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Postural balance during quiet standing in patients with total hip arthroplasty and surface replacement arthroplasty

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Abstract

Background. Primary total hip arthroplasty leads to better functional capacities but a general weakness of abductor muscles often persists. A larger head component may improve the postural balance in the medial–lateral direction. The aims of this study are (1) to compare postural stability in patients after total hip and surface replacement arthroplasties and (2) to evaluate the effect of the biomechanical reconstruction on postural stability.

Methods. Six months post-surgery, three groups of ten subjects (total hip and surface replacement arthroplasties and control) performed quiet standing tasks in both dual and one leg stance and a hip abductor muscles strength test. The root-mean-square amplitude of centre of pressure and centre of mass displacement in the anterior–posterior and medial–lateral directions were calculated for dual stance task.

Findings. Statistical analyses showed greater centre of pressure and centre of mass displacement amplitude in the medial–lateral direction during the dual stance for the total hip arthroplasty compared to the surface replacement and control subjects ($P < 0.05$). All control subjects completed the one leg stance compared to nine in the surface replacement and five in the total hip arthroplasty group. No statistical difference was found between the groups in the hip abductor muscles strength.

Interpretation. The better anatomical preservation, absence of femoral stem and the larger bearing component could account for the return to better postural stability in surface replacement patients in comparison to total hip patients. Further studies are needed to determine the impact of each of these factors on the postural balance.

Keywords: Postural control; Postural balance; Postural mechanism; Surface replacement arthroplasty; Total hip arthroplasty; Muscular strength; Femoral offset

1. Introduction

In the past, hip replacement was mostly performed in elderly sedentary population whereas in present time, patients requiring hip replacement are both increasingly young and active (Crowninshield et al., 2006). These new patients' characteristics are particularly important for the prosthesis performance and durability as well as for the reduction of later complications (Crowninshield et al., 2006). There is therefore a growing interest for the development of newer prostheses restoring better patient's anatomy (Amstutz et al., 1998; Girard et al., 2006) and physiological loading (Amstutz et al., 1998; Daniel et al.,

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2004) as well as for the development of newer surgical techniques (Asayama et al., 2006; Lawlor et al., 2005) and more durable bearing surfaces (Goldsmith et al., 2000; Harris and Muratoglu, 2005).

At the moment, two main types of hip replacements are available: the total hip arthroplasty (THA) with a standard femoral head, (head diameter of 22, 28 or 32 mm) and the surface replacement arthroplasty (SRA). The THA procedures involve patient femoral head and neck removal and replacement by an implant. It is a frequent and successful procedure that relieves pain and improves hip function as early as three to six months post-surgery (Laupacis et al., 2002). Patients' anatomy reconstruction and muscle function restoration depend on the surgeon's ability to reconstruct the hip joint (Kalteis et al., 2006; Parratte and Argenson, 2007) and the implant design (Crowninshield et al., 2006). However, because of its femoral head diameter, THA is associated with high rate of post-operative impingement, instability and dislocation (0.4–7.2%) (Berry et al., 2004; Jolles et al., 2002). In contrast, by conserving parts of the femoral head and neck, SRA has been considered to better preserve hip anatomy (Girard et al., 2006) and to offer superior clinical function (Vendittoli et al., 2006) in comparison to THA. Indeed, the restoration of hip anatomy might improve the functionality of the hip joint; particularly of the abductor muscles (Amstutz et al., 2004; Asayama et al., 2005; Girard et al., 2006).

These latter points are crucial since it has been recognized that one of the main disabilities often reported in patients after conventional THA is a general weakness of abductor muscles (Asayama et al., 2005; McGrory et al., 1995; Perron et al., 2000). Therefore, an improvement of the functionality of hip abductor muscles with SRA may have several implications in daily living activities involving upright stance postural regulation since these muscles are strongly implied in medial–lateral balance control (Winter et al., 1996). Although studies have found that balance is affected up to one year after conventional THA (Majewski et al., 2005; Nallegowda et al., 2003; Trudelle-Jackson et al., 2002), none of them have investigated the specific advantages of the SRA in comparison of the THA. Therefore, the aims of this study are (1) to compare postural stability in patients after they underwent THA or SRA (2) to evaluate the effect of the biomechanical reconstruction on postural stability.

2. Methods

2.1. Patients

A total of thirty subjects divided in three groups (10 controls without hip pathology, 10 THA and 10 SRA) participated in the study. The control subjects were volunteers recruited from the community through the Marie Enfant Rehabilitation Centre and the Maisonneuve-Rosemont Hospital. All patients had unilateral hip disease and the average follow-up of operated subjects was six months (minimum five months, maximum eight months). Exclusion criteria for all subjects included the presence of any interfering pathology that may have affected balance and reported falls for the past six months. Groups' characteristics are presented in Table 1. All participants gave their written consent and the project was approved by the research ethics and scientific committees of our institution.

Each surgery was performed through a posterior surgical approach by three experimented surgeons (P.-A.V, M.L and A.-G.R.). In the SRA group, the Durom hip-resurfacing system (Zimmer, Warsaw, USA) was implanted (Fig. 1). For the THA group, a CLS Spotorno (Zimmer, Warsaw, USA) titanium uncemented femoral stem (Zimmer) was used with a 28 mm Metasul femoral head (Zimmer) articulated with a Metasul bearing insert fitted into an Allofit uncemented acetabular cup (Zimmer, Warsaw, USA) (Fig. 2). During each procedure, the surgeons tried to reproduce patients' hip anatomy using pre-operative templating with the opposite side as a reference and using intraoperative bony landmarks. Surgical technique for all procedure has been described in previous studies (Girard et al., 2006; Vendittoli et al., 2006) .

Table 1
Characteristics of control, total hip replacement (THA) subjects and surface replacement arthroplasty (SRA)

Subjects	Control	THA	SRA
Age (y)	45.1 (10.1)	51.1 (7.8)	43.1 (8.2)
Gender	4 F/6M	5 F/5M	4 F/6M
Weight (kg)	77.3 (14.8)	85.0 (17.4)	83.7 (18.8)
Height (m)	1.71 (0.08)	1.67 (0.90)	1.69 (0.08)
BMI (kg/m^2)	26.9 (2.9)	30.7 (6.3)	29.1 (4.5)

No significant differences were observed between the groups. Means (SD), $P < 0.05$.

Fig. 1. The hybrid Durom hip surface replacement arthroplasty system with chrome–cobalt femoral head and acetabular cup (Zimmer, Warsaw, USA).