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A CASE STUDY - DETERMINING THE MUSCLE IMBALANCE OF THE JUNIORS 3 IN HURDLES EVENTS THROUGH BIODEX SYSTEM 4 PRO™

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Abstract: *A case study was undertaken to determine the agonist - antagonist ratio of the lower limb of the junior athletes three according with the technical demands of the leading leg and trail leg from hurdles events. The leading leg during the hurdles events is using the flexion/extension of the knee while the trail leg movements are more complex including: abduction of the hip, shoulder external rotation. Our study consists in a total of five variables tested using Biodex System ProTM such as: knee extension/flexion, ankle plantar/dorsiflexion, hip extension /flexion, hip abduction / adduction and shoulder internal / external rotation at different speeds (60°*/s 120°/s, 180°/s*.* 300°/s, 450 °/s). *We have compared speeds for each variable to determine differences between right and left leg. In addition, this study aimed to create a more objective image of the agonist - antagonist ratio for the leading/trail leg during hurdles race for junior athletes 3.*

Key words: *muscle imbalance, hurdles, agonist-antagonist ratio.*

1. Introduction

The main interest in hurdles events is the evaluate performance. Over the years isokinetic evaluation in hurdles have been used by researches [3] to establish the best "strength training program".

Another purpose of the isokinetic evaluation used by practitioners, was to determine, '' specific deficits" of the lower and upper body muscles according to [1]. This deficit can be described as a muscle imbalance of the agonist-antagonist muscles. The best way to determine muscle imbalance of the agonist-antagonist ratio between left and right lower limb is create a screening program.

Agonist – antagonist ratio assessment is well known to test muscles “strengths and weaknesses” according to Raske Sparrey [5, p. 4507]. In addition to the strength parameters isokinetic testing can evaluate “functional specificity of the muscles” [3, p.274].

2. Objectives

The present study aims to establish the particular features of the agonist –

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antagonist ratio and strength deficit in order to achieve a more objective interpretation of muscular performance for young hurdlers.

3. Material and Methods

The pilot study was conducted using Biodex System 4 Pro™ at Provita private clinic from Bucharest.

Biodex dynamometer was calibrated concentric/concentric mode, contraction isokinetic bilateral mode. Our athlete involved in this investigation is a hurdles runner, 14 years old. The athlete performed the preliminary warm-up specific to the hurdles test.

We tested five variables: knee flexion /extension at 180°/s. 300°/s, 450 °/s ; hip flexion/extension 180°/s. 300°/s, 450 °/s ; hip adduction/abduction 180°/s. 300°/s, 450 °/s, hip internal/external rotation 180°/s. 300°/s, 450 °/s; ankle plantar and dorsoflexion 60°/s. 120°/s, 180 °/s. Our athlete performed a set of 5 repetitions for the knee and hip flexion/extension, hip abduction/adduction, hip internal/ external rotation and 10 repetitions for ankle plantar and dorsoflexion.

4. Research Hypothesis

It can be said that muscle imbalance can be determine by the driving side of the sports practiced.

Null hypothesis

It can be hypothesized that there are no significant differences in between lefts and right leg.

5. Results and Discussions

Findings from this study show that there is a strong relationship between the agonist - antagonist ratio between left and right lower limb. Agonist - Antagonist ratio can be determined using the next formula:

$$\frac{\text{Peak torque HS}}{\text{Peak torque QS}}$$

Fig. 1. *Agonist-antagonist ratio formula*

5.1. Agonist/antagonist ratio

Agonist/antagonist ratio average of the knee flexion/extension of the left and right lower limb is between 92-99%; hip flexion extension between 97-100%; hip abduction/adduction average between 78-88%; hip internal/external rotation average between 71-110% the higher result recorded. For the ankle plantar and dorsoflexion we have the lowest results, average between 24.50% - 33.37%. Another important aspect is that '' in lower velocities (60-180º/s), the agonist/antagonist ratio should appear as around 60%. At higher velocities (240-300º/s), this ratio increases ands should be around 70 to 80%'' [6].

Studies made by [2] have concluded that the ''agonist/antagonist ratio means below 64%, can indicate a possible muscle imbalance of the knee joint''.

5.2. Strength Deficit

Knee flexion was found to have a deficit of 0.7.% at velocity 180 °/s compared to knee extension which has 42.40% at the same velocity. In addition, ankle plantar flexion has a 8.50% strength deficit at 180 °/s and the ankle dorsoflexion deficit value is 21.10% at 120 °/s. Hip flexion it was found to have 13.10% strength deficit at 450 °/s. However another variable tested such as hip adduction presented a 16% strength deficit for velocity 120 °/s and 9.50% for velocity 450 °/s The lowest

strength deficit was recorded for the hip internal rotation.

We found significant strength deficit for hip external rotation at each velocity: 10.90% - 180 °/s; 27.80% - 300 °/s; 31.90% - 450 °/s (Figure 8).

Agonist – antagonist ratio at different velocities for Left Leg Table 1

Agonist/ antagonist ratio	Knee flexion/ extension	Hip flexion/ extension	Hip abduction/ adduction	Hip internal/ external rotation	Ankle plantar and dorsoflexion
Left leg at 60°/s					25.30%
Left leg at 120°/s					18.80%
Left leg at 180°/s	79%	104%	100%	74%	29.40%
Left leg at 300°/s	75%	102%	76%	84%	
Left leg at 450°/s	122%	95%	87%	56%	
Average	92%	100%	88%	71%	24.50%

Agonist – antagonist ratio at different velocities for Right Leg Table 2

Agonist/ antagonist ratio	Knee flexion/ Extension	Hip flexion/ Extension	Hip abduction/ Adduction	Hip internal/ external rotation	Ankle plantar and dorsoflexion
Right leg at 60°/s					20.40%
Right leg at 120°/s					38.10%
Right leg at 180°/s	65%	103%	64%	79%	41.60%
Right leg at 300°/s	129%	97%	93%	126%	
Right leg at 450°/s	104%	91%	77%	126%	
Average	99%	97%	78%	110%	33.37%

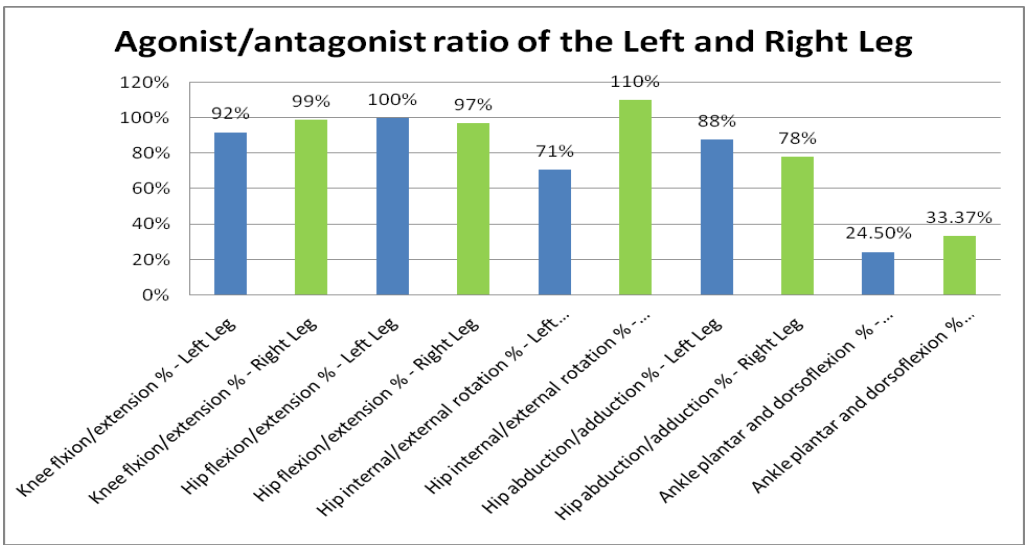


Fig. 2. *Agonist antagonist ratio of the lower limb*

Strength deficit of the internal/external rotation Table 3

Internal rotation 180 °/s	Deficit %	Stronger %	External rotation 180 °/s	Deficit %	Stronger %
	6			10.90	
Internal rotation 300 °/s	Deficit %	Stronger %	External rotation 300 °/s	Deficit %	Stronger %
	1.6			31.90	
Internal rotation 450°/s	Deficit %	Stronger %	External rotation 450°/s	Deficit %	Stronger %
		61.50		27.80	

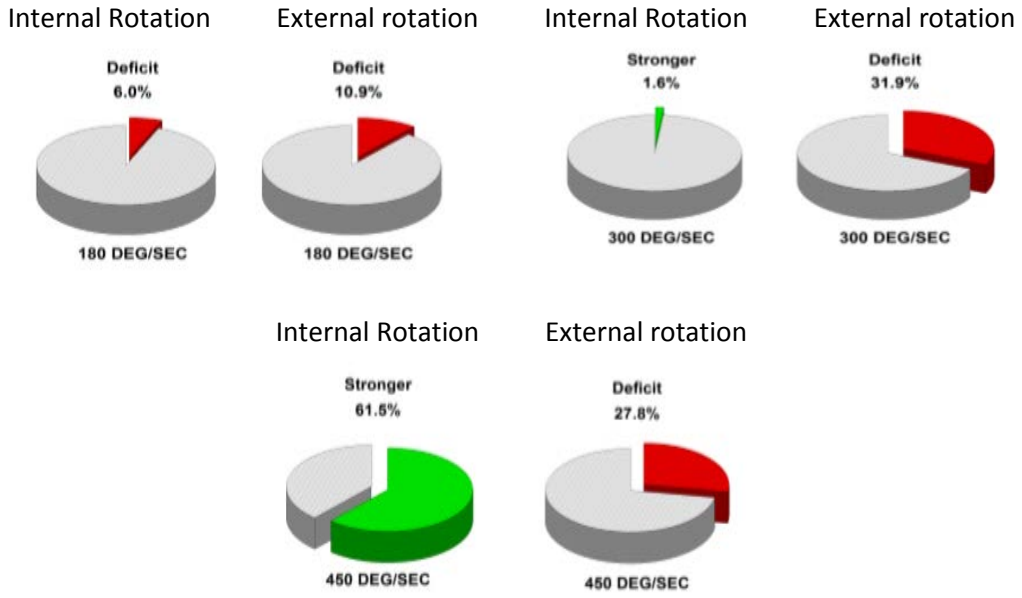


Fig. 3. *Graphical interpretation of the internal/external rotation strength deficit*

Strength deficit of the plantar flexion and dorsoflexion Table 4

Plantar Flexion 60 °/s	Deficit %	Stronger %	Dorsal Flexion 60 °/s	Deficit %	Stronger %
		17.50%			210.80%
Plantar Flexion 120 °/s	Deficit %	Stronger %	Dorsal Flexion 120 °/s	Deficit %	Stronger %
		33.80%		21.10%	
Plantar Flexion 180°/s	Deficit %	Stronger %	Dorsal Flexion 180°/s	Deficit %	Stronger %
	8.50%				156.90%

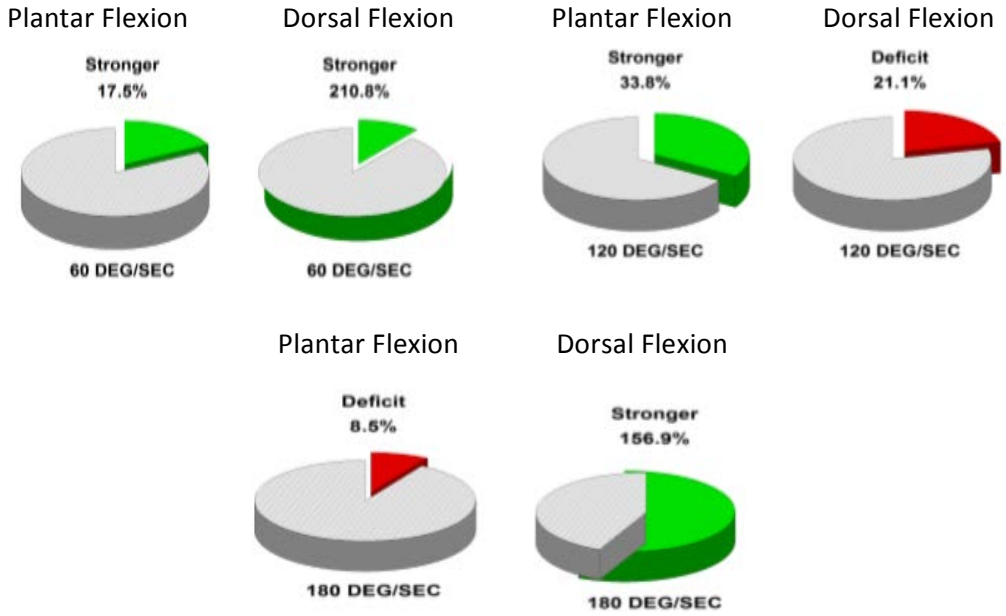


Fig. 4. *Graphical interpretation of the plantar flexion and dorsal Flexion strength deficit*

Strength deficit of the knee flexion extension Table 5

Flexion 180 °/s	Deficit %	Stronger %	Extension 180 °/s	Deficit %	Stronger %
		3.10%			26.70%
Flexion 300 °/s	Deficit %	Stronger %	Extension 300 °/s	Deficit %	Stronger %
	0.70%			42.40%	
Flexion 450°/s	Deficit %	Stronger %	Extension 450°/s	Deficit %	Stronger %
		1.20%			19.10%

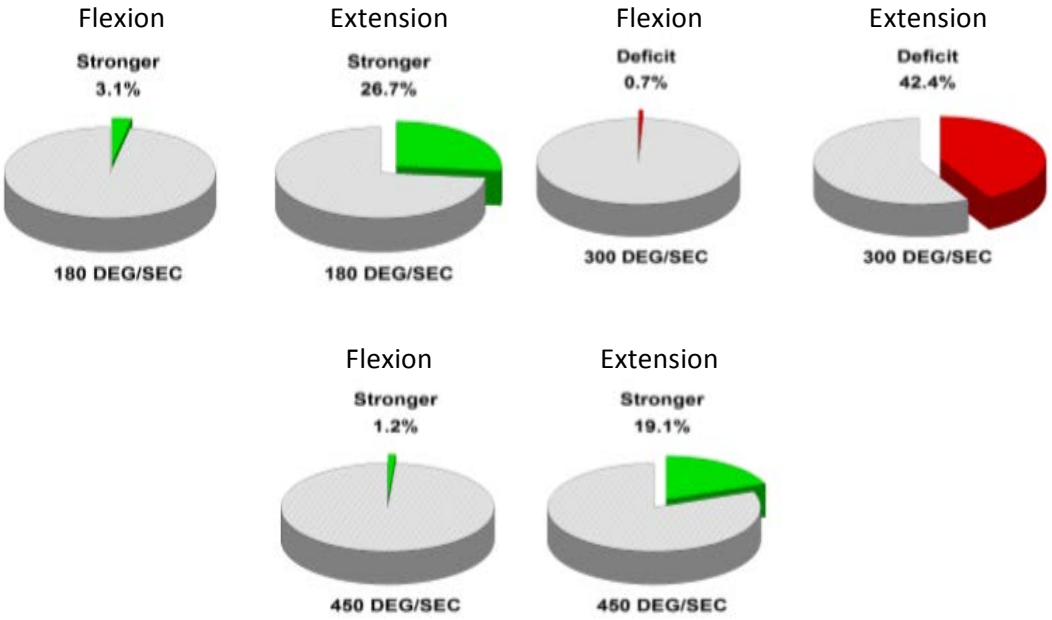
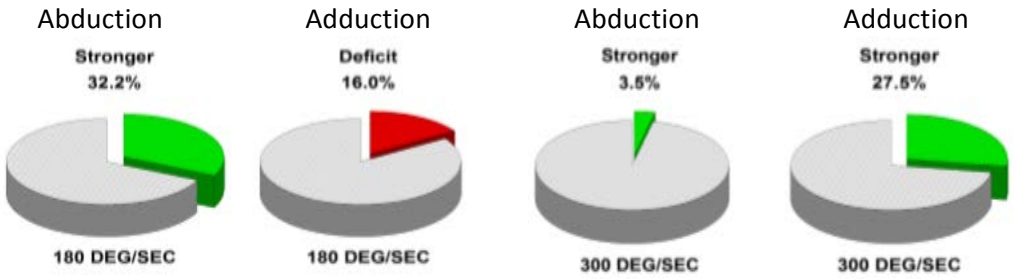


Fig. 5. *Graphical interpretation of the knee flexion and extension strength deficit*

Strength deficit of the hip abduction/adduction Table 6

Abduction 180 °/s	Deficit %	Stronger %	Adduction 180 °/s	Deficit %	Stronger %
		32.20%		16.00%	
Abduction 300 °/s	Deficit %	Stronger %	Adduction 300 °/s	Deficit %	Stronger %
		3.50%			27.50%
Abduction 450°/s	Deficit %	Stronger %	Adduction 450°/s	Deficit %	Stronger %
		2.80%		9.50%	



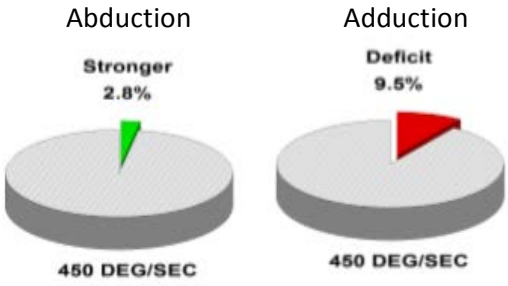


Fig. 6. *Graphical interpretation of the hip abduction/adduction strength deficit*

Strength deficit of the hip flexion/extension Table 7

Flexion 180 °/s	Deficit %	Stronger %	Extension 180 °/s	Deficit %	Stronger %
		24.90%			14.10%
Flexion 300 °/s	Deficit %	Stronger %	Extension 300 °/s	Deficit %	Stronger %
		12.50%			37.20%
Flexion 450°/s	Deficit %	Stronger %	Extension 450°/s	Deficit %	Stronger %
	13.10%				27.80%

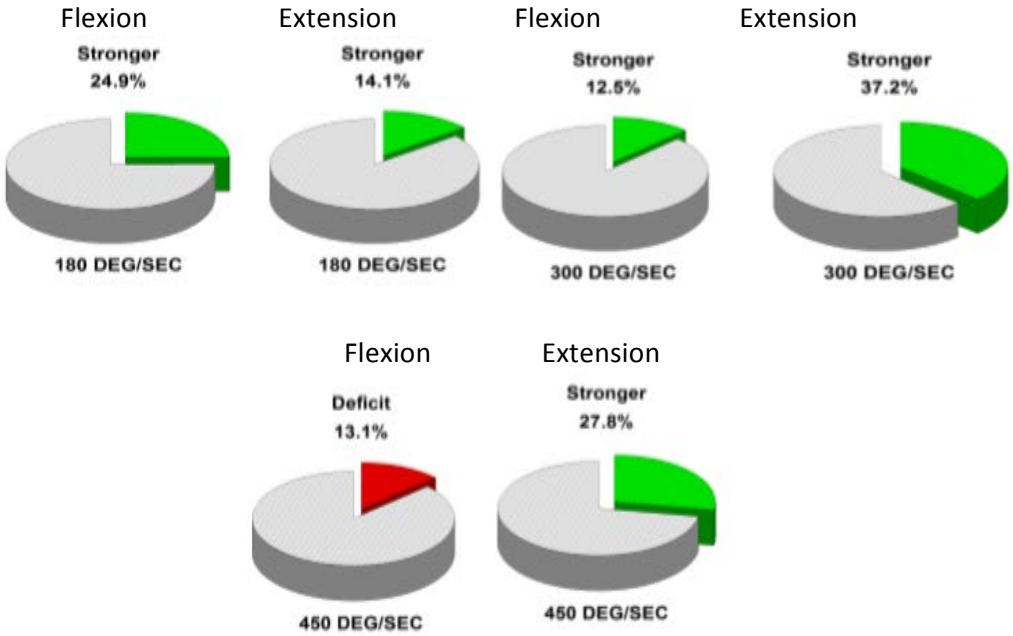


Fig. 7. *Graphical interpretation of the hip flexion/extension strength deficit*

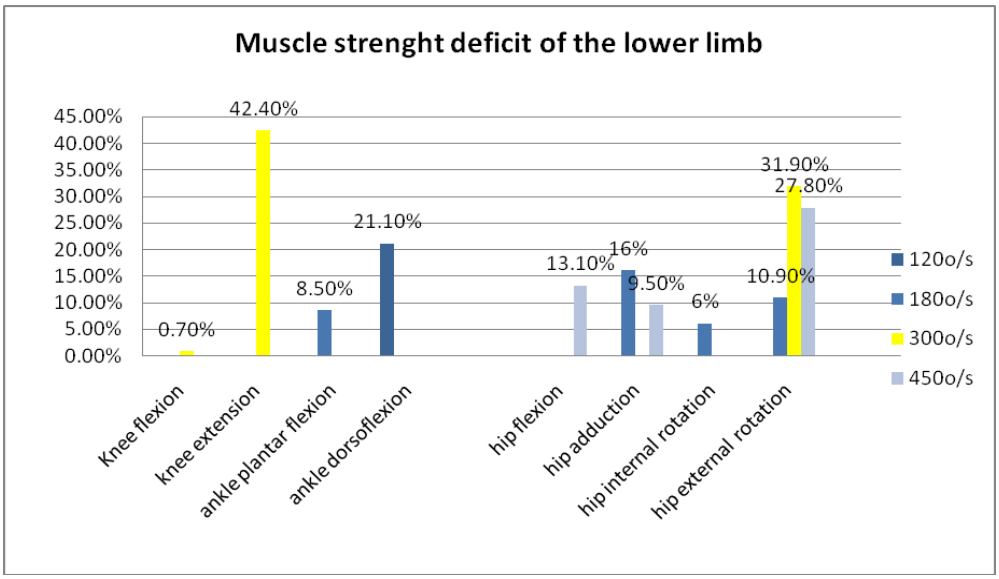


Fig. 8. *Muscle strength deficit of the variables tested*

6. Conclusions

For this athlete to improve their quick strength of knee extensors and flexors, hip extensors/ flexors, plantar / dorsal flexion, abduction/adduction of the hip, internal/external rotation of the shoulder we need to create individualized training for the reduction of the muscle imbalance.

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