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BIOMECHANIC STRATEGIES DURING THE JUMP LANDING IN WOMAN WITH AND WITHOUT PATELLOFEMORAL PAIN SYNDROME

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INTRODUCTION

Patellofemoral pain syndrome (PFPS) is one of the main consequences of biomechanical changes in lower limbs. It is common in women who have a biomechanical disorder known as "dynamic knee valgus," which is characterized by excessive hip adduction and internal rotation during weight-bearing activities.

Among the closed kinetic chain (CKC) activities, jump kinetic and kinematic evaluation has been increasingly discussed because it is a high-impact activity during which compensatory movement patterns are exacerbated, and this may facilitate the understanding of those compensations.

Few studies have analyzed the jump three-dimensional characteristics in patients with PFPS and none have evaluated the triple hop test (THT). Therefore, the aim of this study was to compare the biomechanical strategies of dynamic valgus during the first landing on the THT in women with and without PFPS.

METHODS

This case-control study with a cross sectional methodological design was conducted in the Laboratory of Human Movement Analysis, Nove de Julho University.

We selected 27 women not engaged in regular physical activity between 18 and 30 years. They were divided into two groups, 17 in the control group (CG) and 13 in the experimental group (EG), formed by participants to present pain intensity minimum 30mm on a visual analogue scale (VAS) in at least two of the following activities: prolonged sitting, climbing or descending stairs, squatting, running, and jumping.

Were used eight infrared cameras with a frequency of 100 Hz (BTS SMART-D) that were synchronized with a force plate (Kistler 9286) with a frequency of 400Hz. Retro-reflective markers were set at specific anatomic points in the body, following the Vicon Plug-in Gait® model.

After placement of the markers, volunteers became familiar with the activity. When they felt comfortable with it, they performed the test three times, always maintaining an interval of about two minutes between each attempt.

Once collected, the data were named and saved in TDF (tab delimited files) format on the BTS system and then were exported to C3D format by BTK Toolkit (Biomechanical ToolKit) 0.1.10 into Matlab 2012. The positioning of markers and processing of biomechanical models were made via Vicon Nexus Software 1.5; the Plug-in Gait model was applied. The processed data for each condition was exported to Microsoft Office Excel.

Data corresponding to the first THT landing were defined as the cycle of movement, starting at the moment when the foot hits the platform (0%) and ending at the instant when the foot leaves the platform (100%).

During the time when the cycle was extracted for analysis, the highest value was obtained for each angular articulation in all three planes of motion. The kinetic data were collected at the time of knee flexion and included the maximum value.

Under the fixed positioning of the platform in the laboratory during the jumps used for familiarization with the activity, the distances achieved by each volunteer during the first jump of the THT were collected. This distance was used for the initial positioning of the participants to that them landing in the center of the force platform, without knowing where it was.

The Kolmogorov-Smirnov test (with Lilliefors correction factor) was used to test the normality of distribution of the data collected. Descriptive statistics were presented as a mean and standard deviation (SD) for all assumed normal values of all variables. An independent t test was used to compare the descriptions of the sample (age, weight, height, BMI, and EVA) and the kinematic variables were analyzed. Statistical significance was set at 5% ($P < 0.05$). The analyses were performed using SPSS ® (Statistical Package for Social Sciences version 15.0).

RESULTS AND DISCUSSION

The kinematic strategies found in women with PFPS when compared with the control group were: high obliquity and trunk flexion, pelvic obliquity, adduction and internal rotation of the hip, and foot pronation. However, they had lower peak trunk and pelvis rotation, hip flexion, and knee and ankle dorsiflexion (Table 1).

These movements occurred at different times of the movement cycle in women in the control group. The medial rotation of the hip, knee flexion, dorsiflexion, and pronation occur prematurely and the obliquity and flexion of the trunk, pelvic obliquity, and hip adduction occur late in females with PFPS. The hip flexion showed no differences (Table 1).

The kinetic strategies were: high internal hip abductor and pronator hind foot moment and smaller internal knee extensor moment and plantar flexor in the control group (Table 1).

Our results corroborate studies that describe the biomechanical changes found in the "dynamic valgus" with regard to excessive rotation and hip adduction and pronation of the foot associated with hip and knee flexion and dorsiflexion. This is in contrast to this mechanism for tilt and trunk flexion and contralateral pelvic drop support.

It was observed that during landing, women with PFPS executed the joint sequence movements differently than those in the control group.

Initially in women with PFPS, there was hip internal rotation (~ 12% duty cycle), followed by hip flexion and adduction (~ 34%), pelvic and trunk obliquity (~ 37%), knee flexion, dorsiflexion, and pronation (~ 58%), and trunk flexion (~ 68%). While the control group started with rotation and hip adduction (~ 22%), followed by trunk and pelvic obliquity (28%), hip flexion (34%), and knee flexion, dorsiflexion, pronation, and flexion of the trunk (61%).

CONCLUSIONS

These findings suggest that high-impact activities in the mechanism of "dynamic valgus" seem to be similar to low-impact activities described in the literature, indicating that changes in muscular control of the foot, hip, pelvis, and trunk can affect the kinematics and kinetics of joints of the knee joint complex in multiple planes.

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Table 1: Means and standard deviations of the kinematic and kinetic during jumping landing in women with and without PFPS

	KINEMATIC (°)		TIME (% Cycle)			KINETIC (Nm/Kg)	
	Control	**Experimental**	**Control**	**Experimental**		**Control**	**Experimental**
TRUNK							
Tilt	31.2 ± 6.0	35.9 ± 5.1*	60.5 ± 3.7	68.5 ± 2.9***		-	-
Obliquity	(-)3.5 ± 2.4	(-)9.2 ± 2.4***	28.2 ± 1.9	38.0 ± 1.3***		-	-
Rotation	17.1 ± 5.3	11.5 ± 3.2**	-	-		-	-
PELVIS							
Tilt	34.9 ± 5.0	33.2 ± 03.2	-	-		-	-
Obliquity	4.1 ± 1.6	7.3 ± 2.0***	28.1 ± 1.5	37.8 ± 1.2***		-	-
Rotation	14.7 ± 3.0	10.9 ± 1.6***	-	-		-	-
HIP							
IR	8.9 ± 0.9	12.5 ± 3.3**	22.3 ± 1.5	12.3 ± 1.6***		-	-
Adduction	6.9 ± 0.6	10.3 ± 0.6**	33.2 ± 2.7	23.4 ± 3.1***	ABD Mom	1.8 ± 0.5	2.2 ± 0.2**
Flexion	58.6 ± 3.7	54.4 ± 5.4*	34.8 ± 3.3	35.6 ± 3.0	EXT Mom	2.9 ± 0.5	2.8 ± 0.5
KNEE							
Valgus	7.8 ± 3.0	8.3 ± 2.2	-	-		-	-
IR	14.4 ± 4.6	16.3 ± 5.1	-	-		-	-
Flexion	56.7 ± 4.9	47.8 ± 2.8***	61.8 ± 3.4	58.2 ± 3.3*	EXT Mom	2.8 ± 0.4	1.9 ± 0.3***
FOOT							
DF	32.5 ± 1.54	26.7 ± 0.8**	61.2 ± 3.8	58.2 ± 3.0*	FP Mom	2.4 ± 0.4	2.0 ± 0.3 *
Valgus	6.7 ± 2.24	10.6 ± 4.3**	61.7 ± 3.7	58.3 ± 3.1**	Varus Mom	0.4 ± 0.2	0.6 ± 0.2 *
Progression	(-) 0.08 ± 7.03	1.5 ± 12.0	-	-		-	-

ABD: Abduction; DF: Dorsiflexion; EXT: Extension; FP: Plantar Flexion; IR: Internal Rotation; Mom: Internal Moment. Obliquity down: negative values; Obliquity up: positive values. * $P < 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$. Data are mean ±SD (standard deviation)