GAIT BIOMECHANICS IN HIP ARTHROPLASTY PATIENTS AND CONTROL SUBJECTS: EFFECT OF BIG FEMORAL HEAD AND SURFACE REPLACEMENT PROSTHESES

[1, 4]Vicky Bouffard, [1]Julie Nantel, [1]Marc Therrien, [3]Pascal-André Vendittoli, [3]Martin Lavigne and [1, 2, 4]François Prince

[1]Laboratoire Posture-Locomotion, Centre de Réadaptation Marie Enfant, Montréal, Qc, Canada
[2] Département chirurgie, Faculté de Médecine, Université de Montréal, Montréal, Qc, Canada
[3]Département d'orthopédie, Hôpital Maisonneuve-Rosemont, Montréal, Qc, Canada
[4]Département de kinésiologie, Université de Montréal, Montréal, Qc, Canada

Email: vicky.bouffard@umontreal.ca

INTRODUCTION

Since younger patients are now more frequently affected by osteoarthritis (OA) [1] hip arthroplasty expectations have changed. Indeed, patients not only want to be relieved from pain and stiffness but also wish to return as soon as possible to a higher level of physical activity [2].

Previous studies have reported that the hip abductor muscles of patients undergoing hip arthroplasty generate less strength compared to those of healthy subjects [3, 4]. This may explain the smaller hip abductor moment measured during gait [5]. One way to compensate for weaker hip abductor strength may be by shifting the body center of mass (COM) toward the hip prosthesis joint center (HPJC). This strategy implies a reduction of the moment arm length which consequently causes a decrease in the magnitude of the hip abductor moment and of the amount of strength needed from these muscles [6].

The purposes of this study are twofold: 1) to compare the distance between the COM and the HPJC during gait, and 2) to compare two types of prostheses: big femoral head (BFH) and surface replacement arthroplasty (SRA) at 12 months post surgery.

METHODS

All patients were diagnosed with hip OA and had a surgical intervention using a posterior approach. A control group was used for comparison. Groups' characteristics are shown in Table 1.

Table 1. Means (SD) of the groups' characteristics.

	BFH (n=12)	SRA (n=12)	Control (n=11)
Age (y)	50.8 (6.1)	52.8 (6.7)	47.7 (8.2)
Gender	5 F/ 7 M	6 F/ 6 M	7 F/ 4 M
Weight (kg)	75.3 (15.3)	74.1 (15.4)	73.5 (11.3)
Height (m)	1.68 (.04)	1.67 (.08)	1.67 (.09)
BMI (kg/m^2)	26.7 (4.7)	26.3 (3.8)	26.3 (3.0)

All subjects were asked to walk at their normal speed on a 10m walkway with two embedded force platforms (120Hz). Kinematics were recorded from an 8-Vicon cameras system (60Hz). The COM position was calculated from marker positions and anthropometric tables while the distance (in mm) from HPJC and COM was calculated in the frontal plane. Distances were normalized to the inter- ASIS distance for each individual (ratio = distance COM-HPJC/ distance inter-ASIS). The coefficient of variation (CV) ((SD/ average)* 100) was also calculated. Data were extracted for three different trials at five specific moments in the gait cycle heel contact (HC), maximum weight acceptance (MWA), mid-stance (MS), push-off (PO), and toe off (TO).

The results were then analysed using a one-way ANOVA. As required, the results were further analyzed with the Kruskal-Wallis test. All analyses were done with a level of significance set at 0.05.

RESULTS AND DISCUSSION

No difference was observed for the sociodemographic data.

No statistical significance was found for the COM-HPJC distance ratio (Table 2). These results suggest that our groups were similar to the healthy subjects.

Table 2. Mean (SD) of the HPJC-COM distance ratio

	BFH	SRA	Control
HC	0.344	0.331	0.333
	(.037)	(.027)	(.025)
MWA	0.357	0.339	0.359
	(.029)	(.027)	(.032)
MS	0.359	0.339	0.358
	(.033)	(.029)	(.026)
PO	0.363	0.348	0.363
	(.032)	(.026)	(.022)
TO	0.352	0.340	0.336
	(.039)	(.031)	(.025)

No statistical difference was found for the CV (Table 3). These results show, once again, that both prostheses groups did not differ from the control subjects.

Table 3. Mean (SD) of CV in %.

	BFH	SRA	Control
HC	3.3 (2.1)	3.1 (1.9)	4.3 (3.6)
MWA	2.8 (2.0)	3.2 (2.5)	3.5 (2.1)
MS	2.5 (2.4)	2.4 (1.5)	3.1 (1.4)
PO	3.4 (2.5)	2.4 (1.6)	3.5 (1.5)
TO	3.4 (2.9)	3.4 (2.6)	4.2 (1.0)

The absence of statistical significance between the two prostheses and the control subjects during a walking task, suggest that patients did not adapt their gait strategy. In fact, they did not decrease their moment arm length, by shifting more body weight on their affected limb to reduce constraints on their prosthetic hip joint and minimize the effort of their hip abductor muscles. One year post-surgery, patients who underwent hip arthroplasty control their COM the same way as that of the control subjects.

Furthermore, the absence of statistical significance between the CV revealed that our three groups were similar. In other words, the dispersion of data is the same between groups.

CONCLUSIONS

One year following surgery, patients undergoing hip arthroplasty do not seem to adapt their gait strategy by decreasing their moment of arm length, the COM-HPJC distance, in the frontal plane to compensate for their hip abductors weakness.

In this study, the predictive method was used to calculate the hip joint center. Recently, a new method known as the functional method was developed [7]. The latter method may be more efficient in this case because it takes into consideration the individual characteristics of patients. It could have an impact on the results.

REFERENCES

1. Loeser, RF., *Osteoarthritis cartilage* **17**, 971-979, 2009.
2. Mackichan F, et al. *Rheum Dis Clin North Am* **34**, 311-330, 2008.
3. Majewski M, et al. *J Bone Joint Surg Br* **87**, 1337-1343, 2005.
4. Trudelle-Jackson E, et al. J *Orthop Sports Phys Ther* **32**, 260-267, 2002.
5. Mont MA, et al. *J Arthroplasty* **22**, 100-108, 2007.
6. Asayama I, et al. *J Arthroplasty* **20**, 414-420, 2005.
7. Ehrig RM, et al. *J Biomech*. **39**, 2798-2809, 2006.

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