitoring the training programm. Methods: The aim of this study is to evaluate the results of musce training for lower limb, using the method which help to have informations about the viscoelastic parameters of skeletal muscle. The muscle training is based on stretching and plyometry. The assessment was made for biceps femoris (BF) and rectus femoris(RF), at two moments: relax and isometric contraction, both side-right and left side. Results: For complet evaluation the measurements calculate the index of symmetry and the results an improvement of symmetry index of viscoelastic parameters which has a good evolution for RF after muscle training. Conclusions: The evaluation of viscolealstic parameters give informations about the muscle behaviour after training and also about muscle fatigue and to design the programm for restore the muscle function.
Keywords: muscle tone, elasticity, assessment, muscle training

Introduction

Muscles are the group of viscoelastic structures, means that are between elastic and fluids: means that the tissue store the elastic energy which is changed in mechanic energy.
Muscle tone means the intervention of nervous central system (NSC) but also depend on muscle structure which is strong relation with conjunctive tissue[1]. Muscle depends also of muscle vascularization and contractile protein content. The parameters that is mechanic tenssion even in relax[2]. Stiffnessul is the capacity of the muscle to resist against of force. Elasticity is the muscle property to restore its shape after stimulation. Any muscle training programm could be monitoring by myotononemtric method which give us informations about the viscoelastic parameters(muscle tone, elasticity, stiffness). The aim of this study is to make a evaluation of viscoelastic muscle property using myotonometry[3] method, before and after muscle training based on stretching and plyometry. Muscle tone depends of nervous central system action and also muscle structure, especially conjunctive tissue from endomissium, perimissium and muscle fiber. Muslce tone [4]depends also on muscle vascularization, and content of contractile protein. By myotonometry is possible to evaluate the muscle tone along the muscle fiber[5] and to assess two important features like elasticity and stiffness.

Methods

The study included 9 subjects(girls, average age 16years) basketball palyers at C.S.U Craiova, Romania. Myotonometric method used Triple-scan mode, 3 determinations. The measurements are made in relax and isometric muscle contraction, for biceps femoris (BF)(fig.10 and rectus femoris(RF) (fig. 2). The measurements are made using Myoton 3 which has a sensor [6] that will be place under the muscle belly on the left and right side. Firts measurement is on the left side and then on right side using a specila patter create for lower limb.The time of each measurement is 15ms. Myoton is a device use for assessment of muscle tone which was made by Tartu University Estonia. Clinical studies show that it helps the clinicians for have a real evaluation of muscle tone and contributes to obtain the values of muscle viscoelastic proprieties[7], elasticity and stiffness less then 5 minutes. Prone position, point of measurement is on 1/3 midle point on BF.

Fig.1 Biceps femoris measurement

Corresponding Author FILIPE MANUEL CLEMENTE, E-mail: filipe.clemente5@gmail.com

Supine position, point of measurement is on the distal point of RF

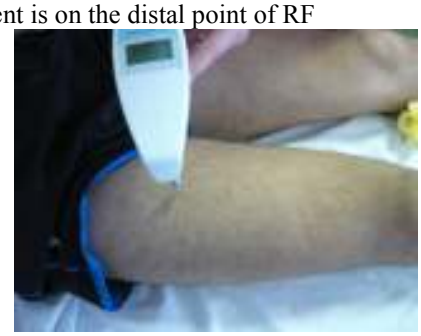

Fig.2-rectus femoris (RF)

We evaluate is symmetry index for each muscle parameters: muscle tone, elasticity, stiffness, for agonists and antagonists muscles[8]. This index helps us to evaluate the muscle role in joint stability during development of muscle explosive force. Muslce training is based on sisometric stretchin 10sec x3repetions, 5sets. and plyometry. Both technics methods involve an improvement of neural conduction and muscle adaptation. Symmetry is the index that should not be more then 5% between left nd right side. Start from this threshold the difference between left and right side coudl be: 5%(normal), 5%-10% need attention, more then 10% means a level of risk and presence of muscle fatigue.

Results and discussion

Symmetry index before the training programm (Tables I,II)

TABLE 1. SYMMETRY INDEX EIGHT/LEFT FOR BF/RF RELAX

	Muscle	Tone (freq-Hz)	Elasticity (decrement)	Stiffness (N/m)
1.	BF	6.40	5.19	2.23
	RF	3.81	3.97	0.00
2.	BF	5.69	1.08	8.05
	RF	0.88	8.00	3.37
3.	BF	5.49	6.14	6.77
	RF	0.88	11.19	3.90
4.	BF	1.98	10.79	7.38
	RF	3.14	2.75	2.15
5.	BF	5.97	0.00	9.90
	RF	0.43	18.29	1.67
6.	BF	4.63	10.60	4.98
	RF	4.27	1.67	0.65
7.	BF	1.37	3.01	0.85
	RF	5.42	4.35	0.50
8.	BF	0.94	6.91	1.49
	RF	3.26	15.60	10.00
9.	BF	3.80	0.59	4.35
	RF	5.45	1.24	8.66

TABLE 2. SYMMETRY INDEX EIGHT/LEFT FOR BF/RF CONTRACTION

Nr	Muscle	Tone (freq-Hz)	Elasticity (decrement)	Stiffness (N/m)
1.	BF	0.39	6.22	0.46
	RF	9.40	4.27	14.09
2.	BF	12.28	3.47	15.80
	RF	2.05	0.00	5.40
3.	BF	5.23	2.31	9.23
	RF	3.94	3.86	5.82
4.	BF	2.94	4.11	5.83
	RF	0.41	0.00	4.64
5.	BF	8.11	0.93	10.07
	RF	1.13	2.06	7.26
6.	BF	5.71	2.27	0.84
	RF	5.18	16.06	1.00
7.	BF	6.51	2.61	11.76
	RF	4.81	12.45	3.18
8.	BF	0.47	19.35	2.73
	RF	2.91	7.77	5.97
9.	BF	1.12	10.12	4.07
	RF	4.27	12.42	7.02

These results show us that muscle tone and stiffness are in the risk zone, (value more the 5), the elasticity has an asymmetry much more for RF, decrease of elasticity for RF that justify the role of muscle training based on isometric stretching. After the training program the results are(Tables III,IV):

TABLE 3. SYMMETRY INDEX EIGHT/LEFT FOR BF/RF RELAX

Nr.	Muscle	Tone(freq-Hz)	Elasticity(decrement)	Stiffness(N/m)
1.	BF	1.72	5.49	0.81
	RF	0.98	1.12	3.51
2.	BF	1.28	4.24	0.40
	RF	0.85	3.25	2.12
3.	BF	0.00	7.09	2.26
	RF	0.89	5.51	2.79
4.	BF	4.29	0.94	4.55
	RF	0.84	4.09	0.84
5.	BF	1.40	3.54	0.67
	RF	1.03	13.56	2.12
6.	BF	4.88	1.44	2.07
	RF	1.37	3.25	8.89
7.	BF	5.26	0.84	8.52
	RF	1.90	2.11	4.12
8.	BF	0.00	2.49	0.75
	RF	1.83	0.00	0.20
9.	BF	3.80	0.59	4.35
	RF	5.45	1.24	8.66

TABLE 4. SYMMETRY INDEX EIGHT/LEFT FOR BF/RF CONTRACTION

Nr.	Muscle	Tone(freq-Hz)	Elasticity(decrement)	Stiffness(N/m)
1.	BF	4.18	0.44	9.91
	RF	3.70	5.02	13.61
2.	BF	7.63	5.00	11.62
	RF	3.56	3.65	3.95
3.	BF	3.97	4.35	0.16
	RF	3.97	3.82	6.34
4.	BF	5.84	3.33	11.14
	RF	6.22	2.72	6.31
5.	BF	0.71	4.81	2.61
	RF	2.81	2.59	5.30
6.	BF	5.06	1.02	1.13
	RF	3.54	1.98	9.38
7.	BF	2.70	1.21	2.21
	RF	7.75	23.29	12.40
8.	BF	5.23	2.31	9.23
	RF	3.94	3.86	5.82
9.	BF	1.28	4.24	0.40
	RF	0.85	3.25	2.12

Analyze the results show us that are a good evolution of symmetry index for all parameters [4], which much evident for RF, which is in according with training program. Even this is important to underline the importance of implementation the recovery [9]post effort. The results are presented for each subject.

Subject 1(S1) has a decrease of muscle tone(T) for BF bilateral, in relax and decrease of symmetry index (SI).During contraction is no change of T but an increase of SI, but no more then 5%. These results are correlate with decrease of elasticity in relax and increase during contraction demonstrate the efficiency of isometric stretching[10]. Regarding stiffness SI report show a semnificative increase of SI to the high limit much more during contraction to BF.

For subject 2(S2) at BF are a decrease of T,E and S during relax and contraction, but at right BF is a low level of SI. For RF right is an increase of T, E, S that means a tendency of increase the muscle force. During contraction the parameters decrease means a good adaptation at muscle training , improvement of muscle metabolism reduce by stretching exercises. For the other side an increase of parameters are correlate with evolution of BF parameters.

For SI increase the values during contraction reflect the muscle fatigue.

For subjects 3, 4(S3, S4) to the posterior side of thigh are a symmetry of T left/right, increase of E much more to left lower limb and decrease of S. On the anterior part of the thigh is also a symmetry of T , decrease of E during

rest position, decrease of S that means a symmetry antero-posterior that could be explain by isometric contractions exercises.

Subject 5(S5) T has the values which are close to the value before the training , increase he E, decrease the S and SI shows a high symmetry left right at thigh.
This aspect suggest that the symmetric muscle training.

Subject 6 (S6) to the high , T has a constant value, decrease of E and S during relax and increase of S at anterior part of the thigh. During contraction increase the S and decrease of E, means training based on isotonic muscle contraction exercises and tendency to evolution to muscle fatigue.

Subjects 7 (S7) has an increase of T and E, more evident to posterior part of the thigh and increase of S to anterior part. SI is in normal limits. These suggest that isometric stretching is the best choice.
Subjects 8(S8) show a increase of T and S,E.
Subject 9(S9) show a decrease of T and S, but an increase of E much more to anterior muscle group of the thigh based on ballistic stretching.

Conslusions

Isometric stretching improves the viscoelastic muscle parameters
Assessment of muscle tone in relax and during muscle contraction give informations about muscle fatigue
Stiffness is the parameter which give informations about the muscle contraction and muscle status in relax.

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