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Biomechanic parameters analysis of trunk in oina game

Cristian Vaduva[1], Mihai Rusu[2], Mihnea Marin[2], Ligia Rusu[2]
[1] *University Babeș-Bolyai, Cluj-Napoca, Romania,*
[2] *University of Craiova, Romania*

Abstract. The performance in oina game is in connection with the possibility to develop the optimal position of trunk, upper and lower limbs, much more focus on hip position. For throwing the success means to have a strong stabilisation of the trunk. The aim of this paper is to present the biomechanical analysis of paravertebral muscle during the kick ball movement. *Material and Method*. The study has been made like a case report. The subject is a man age 43years old, weight 78kg, height 1,75m, body mass index (BMI) 25,46%, practiced oina from 20years. For visual capture we used VICON system. Muscle groups are from paravertebral muscle group. The movement analysis has been made during kick ball and has three important moments. *Results.* Analysing the recorded results of the muscle forces developed by the 7 muscle groups studied whose major component is the erector spinae, we can state that there is an interesting disequilibrium right-left and also some major differences of the charge of these muscle groups depending on the function during the moment of movement. *Discussions.* The analysis of the muscle behaviour at the level of the spine is in direct connection to the movements of the upper limb so that the success of the hit with the bat is influenced by the rotation movement of the spine. This result was obtained through measurements of the muscle values of the spine and they showed that that the spine has the tendency of stabilization through am isometric stretching contraction. *Conclusions.* We have also noticed the muscle reflex which lead to an overload of the lumbar area L3, where the torsion movement and the maximum para spinal disequilibrium takes place. The increased values of the muscle forces formed at the level of inter spinal canals explain a possible increase of the elastic energy.
Key words: *muscle, behaviour, torsion, contraction, overload.*

Introduction

The performance in oina game is in connection with the possibility to develop the optimal position of trunk, upper and lower limbs, much more focus on hip position. These positions have to allow a good trunk stabilisation and to create the possibility to have a explosive force. In this moment the research studies are focused on softball and baseball, which are closed to oina game because need a lot of skills like targeting with the stick, throwing and movement on specific routes. So, for this reason are need a lot of training for the players decide the results of the game. In this context, Rivera, M.et al (1) speaks about the importance of stick speed and trunk rotation.

Take in consideration the role of the trunk is important to make a biomechanical analysis for evaluate the motion and muscle force development. Like in other games throwing is a skill that could be develop if is possible to make an analysis of behaviour of body segments, because there are different types of throws that a thrower must be able to throw accurately. There are numerous aspects of throwing making it a complex skill to master, such as ball velocity, ball movement, arm velocity, and arm movement. However these aspects have little effect if the thrower cannot place their throws precisely, that is to say, throw strikes. Even though throwing accuracy can be increased by improving technique and practicing muscle memory (2), coaches are constantly seeking other means.

For throwing the success means to have a strong stabilisation of the trunk, because it is the key point and has a significant influence on elbow movement, shoulder (3) wrist movement and also on ball speed. Knowledge the dynamic information could help the coach to improve the training methods and to see how could be influence the energy metrics. During the throwing in oina game are a three stage rocket system: lower limb system included pivot leg (extension, hip abduction, internal rotation of hip), trunk torsion (waist twist and lateral bending, shoulder moves forward and upward), pitching arm (shoulder adduction, internal rotation, elbow extension, forearm medial rotation) (4).

The aim of this paper is to present the biomechanical analysis of paravertebral muscle during the kick ball movement. The analysis reflects the evolution of trunk movement during kick ball and how is the loading of the spine during this movement.

Material and method

The study has been made like a case report. The subject is a man age 43years old, weight 78kg, height 1,75m, body mass index (BMI) 25,46%, practiced oina from 20years. The study has been made in according to Declaration of Helsinki, version 2013, the subject signed an informed consent before start the study.
Study design. Equipment - The research has been made in Research Laboratory of *Technics and Innovative Process in Bioengineering,* INCESA-Craiova, in 2018, and consist in evaluate the specific kick ball movement that the athlete simulated in the laboratory. For visual capture we used VICON system (*https://www.vicon.com*), using 14 ultra-speed infrared cameras. By this way we recorded the trajectories of specific points marked on the body, using VICON model (Fig.1).
The software NEXUS, associates with VICOSN system, has been used for data analysis and created the specific file like*.*c3d*, that contain the trajectories of the marked points, reported to referential system of the laboratory. This file has been imported in BOB software *(Biomechanics of Bodies*, *https://www.bob-biomechanics.com/*), for simulation and analysis the muscle force development during specific movement, based on kinetic parameters collected by VICON system. Calculation of the muscle forces has been made by modeling program and reverse engineering.
Muscle groups are from paravertebral muscle group, named muscle *erector spinae* which its components *iliocostalis cervicis, thoracis, lumborum and spinals* muscle (Fig. 2).The movement analysis has been made during kick ball and has three important moments (Fig. 3a, 3b, 3c): moment zero or initial moment for start the movement included put in tension the muscle groups- t=0.00s (mom 0); moment of kicking using the oina stick t=0.75s (mom 1); final moment final or end of kicking t=1.05s (mom 2).

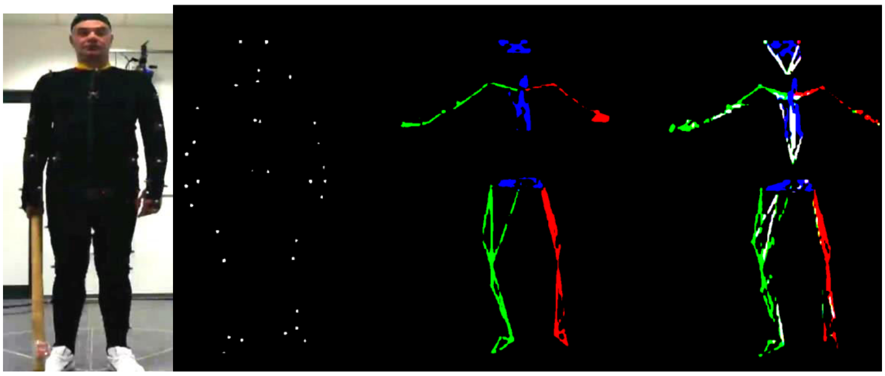

Figure 1. Markers position in standard VICON system

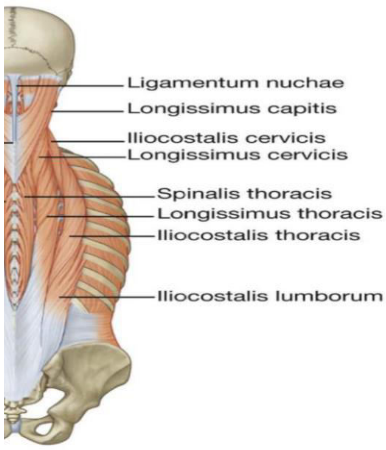

Figure 2.View of muscle groups
(*https://quizlet.com/371092869/deep-muscles-of-the-back-labeling-erector-spinae-only-diagram/)*

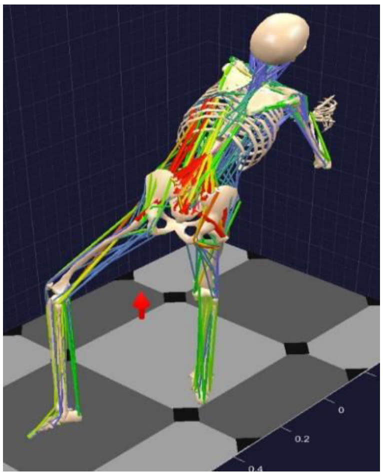
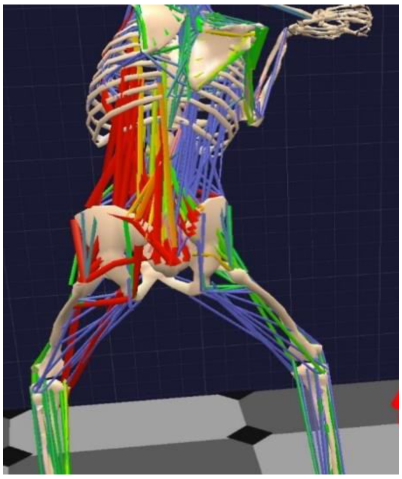
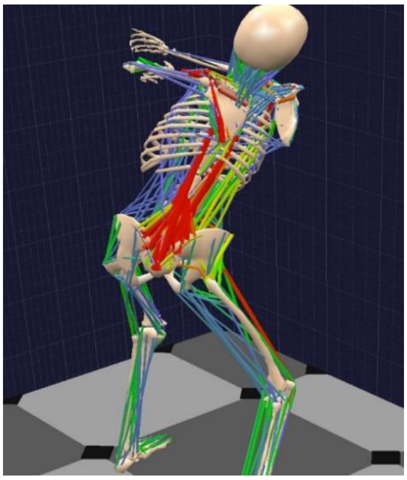

Figure 3a.Moment zero t=0.00s **Figure** 3b.Moment t= 0.75s **Figure** 3c.Moment t=1.05s

Results

The results are presented in tables 1a and 1b, for each muscle at three moments. Analysing the recorded results of the muscle forces developed by the 7 muscle groups studied whose major component is the *Erector spinae*, we can state that there is an interesting disequilibrium right-left and also some major differences of the charge of these muscle groups depending on the localisation and the function during the moment of movement.

Table 1a. Muscle force values for each moment and for all muscle groups il c9, il c10, il l1

Time	il_c9_left	il_c9_right	il_c10_left	il_c10_right	il_l1_left	il_l1_right
Moment zero 0(mom0)	42.0967	0.33709	14.0175	0.29014	100.3163	14.2452
0.05	31.0057	0.75346	14.497	0.63233	76.7384	17.4833
0.1	26.7162	0.80402	13.5657	0.67037	70.6821	17.8362
0.15	17.7895	0.77677	10.154	0.61815	61.6615	22.6249
0.2	16.9504	1.3735	5.8405	1.0186	67.828	40.2789
0.25	10.8283	0.9659	3.9977	0.67221	58.5256	59.4115
0.3	11.8977	0.95678	3.5692	0.65432	70.5345	62.7716
0.35	25.5997	0.95406	5.6591	0.67204	86.3042	70.1027
0.4	14.9998	0.97126	4.3663	0.6324	80.7126	83.188
0.45	11.2375	3.8812	9.7579	2.6787	36.2863	33.9018
0.5	18.7746	2.0119	35.5027	2.4529	1.38E-05	3.8261
0.55	45.3089	0.037225	95.0647	0.042898	0.22565	0.16815
0.6	60.6907	0.016999	74.7702	0.019033	35.218	0.044986
0.65	77.8135	0.009136	135.3574	0.00868	61.7779	0.08562
0.7	83.9082	0.003284	148.3231	0.003184	55.9984	0.029939
Moment kicking (mom1) 0.75s	57.1694	0.01626	79.691	0.014937	57.1553	3.6784
0.8	40.2263	0.52121	7.428	0.40741	59.6143	67.3068
0.85	0.74245	6.6866	0.83687	1.5875	0.90516	30.8079
0.9	0.024884	21.9266	0.023283	8.3269	34.5966	74.0857
0.95	4.9813	1.6487	2.2432	2.3741	25.2459	1.8603
1	36.4116	1.7448	13.526	1.9272	28.2876	4.2708
Final moment (mom2) 1.05s	46.5437	1.1961	11.4237	1.3665	25.0681	2.5668

Translating these results into tables and in charts (fig. 4-10) meant that for Ilc9 - the maximum charge is during the first moment, mostly in the left part which continues throughout the whole movement.

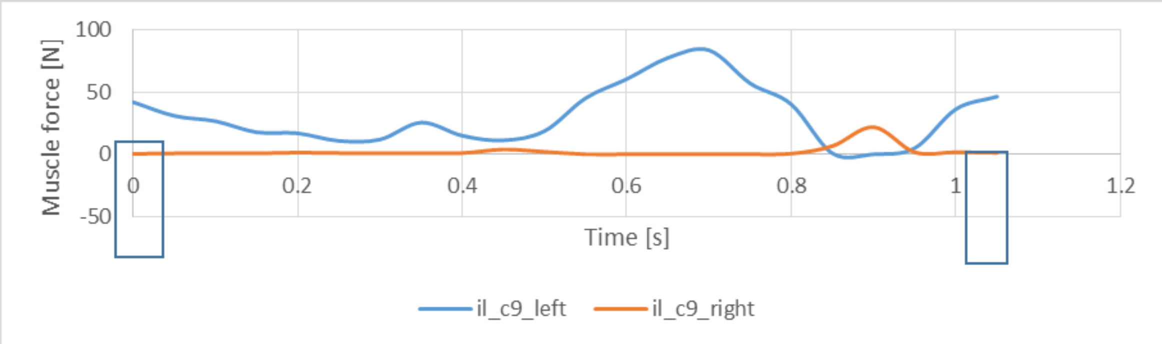

Figure 4.Variation of Erector spinae iliocostalis cervicis c9 muscle force during the movement

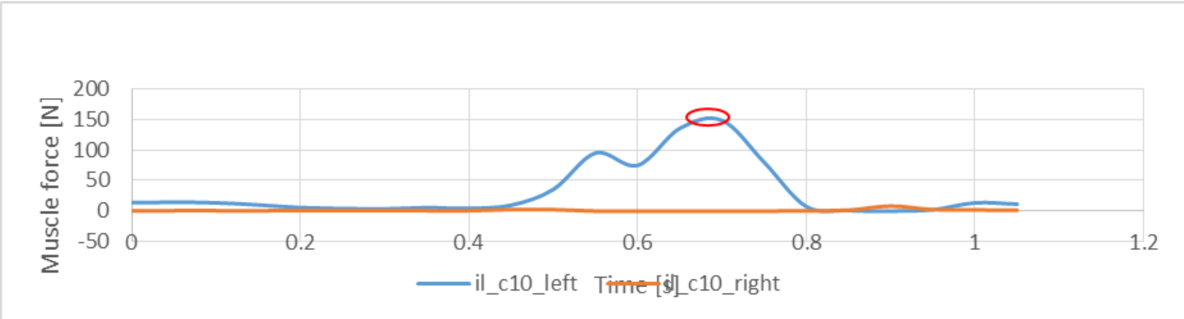

Figure 5. Variation of Erector spinae iliocostalis cervicis c10 muscle force during the movement

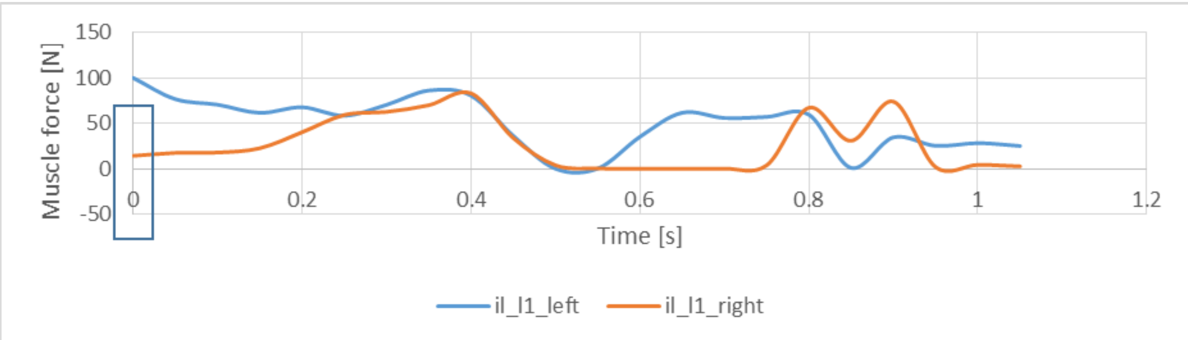

Figure 6.Variation of Erector spinae iliocostalis lumborum l1 muscle force during the movement

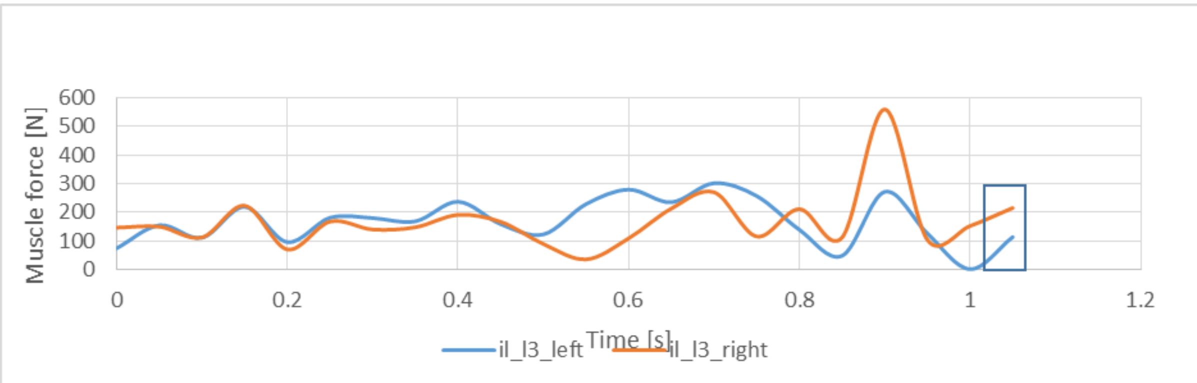

Figure 7. Variation of Erector spinae iliocostalis lumborum l3 muscle force during the movement

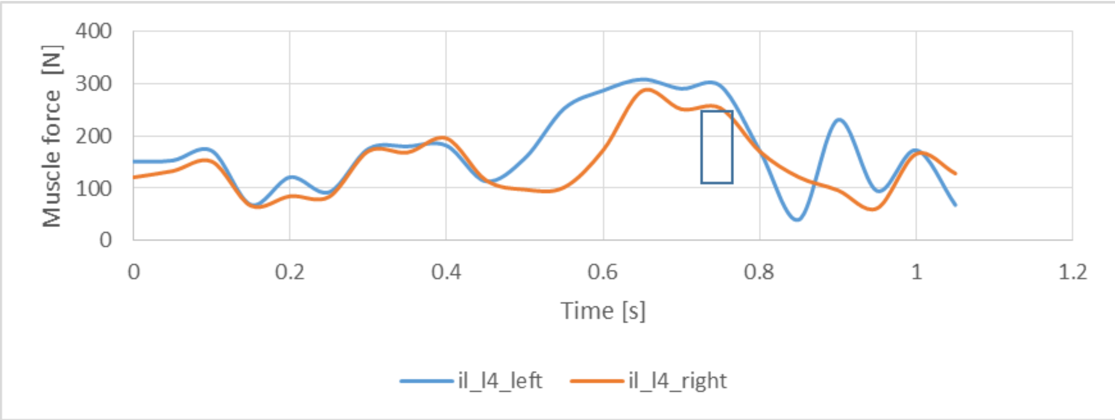

Figure 8.Variation of Erector spinae iliocostalis lumborum l4 muscle force during the movement

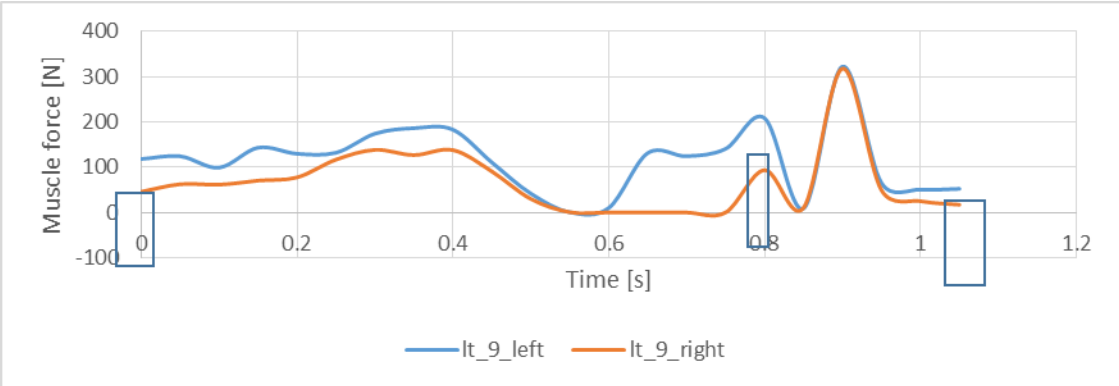

Figure 9. Variation of Erector spinae iliocostalis thoracis lt 9 muscle force during the movement

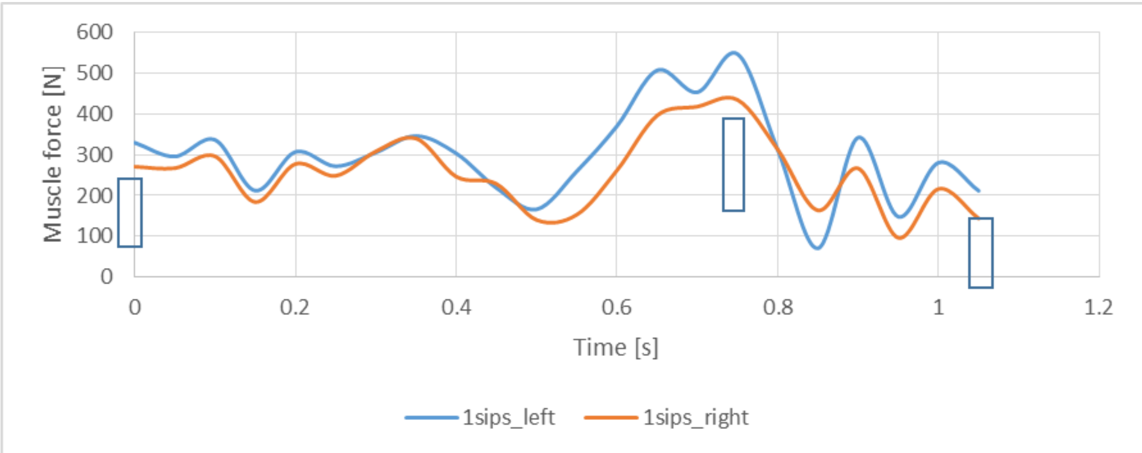

Figure 10.Variation of Erector spinae iliocostalis spinalis muscle force during the movement

When referring to the Ilc 10 we have notice that there is the same difference, the maximum charge being also in the first moment, on the felt side and the highest point of relaxing is in the second moment (table 1a, fig. 5). Il1 is maximum charged in the left area during the zero moment which leads to a difference of tension between the left and right areas which means that there is a marked asymmetry (table 1a, fig.6). Il3 at the zero moment has an asymmetry between the right and left areas with stresses mostly in the right area, then, during the moment 1 the difference increases but the charge is maximum in the left area and during moment 2 the right area is charged (table 1b, figure 7).

This means that this is where the torsion and the overcharging area are.
Il4 has an important asymmetry during the final moment with stress on the right area, which can be explained through the role that the spine has, mainly to control and stabilise together with Il3, the charge being at the level of Il3 (table 1b, fig. 8).
In the Ilt area the charge is mostly on the left part, during moment 1 (table 1b, fig. 9). We could also measure that the charge is the highest during the moment 1 at the level of spinal muscles, and it is in this particular moment that there a big asymmetry between left and right areas (table 1b, fig. 10).
We also reached the conclusion that the maximum charge is on the left side at all studied levels, except for the Il3 level. The interest area is IL3-Il4 al well as the thoracic area, the major differences being during moment 1. Analysing the values of the muscular forces developed in all muscle groups we could notice that the values are increased at the muscle levels which means that they are involved in the stabilization of the spine.

Table 1b. Muscle force values for each moment and for all muscle groups il l3, il l4, il t9, 1sips

Time	il_l3_left	il_l3_right	il_l4_left	il_l4_right	lt_9_left	lt_9_right	1sips_left	1sips_right
Moment 0 (mom0)	74.7409	146.8019	151.3017	121.1262	118.4573	45.922	329.9478	270.9437
0.05	155.2135	150.0394	153.3758	133.0961	124.4663	62.7573	295.9637	267.2912
0.1	111.7708	112.5641	171.7846	151.262	99.4733	61.6754	336.7352	296.4792
0.15	219.1122	223.2291	68.3396	66.514	143.4316	70.6613	211.9015	184.0359
0.2	96.2666	70.58	121.3124	84.9995	130.05	77.7202	307.2355	277.5612
0.25	181.4739	167.8089	92.6115	83.9689	132.2495	117.0768	272.0322	248.5282
0.3	180.1656	140.2097	175.5921	171.3281	174.394	138.6471	305.9121	308.445
0.35	168.8436	148.0126	180.3735	168.7515	186.6207	127.1288	346.4836	340.3043
0.4	237.4059	191.4592	181.7562	195.7382	183.212	138.2205	303.7488	246.4934
0.45	158.8905	167.0665	113.598	115.6477	110.849	90.9146	218.9384	228.7101
0.5	123.2137	89.5862	157.8038	97.6124	42.0196	30.1283	166.0798	139.8768
0.55	229.0569	35.9938	252.6739	101.7315	0.7579	0.76043	259.6974	152.996
0.6	279.5069	109.4596	287.4369	173.1666	10.2747	0.23249	370.6941	261.9504
0.65	235.4827	213.6137	308.8003	286.7782	131.3517	0.13542	507.6649	396.8459
0.7	301.8203	270.3658	290.9391	251.671	124.6319	0.047701	454.0428	418.6294
Moment of kicking (mom1)0.75s	257.1124	115.9276	296.2319	253.6292	140.89	0.24895	547.7227	435.1997
0.8	139.4221	211.6098	172.2767	170.7494	208.7864	93.9763	311.891	312.8318
0.85	48.4487	112.2538	39.8558	121.3929	9.2528	10.6077	70.2601	163.5208
0.9	271.9349	559.6601	231.2515	96.2357	322.7347	318.0555	342.514	266.9094
0.95	126.3771	104.1836	94.9477	61.5757	65.1616	49.4237	147.69	96.0295
1	1.6924	152.5636	173.1827	165.9841	50.9456	25.282	280.8135	216.2488
Final moment (mom2)1.05s	113.9947	215.4336	67.9185	128.4097	52.5736	17.4398	211.6614	143.515

Discussions

The analysis of the muscle behaviour at the level of the spine is in direct connection to the movements of the upper limb so that the success of the hit with the bat is influenced by the rotation movement of the spine. This result was obtained through measurements of the muscle values of the spine and they showed that that the spine has the tendency of stabilization through am isometric stretching contraction.
This conclusion was also reached by (2). He mentioned the intervention of the spinal muscle located in the vertebral canals which makes the bones work together.
In this context the author underlines the major contribution that this muscle group has through the increased values of the muscular force with values which can reach 547N.
At the same time, the charge of the left area and the left-right asymmetry is also noticed by (5) which allows the right muscle to accumulate energy which will later on be released over the upper limbs and reflected in the speed of the hit and the distance at which the ball is thrown.
The rotation movement of the spine and the torsion of the Il3 area is also brought into question by (6,7) who stated that once the spine contracts, the pelvis will be projected behind and the rotation of the hip will form an elastic energy which will be later released making the inferior limbs to be stable (2).
These aspects which involve the elastic energy accumulated at the level of deep para spinal bones and the asymmetric load were also discussed by Togo (8) and his coworkers. In this regard Togo stated that this asymmetry allows the arms to accumulate energy and develop the explosive force necessary for the hit with the ball.

Conclusions

In conclusion, gaining a sufficient speed and power requires making an isotonic contraction game, an isotonic stretching from left to right of the para spinal bones which form the chain of transmitting a movement to and from the upper limbs which are the ones ultimately responsible for the hit of the ball.
It is necessary to analyse the behavior of the para spinal bones in connection to the kinematic necessities of the upper limb and of the arms in order to develop special training (9) programs.
We have also noticed a certain response of the muscle reflex which lead to an overload of the lumbar area L3, the place where the torsion movement and the maximum para spinal disequilibrium takes place. The increased values of the muscle forces formed at the level of inter spinal canals explain a possible increase of the elastic energy which can be released later during the movement of the inferior limbs (10). The conclusions of this study are in direct connection to the increased results of the player and can represent key points in adjusting the training (10) programs.

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Corresponding Author
Ligia Rusu
Sport Medicine and Physical Therapy Department
University of Craiova, Romania
E-mail address: *ligiarusu@hotmail.com*

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