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Letter to editor

On the evaluation of postural stability after ACL reconstruction

Dear Editor-in-chief

Anterior cruciate ligament (ACL) reconstruction surgery causes, among others, postural stability impairments. For this reason, quantification of balance is beneficial for monitoring effectiveness of rehabilitation. However, research findings comparing normal quiet stance (NQS) or one-leg stance (OLS) stability between individuals who underwent ACL reconstruction and controls are conflicting (Bonfim et al., 2003; Chmielewski et al., 2002; Harrison et al., 1994; Henriksson et al., 2001; Hoffman et al., 1999).

A factor which may be responsible for these diverse research findings is the parameter used to quantify body sway. Particularly, posturographic or stabilometry analysis is based on the behaviour of the center of pressure (CoP) during the test (Tropp and Odenrick, 1988). Previous studies in OLS have measured the standard deviation of COP relative to the baseline (Bonfim et al., 2003), the dispersion index (Harrison et al., 1994), the angle between the foot and the horizontal (Henriksson et al., 2001), the center of gravity sway (Chmielewski et al., 2002) and sway path linear mean (average distance traveled per sample interval) (Hoffman et al., 1999). The interpretation of various stabilometric parameters with respect to balance strategies is not easy and in several instances different variables may represent different mechanisms (Tropp and Odenrick, 1988). For example, two patients may show the same CoP displacement during the balance task, but a very different CoP speed. This would mean that although both patients display the same stability (in terms of CoP displacement), one of them may show a much higher number of CoP oscillations per unit of time (and therefore he/she is less stable). To our knowledge, important stability indexes such as the CoP path, CoP speed and sway area (Tropp and Odenrick, 1988) have not been examined after ACL reconstruction.

We tested postural stability in fifteen men (aged 25.9 ± 0.8 yrs) three months after ACL reconstruction (with semitendinous graft) in the right knee, on average 4.3 months after rupture and 15 controls (age 24.3 ± 0.6 yrs) after signing informed consent forms. Participants performed a 30 sec Normal Quiet Stance (NQS) test and One-Legged Stance (OLS) (foot raised above the ground above the ground with the hip and knee flexed at 90° on a pressure platform (Comex SA, 50Hz, Loran Engineering Ltd, Bologna, Italy). Subsequently, the total sway path of the CoP, average speed of CoP, the standard deviation of the CoP in anteroposterior and mediolateral axis and the sway area (Tropp and Odenrick, 1988) were calculated. The best of three trials was further analysed.

Subjective evaluation of muscle function (IDKC form) (Irrgang et al., 2001) was significantly lower ($p < 0.05$) in ACL patients (29.8 ± 13.3) than controls (89.1 ± 8.2). An example of raw platform data from an individual with ACL reconstruction is provided in Figure 1. Analysis of variance showed that individuals with ACL reconstructtion displayed statistically significant higher NQS and OLS values compared with controls ($p < 0.05$). Statistically significant ($p< 0.05$) bilateral limb differences were observed only for total COP path of the ACL patients (Table 1).

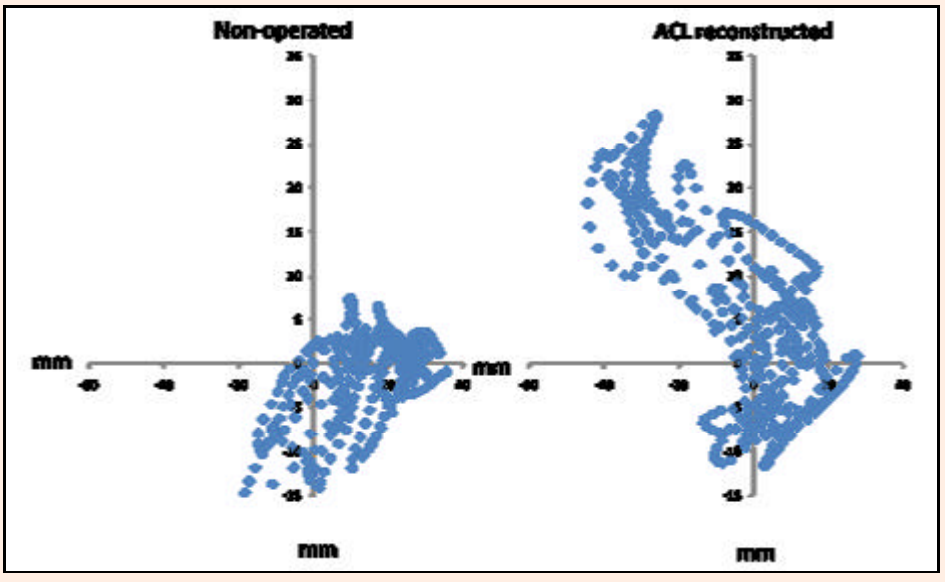

Figure 1. Typical center of pressure (CoP) path from an individual with ACL reconstruction who performed a one leg-stance test on the operated and the non-operated leg.

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Table 1. Mean (± standard deviation) of Center of Pressure (CoP) measures for individuals with ACL reconstruction (ACLr) and typical individuals (Controls) during normal quite stance and one leg stance (OLS). For each group comparison, the F-ratio resulting from the analysis of variance and the relevant p value are presented.

	ACL reconstruction		Controls		F-ratio, p value
			One leg Stance		
	Operated (Right)	Non-operated (left)	Right	Left	
CoPsd M/L (mm)	.60 (.33)	.51 (.20)	.34 (.16) *	.36 (.12)	7.64, p = .010
CoPsd A/P (mm)	.83 (.41)	.68 (.28)	.44 (.24) *	.47 (.23) *	7.69, p = .007
Total CoP path (mm)	384.5 (186.4)	304.9 (99.1) #	316.5 (89.0) *	324.4 (84.1)	12.32, p = 0.01
CoP Speed (mm/s)	20.37 (14.34)	17.21 (6.41)	12.21 (4.90) *	12.42 (5.45) *	4.87, p = .034
Sway area (mm^2)	44173 (18101)	41100 (9681)	34104 (17232) *	34184 (15684) *	5.35, p = .031
			Normal Quite Stance		
CoPsd M/L (mm)	1.58 (.11) *		.72 (.51)		6.96, p = .013
CoPsd A/P (mm)	2.30 (1.31) *		.67 (.26)		12.32, p = .01
Total CoP path (mm)	61.8 (43.0) *		29.1 (10.9)		8.69, p = .006
CoP Speed (mm/s)	2.33 (1.47) *		1.07 (.47)		9.41, p = .005
Sway area (mm^2)	6526 (4392) *		3185 (1412)		8.35, p = .007

CoPsd M/L : standard deviation of the CoP in the mediolateral axis; CoPsd A/P : standard deviation of the CoP in the anteroposterior axis; *: significantly lower compared with the same leg of the ACL group; # significant different compared with the other leg of the same group, $p < 0.05$.

As expected, our results show that operated subjects showed not only a higher CoP displacement compared with controls but they also displaced their CoP at a higher rate (Table 1). This indicates that patients in this group are particularly deficient in performing daily activities, especially the most demanding ones. This agrees with some studies (Bonfim et al., 2003) but it disagrees with others (Harrison et al., 1994; Henriksson et al., 2001; Hoffman et al., 1999).

It was interesting that, in contrast, to our expectations, no bilateral differences in postural stability were found. This is agreement with previous studies, although these studies refer to individuals measured 18 months after surgery (Harrison et al., 1994; Henriksson et al., 2001; Hoffman et al., 1999). From a practical point of view, this result means that it is difficult to use OLS scores of the unaffected leg to set the targets of rehabilitation of the affected one (Chmielewski et al., 2002). Consequently, using CoP related measures to monitor progress of the subjects should be based either on pre-post treatment changes in stability tests of the same leg or by comparing the OLS values compared with normative values obtained from controls. Our results did not show that group differences in stability depend on the type of CoP measurement. This may be due to the fact that ACL reconstruction had a large effect on stability three months after surgery. Nevertheless, it appears that ACL reconstruction impairs stability of the patients in a variety of ways.

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