Orthopaedics & Traumatology: Surgery & Research 105 (2019) 445–452

Contents lists available at ScienceDirect

Orthopaedics & Traumatology: Surgery & Research

journal homepage: www.elsevier.com

Original article

Does the direct anterior approach allow earlier recovery of walking following total hip arthroplasty? A randomized prospective trial using accelerometry

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ARTICLE INFO

Article history:
Received 21 October 2018
Accepted 1st February 2019

Keywords:
Anterior approach
Posterior approach
Total hip arthroplasty
Gait
Functional scores

ABSTRACT

Introduction: In total hip arthroplasty (THA), the anterior approach is attractive, being intermuscular, with theoretic functional benefit. Such benefit has been frequently claimed, but there are few data from randomized comparative studies using more precise metrics than patient satisfaction. We therefore conducted a randomized trial comparing early functional results between anterior and posterior approaches on gait analysis and functional scores.

Hypothesis: The study hypothesis was that there is no difference between the two approaches in terms of early recovery of walking.

Materials and method: A single-center single-surgeon prospective randomized study was conducted between February 2017 and April 2018. Inclusion criteria comprised: age < 85 years, body-mass index (BMI) < 32, and hip osteoarthritis with indication for THA. Preoperatively, the 2 groups were comparable for age, gender, BMI, Charnley, Harris, Postel-Merle-d'Aubigné and Oxford-12 scores and locomotor parameters (triaxial acceleration, step regularity and walking power). Preoperative and 3-, 6- and 12-week assessment comprised triaxial acceleration in walking and Postel-Merle-d'Aubigné, Harris and Oxford SF-12 scores.

Results: One hundred patients were randomized to the anterior approach (AA: $n = 50$) and posterior approach (PA: $n = 50$) groups. Hospital stay was comparable between groups: PA, 2.8 ± 1.78 days [range, 2.29-3.31 days]; AA, 2.84 ± 1.25 days [range, 2.48-3.2 days] ($p = 0.8$). Operative time was significantly longer in AA: 70.1 ± 11 minutes vs. 56.7 ± 11.79 ($p < 0.0001$). There were no significant differences in locomotor parameters (p 0.122 to 0.987) or functional scores (p 0.052 to 0.968) over the 3-month follow-up. There was no difference in cup inclination: PA, 39.6 ± 6.87° [range, 37.65-41.55°] vs. AA, 37.74 ± 4.2° [range, 36.55-38.93°] ($p = 0.09$). There were 8/50 cases (16%) of neurapraxia of the lateral cutaneous nerve of the thigh in the AA group; rates for other complications did not differ between groups.

Conclusion: Early functional results and especially objective locomotor parameters following THA were comparable between anterior and posterior approaches at 3 to 12 weeks. The approach should be chosen according to the surgeon's experience.

Level of evidence: II, low-power prospective randomized study.

1. Introduction

Total hip arthroplasty (THA) is effective and reproducible, providing functional recovery, pain relief and improved quality of life. Around 150,000 THAs are performed per year in France [1], and the number can be expected to increase over coming decades as the population ages [1]. Various surgical approaches have been described. The posterior approach (PA) is classical, but Hueter's anterior approach (AA) has met with renewed interest, being anatomically attractive and having theoretic functional advantages [2].

The literature reports contradictory findings. In a meta-analysis of the 2 approaches, Higgins et al. [2] found no superiority, notably in terms of early functional results, which, however, are often

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https://doi.org/10.1016/j.otsr.2019.02.008
1877-0568/

highlighted by AA advocates. There have in fact been few randomized trials, and assessment was often based on patient satisfaction, without objective evaluation of benefit [2].

We therefore conducted a randomized study comparing early functional results between AA and PA, with measurement of triaxial acceleration during walking on a Locometrix^{TM} accelerometer, an easy-to-use device compared to other gait analysis systems, and 3 reference functional scores. The study hypothesis was that the 2 approaches do not differ in terms of early recovery of walking.

2. Materials and method

2.1. Patients

A single-center prospective study involved a single surgeon experienced in the posterior approach and also using the anterior approach for some 10 years. One hundred and eight of the 167 patients on the surgeon's schedule were included in the prospective randomized study conducted from February 2017 to April 2018. Inclusion criteria comprised: age < 85 years, body-mass index (BMI) < 32 kg/m^2, and symptomatic hip osteoarthritis with indication for THA. Eligible patients agreeing to participate signed an informed consent form after information on the study procedure. The trial was registered under RCB ID n° 2017-A02875-48 after review board approval (registered with the Clinical Research and Innovation Delegation under n° PI2017-843-0023).

Exclusion criteria comprised: patients not meeting the inclusion criteria, not complying with the follow-up protocol, without health insurance cover, with significant cognitive impairment, with musculoskeletal disease or unable to walk without assistance.

Patients were randomized to the AA and PA groups using the Randomizer for Clinical Trial software (Medsharing, Fontenay-sous-Bois, France).

2.2. Methods

PA was Moore's posterolateral approach, sparing the quadratus femoris muscle but not the piriformis, with transosseous reinsertion of the pelvitrochanteric muscles and capsule. AA was Hueter's anterior approach, performed with the patient supine on the traction table, without intraoperative radioscopic control.

Choice of implants, fixation and bearing was at the surgeon's discretion. Preoperative planning used 100%-scale standard radiographs aided by implant templates. The perioperative protocol was the same in both groups. Preoperatively, patients were encouraged to attend an information meeting to prepare for the operation.

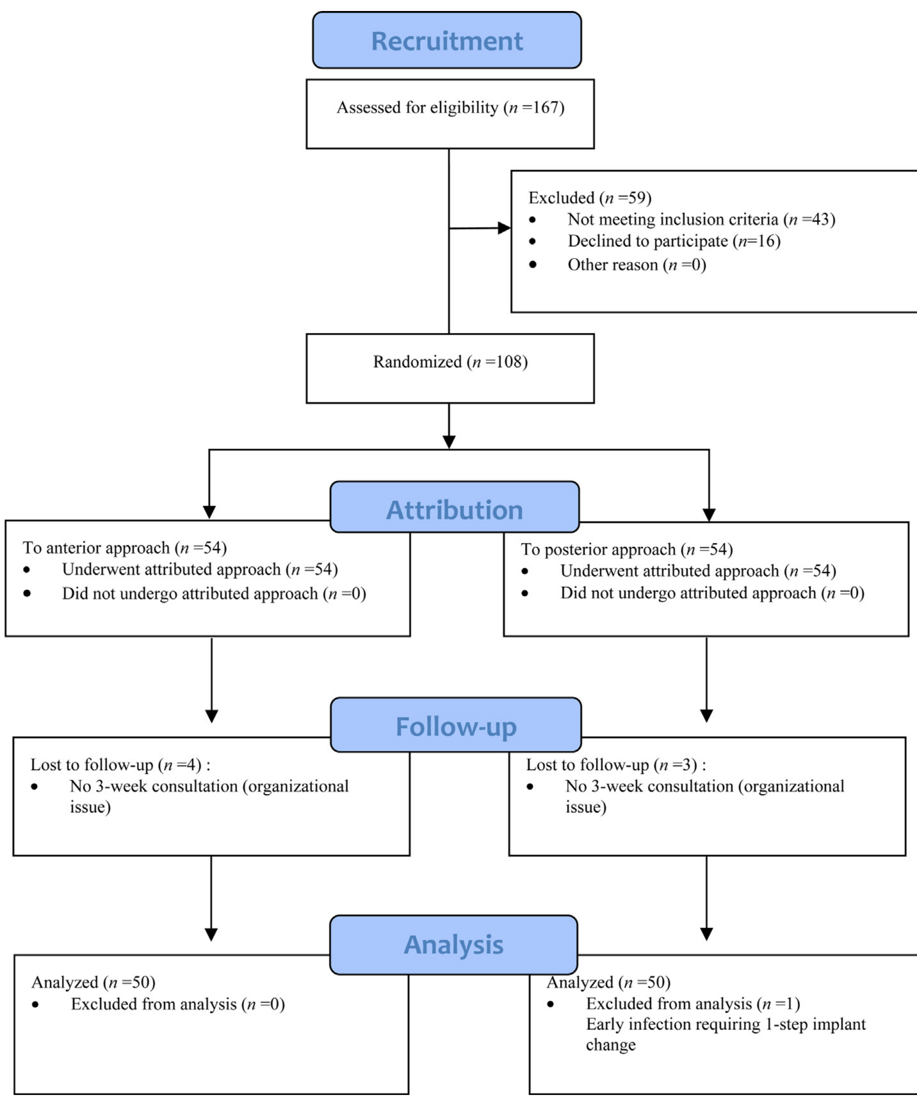

Fig. 1. CONSORT recruitment flowchart.

Intraoperatively, local injection of anti-inflammatories (ketoprofen 100 mg/4 mL) and step-3 analgesics (ropivacaine 200 mL at 2 mg/mL) was administered. Tranexamic acid was injected at induction, end of surgery and 5 hours after. Postoperatively, patients were raised during the first evening. Discharge was authorized, generally on postoperative day 2, only if walking and unassisted climbing up and down stairs was possible. Fifteen physiotherapy sessions were prescribed; rehabilitation in a residential center was authorized only for patients living alone.

2.3. Assessment

Perioperative changes in dynamic gait parameters were analyzed on triaxial accelerometry close to the subject's center of gravity (Locometrix, Centauremetrix, Evry, France) [3–5]. The device was positioned dorsally at lumbar levels 3 and 4. Data were recorded in a single corridor to analyze 20 seconds' stabilized gait: rhythm, regularity, mediolateral instability, and power in the craniocaudal, anteroposterior and mediolateral planes and total power.

Perioperative changes in the 3 reference functional scores (Harris [6], Postel-Merle-d'Aubigné [7] and the self-reported Oxford-12) were also analyzed [8,9], along with the Lequesne algofunctional index [10] to assess preoperative osteoarthritis severity. Assessments were conducted the day before surgery and at 3, 6 and 12 weeks.

Other parameters comprised cup inclination, global offset measured radiologically by 2 independent observers, and onset of complications within 3 months. Cup anteversion was not studied, as it is difficult to analyze reliably and reproducibly on plain X-ray.

2.4. Statistics

Statistical analysis used SPSS 23.0 software (IBM, Bois-Colombes, France). Normal distribution was checked on Shapiro-Wilk test. The Student test was used to compare independent quantitative variables: mean functional scores and gait analysis data. The Chi^2 test with Yates correction or Fisher test as appropriate were used to compare qualitative variables: demographic data, implant distribution and Harris subscores. With step regularity as criterion, bilateral alpha risk of 5% and 90% power, each group required at least 39 subjects. As the study was to be conducted over an extended period of time, 25% attrition was anticipated, and group size was set at > 49.

3. Results

Four AA and 3 PA subjects were excluded for missing the first postoperative consultation (due to organizational issues). One further PA subject was excluded following early infection requiring 1-step implant exchange. Finally, each group comprised 50 subjects (Fig. 1).

The groups were comparable for all preoperative parameters: demographic data, gait analysis and functional scores (Table 1).

Operative time was significantly longer in the AA group ($p < 0.0001$). Hospital stay was similar in both groups ($p = 0.897$), as was the post-operative rehabilitation conditions. Dual mobility X.NOV X.CUP MOB™ cups predominated in the PA group ($p < 0.0001$) and Mathys RM Pressfit™ cups in the AA group ($p < 0.0001$). Cup inclination was comparable between groups ($p = 0.0993$). Global offset was restored comparably between groups (Table 2).

Postoperatively, locomotor parameters (rhythm, regularity, power in the 3 planes and mediolateral instability) showed no intergroup difference in recovery of walking at 3, 6 and 12 weeks (Table 3).

There were no significant intergroup differences in the 3 scores, including Harris subscores (notably, pain, walking distance and global function), at the various postoperative time-points (Table 4).

The rate of neurapraxia of the lateral cutaneous nerve of the thigh was 8/50 (16%) in AA and zero in PA. One anterior dislocation occurred in the AA group, before week 2, occasioned by trauma in a very active patient with excellent postoperative results. Other complications did not differ between groups (Table 5).

Table 1
Preoperative data.

Variables (mean ± standard deviation [95%CI][b])	Posterior approach	Anterior approach	*p*-value
Age (years)	68.98 ± 7.93 [66.73-71.23]	67.26 ± 10 [64.42–70.1]	0.3432
Male/female	23/27	21/29	0.8403
BMI (kg/m^2)	26.69 ± 3.12 [25.8–27.58]	26.46 ± 3.58 [25.44-27.47]	0.7311
Right side[a]	20 (40%)	28 (56%)	0.1612
Charnley			
A[a]	25 (50%)	28 (56%)	0.6886
B[a]	15 (30%)	18 (36%)	0.6706
C[a]	10 (20%)	4 (8%)	0.1496
Lequesne algofunctional index(0–24) [10]	13.7 ± 4.29 [12.48–14.92]	13.1 ± 3.98 [11.92–14.18]	0.4343
Postel Merle d'Aubigné (0–18) [7]	11.66 ± 2.51 [10.95-12.37]	11.62 ± 2.21 [10.99-12.25]	0.9328
Harris Hip Score [6]			
Stairs normally[a]	36 (72%)	37 (74%)	1
Distance unrestricted[a]	3 (6%)	9 (18%)	0.1239
Shoes and socks easily[a]	4 (8%)	9 (18%)	0.2343
Unassisted walking[a]	31 (62%)	30 (60%)	1
Pain (0-44)	19 ± 7.07 [16.99–21.01]	18.2 ± 8 [15.93–20.47]	0.5975
Function (0–46)	26.9 ± 10.53 [23.91-29.89]	28.16 ± 11.16 [24.99-31.33]	0.5628
Total (0–100)	52.31 ± 13.06 [48.6-56.03]	54.04 ± 14.94 [49.79–58.28]	0.5410
Oxford SF12 (0–48) [8,9]	20.72 ± 7.69 [18.54-22.9]	20.86 ± 7.66 [18.68–23.04]	0.9275
Locometrix™			
Rhythm (Hz)	0.84 ± 0.19 [0.78–0.89]	0.84 ± 0.17 [0.79–0.89]	0.8220
Regularity (no unit)	145.18 ± 57.09 [128.95-161.41]	145.92 ± 57.77 [129.5–162.34]	0.9488
Craniocaudal power (W/kg)	1.44 ± 1.08 [1.13–1.74]	1.42 ± 0.86 [1.18–1.66]	0.9389
Anteroposterior power (W/kg)	0.89 ± 0.63 [0.71–1.07]	0.93 ± 0.56 [0.77–1.09]	0.7251
Mediolateral power (W/kg)	0.94 ± 0.75 [0.73–1.16]	0.96 ± 0.65 [0.78–1.15]	0.8838
Mediolateral instability (no units)	29.48 ± 8.58 [27.04-31.92]	30.2 ± 8.98 [27.65–32.75]	0.6827
Total power (W/kg)	3.27 ± 2.33 [2.61–3.93]	3.32 ± 1.87 [2.78–3.85]	0.9331

[a] N (%).
[b] 95% confidence interval.

Table 2
Perioperative data.

Variables (mean ± standard deviation [95%CI][b])	Posterior approach	Anterior approach	*p*-value
Surgery time (minutes)	56.7 ± 11.79 [53.35–60.05]	70.1 ± 11 [66.99–73.25]	< 0.0001
Hospital stay (days)	2.8 ± 1.78 [2.29–3.31]	2.84 ± 1.25 [2.48–3.2]	0.8970
Postoperative course			
Home[a]	41 (82%)	40 (80%)	1
Rehabilitation center[a]	9 (18%)	10 (20%)	1
Femoral implants			
Cemented[a]	7 (14%)	7 (14%)	1
Non-cemented[a]	43 (86%)	43 (86%)	1
Non-cemented acetabular implants			
XNOV X.CUP MOB™[a]	30 (60%)	1 (2%)	< 0.0001
XNOV X.CUP™[a]	18 (36%)	14 (28%)	0.5201
MATHYS RM Pressfit™[a]	1 (2%)	35 (70%)	< 0.0001
Cup inclination (°)	39.6 ± 6.87 [37.65–41.55]	37.74 ± 4.2 [36.55–38.93]	0.0993
Global offset (mm)			
Preoperative	82.9 ± 9.78 [80.12–85.68]	80.4 ± 8.24 [78.06–82.74]	0.1700
Postoperative	83.58 ± 8.43 [81.18–85.98]	81.34 ± 7.71 [79.15–83.53]	0.1689

[a] N (%).
[b] 95% confidence interval.

Table 3
Postoperative gait data–Locometrix™.

Variables (mean ± standard deviation [95%CI][a])	Week 3		
	Posterior approach	Anterior approach	*p*-value
Rhythm (Hz)	0.82 ± 0.17 [0.77–0.87]	0.83 ± 0.17 [0.78–0.87]	0.8743
Regularity (no unit)	133.44 ± 49.55 [128.95–161.41]	148.16 ± 44.88 [135.41–160.1]	0.1228
Craniocaudal power (W/kg)	1.11 ± 0.59 [0.94–1.27]	1.12 ± 0.54 [0.97–1.28]	0.8856
Anteroposterior power (W/kg)	0.77 ± 0.45 [0.64–0.89]	0.81 ± 0.4 [0.69–0.92]	0.6349
Mediolateral power (W/kg)	0.75 ± 0.47 [0.62–0.89]	0.78 ± 0.51 [0.63–0.93]	0.7727
Mediolateral instability (no units)	28.44 ± 6.93 [26.47–30.41]	28.16 ± 7.55 [26.01–30.31]	0.6827
Total power (W/kg)	2.62 ± 1.42 [2.22–3.03]	2.71 ± 1.33 [2.33–3.09]	0.7513
Variables (mean ± standard deviation [95%CI][a])	Week 6		
	Posterior approach	Anterior approach	*p*-value
Rhythm (Hz)	0.9 ± 0.14 [0.86–0.94]	0.9 ± 0.11 [0.87–0.93]	0.9876
Regularity (no unit)	171.94 ± 55.7 [156.11–187.77]	173.54 ± 54.13 [158.16–188.92]	0.8845
Craniocaudal power (W/kg)	1.68 ± 0.89 [1.43–1.94]	1.63 ± 0.87 [1.38–1.87]	0.7515
Anteroposterior power (W/kg)	1.1 ± 0.59 [0.93–1.27]	1.05 ± 0.54 [0.9–1.21]	0.6876
Mediolateral power (W/kg)	1.03 ± 0.64 [0.85–1.21]	0.98 ± 0.64 [0.8–1.16]	0.6839
Mediolateral instability (no units)	27.08 ± 7.48 [24.95–29.21]	26.64 ± 6.92 [24.67–28.61]	0.7608
Total power (W/kg)	3.76 ± 1.89 [3.22–4.29]	3.66 ± 1.85 [3.13–4.19]	0.7958
Variables (mean ± standard deviation [95%CI][a])	Month 3		
	Posterior approach	Anterior approach	*p*-value
Rhythm (Hz)	0.94 ± 0.1 [0.91–0.96]	0.93 ± 0.12 [0.9–0.96]	0.7544
Regularity (no unit)	190.78 ± 57.31 [174.49–207.07]	192 ± 63.34 [174–210]	0.9198
Craniocaudal power (W/kg)	1.97 ± 1.1 [1.66–2.28]	1.95 ± 0.98 [1.67–2.23]	0.9146
Anteroposterior power (W/kg)	1.26 ± 0.62 [1.09–1.44]	1.31 ± 0.63 [1.13–1.48]	0.7250
Mediolateral power (W/kg)	1.23 ± 0.77 [1.01–1.45]	1.27 ± 0.82 [1.03–1.5]	0.8213
Mediolateral instability (no units)	26.66 ± 8.23 [24.32–29]	27.22 ± 8.13 [24.91–29.53]	0.7329
Total power (W/kg)	4.44 ± 2.23 [3.81–5.07]	4.51 ± 2.17 [3.89–5.13]	0.8764

N (%)
[a] 95% confidence interval.

4. Discussion

In view of the scarcity of randomized comparative studies using more precise metrics than patient satisfaction, we conducted a prospective randomized trial associating reference scores and locomotion analysis. Analysis of gait parameters during the first 3 months failed to demonstrate superiority for either the AA or the PA approach. This was in agreement with previous comparative studies using spatiotemporal gait analysis [11–15], and notably the recent prospective comparative study by Taunton et al. [15], with 101 patients, which found no significant difference in gait monitoring results as of the second postoperative month. Only Zhao et al. [16] found superiority for AA in terms of gait at 3 months, but gait analysis results were not detailed and no data were collected before month 3 in their prospective randomized study with 20 patients [16]. Some authors suspect the anterior approach might have negative impact on posture. Van Driessche et al. [17] and Bernard et al. [18] stressed the importance of trauma induced by the retractors or by simply ligating the anterior circumflex artery onto the tensor fasciae latae or sartorius muscle, in which postoperative amyotrophy greatly impairs posture.

In the present study, there were no significant differences in Harris scores during the first 3 months, including analysis of the various subscores. Most other studies likewise found no differences in Harris scores over comparable periods [19–22]. Taunton et al. [15] reported 2-month Harris scores of 95 ± 6 for

Table 4
Postoperative data.

Variables (mean ± standard deviation [95%CI][b])	Week 3		
	Posterior approach	Anterior approach	*p*-value
Time to consultation (days)	21.22 ± 3.58 [20.2–22.24]	20.94 ± 3.1 [20.06–21.82]	0.3386
Postel Merle d'Aubigné (0–18) [7]	14.38 ± 2.13 [13.78–14.98]	14.4 ± 2.86 [13.59–15.21]	0.9685
Harris Hip Score [6]			
Stairs normally[a]	44 (88%)	45 (90%)	1
Distance unrestricted[a]	4 (8%)	8 (16%)	0.3559
Shoes and socks easily[a]	9 (18%)	18 (36%)	0.0715
Unassisted walking[a]	15 (30%)	16 (32%)	1
Pain (0–44)	29.88 ± 9.34 [27.23–32.53]	30.6 ± 9.22 [27.98–33.22]	0.6989
Function (0–46)	28.86 ± 10.55 [25.86–31.86]	30.68 ± 10.4 [27.73–33.64]	0.3872
Total (0–100)	68.13 ± 14.6 [63.98–72.28]	69.46 ± 15.39 [65.09–73.84]	0.6580
Oxford SF12 (0–48) [8,9]	31.08 ± 7.8 [28.36–33.3]	32.86 ± 8.59 [30.42–35.3]	0.2807
Variables (Mean ± standard deviation [95%CI][b])	Week 6		
	Posterior approach	Anterior approach	*p*-value
Time to consultation (days)	43.7 ± 6.85 [41.75–45.65]	43.8 ± 6.9 [41.83–45.73]	0.4768
Postel Merle d'Aubigné (0–18) [7]	16.0 ± 1.5 [15.36–16.28]	15.9 ± 1.8 [15.69–16.67]	0.7029
Harris Hip Score [6]			
Stairs normally[a]	49 (98%)	49 (98%)	1
Distance unrestricted[a]	15 (30%)	18 (36%)	0.6706
Shoes and socks easily[a]	19 (38%)	23 (46%)	0.5433
Unassisted walking[a]	34 (68%)	39 (78%)	0.3676
Pain (0–44)	34.64 ± 8.2 [32.31–36.97]	37 ± 8.44 [34.6–39.4]	0.1592
Function (0–46)	36.28 ± 8.97 [33.73–38.83]	37.18 ± 8.3 [34.82–39.54]	0.6036
Total (0–100)	80.37 ± 13.38 [76.57–84.17]	83.52 ± 13.44 [79.7–87.33]	0.2433
Oxford SF12 (0–48) [8,9]	36.82 ± 6.89 [34.86–38.78]	38.42 ± 8.23 [36.08–40.76]	0.2946
Variables (Mean ± standard deviation [95%CI][b])	Month 3		
	Posterior approach	Anterior approach	p-value
Time to consultation (days)	92.14 ± 8.31 [89.78-94.5]	91.8 ± 7.8 [89.57-94.03]	0.4169
Postel Merle d'Aubigné (0-18) [7]	17.4 ± 0.8 [17.12-17.56]	16.6 ± 2.2 [16.76-17.48]	0.0520
Harris Hip Score [6]			
Stairs normally[a]	49 (98%)	48 (96%)	1
Distance unrestricted[a]	28 (56%)	34 (68%)	0.3029
Shoes and socks easily[a]	34 (68%)	35 (70%)	1
Unassisted walking[a]	40 (80%)	39 (78%)	1
Pain (0-44)	40.16 ± 6.11 [38.42-41.9]	39.6 ± 7.55 [37.45-41.75]	0.6844
Function (0-46)	41.12 ± 6.52 [39.27-42.97]	40.8 ± 7.4 [38.7-42.9]	0.8190
Total (0-100)	91.3 ± 9.48 [[88.6-93.99]	89.95 ± 12.73 [86.33-93.56]	0.5490
Oxford SF12 (0-48) [8,9]	43.64 ± 5.41 [42.1-45.18]	43.4 ± 6.77 [[41.48-45.32]	0.8452

[a] N (%).
[b] 95% confidence interval.

Table 5
Postoperative complications.

Type of complication	Posterior approach	Anterior approach	*p*-Value
Dislocation	0	1 (2%)	1
Neurapraxia of lateral cutaneous nerve	0	8 (16%)	0.0058
Operative site infection	1 (2%)	0	1
Intraoperative fracture	0	0	1
Thromboembolic	0	1 (2%)	1

the anterior and 92 ± 8 for the posterior approach ($p = 0.07$). Zhao et al. [16], in contrast, found significantly better scores for the anterior approach at 3 months ($p = 0.04$). Barret et al. [23] likewise reported better total Harris score ($p < 0.0001$), better function ($p = 0.0027$), easier putting on of shoes and socks ($p < 0.0001$) and climbing stairs ($p = 0.0023$) with the anterior approach at 6 weeks. Throughout the first 3 months, a greater percentage of patients were able to walk without restricted distance in the AA group (p= 0.026) [23]; other scores displayed no significant differences over this period. Cheng et al. [24] likewise reported no significant differences in Oxford SF12 scores at 2 weeks, 6 weeks or 3 months; nor did Taunton et al., at 2 months [15] (Tables 4 and 6).

In the present series, operative times were shorter in AA, in contrast with the surgeon's experience. Hospital stay did not differ according to approach. Higgins, on the other hand, in a meta-analysis, found no significant difference in operative time (7.9 minutes; 95% CI: -1.8 to 17.7 minutes), while hospital stay was significantly shorter with an anterior approach (-0.53 days; 95% CI: -1.01 to 0.04 days) [2]. That no difference emerged for cup inclination is in agreement with the literature [2,16,24–26]. Complications rates were similar between the two groups, as in most reports [21,23,27,28]. Neurapraxia of the lateral cutaneous nerve of the thigh is, however, specific to the anterior approach [13,24,29], and probably still underestimated [30] due to the wide anatomic variations in this nerve [31]. The case of dislocation in the AA group occurred earlier than week 2, following trauma in a very active patient who had had excellent postoperative results.

Table 6
Main literature results within 3 months for scores used in the present study.

Study (date)	Sample size (PA/AA)	Functional scores	Follow-up	Significant differences (PA/AA)	*p*-value	Superiority
Prospective randomized studies						
Tauton et al. [15]	49/52	Harris Hip Score	2 months	Total		None
				92 ± 8/95 ± 6	0.07	
		Oxford SF12	2 months	Total		None
				42 ± 8/45 ± 10	0.12	
Cheng et al. [24]		Oxford SF12	2 weeks	Total		None
				26.8 ± 1.5/28.5 ± 1.56	0.44	
			6 weeks	Total		None
				37.3 ± 1.01/39.8 ± 1.05	0.1	
			3 months	Total		None
				42.8 ± 0.84/43.8 ± 0.87	0.14	
Rykov et al. [19]	23/23	Harris Hip Score	6 weeks	Total		None
				90 ± 9.14/93 ± 10.87	0.36	
Zhao et al. [16]	60/60	Harris Hip Score	3 months	Total		AA
				79.6 ± 11.87/85.9 ± 17.36	0.04	
Christensen et al. [20]	23/28	Harris Hip Score	6 weeks	Total (results not shown)	> 0.05	None
				Distance unrestricted[a]		None
				5 (22%)/4 (14%)	0.71	
				Stairs normally[a]		None
				7 (30%)/8 (29%)	> 0.99	
				Shoes and socks easily[a]		None
				9 (39%)/12 (43%)	> 0.99	
Barret et al. [23]	44/43	Harris Hip Score	6 weeks	Stairs normally[a]		AA
				7 (18%)/21 (50%)	0.0023	
				Distance unrestricted[a]		AA
				17 (55%)/34 (81%)	0.0005	
				Shoes and socks easily[a]		AA
				1 (3%)/28 (67%)	< 0.0001	
				Pain		None
				38.4 ± 5.4/39.8 ± 4.4	0.2056	
				Function		AA
				25.5 ± 5.3/28.7 ± 3.7	0.0027	
				Total		AA
				81.4 ± 9.8/89.5 ± 8.1	0.0001	
			3 months	Distance unrestricted[a]		AA
				28 (74%)/33 (94%)	0.0260	
				Other	> 0.05	None
Taunton et al. [22]	27/27	Harris Hip Score	3 weeks	Pain		None
				44/44	0.432	
				Function		None
				32/37.5	0.08	
				Total		None
				81/86.5	0.085	
			6 weeks	Pain		None
				44/44	0.224	
				Function		None
				43/45	0.079	
				Total		None
				93/97	0.135	
Prospective non-randomized study						
Rodriguez et al. [21]	60/60	Harris Hip Score	2 weeks	Total		None
				64 ± 9.4/69 ± 13	0.09	
			6 weeks	Total		None
				80 ± 11/83 ± 12	0.13	
			3 months	Total		None
				88 ± 10/89 ± 10	0.29	

PA: posterior approach; AA: anterior approach.
[a] N (%).

Study bias was minimized by the prospective randomized and single-surgeon design. There were, however, some limitations. 1) To be interpretable, Locometrix™ data have to be based on stabilized gait; initial swing and the slow-down in final swing were therefore excluded. Moreover, the apparatus cannot deal with walking assisted by a frame, crutch or cane, and such patients had to be excluded from gait analysis. 2) Identical autonomy criteria were required for discharge, but no immediate postoperative analysis was made, with data being first collected at postoperative week 3. Special attention should be paid to the possible benefit of the anterior approach during the first postoperative days, before the 3-week time-point, which is already too late for any difference to appear. In the study by Taunton et al. [15], patients operated on by an anterior approach gave up walking aids a mean 7 days earlier than with a posterior approach (day 17 ± 8 vs. 24 ± 14; $p = 0.04$), bearing out this hypothesis. We were unable to collect such data, for organizational reasons and the confusion bias such early analysis would have entailed: with whichever approach, patients were unable to walk for the distance required by locomotion analysis until the third postoperative week. 3) Analgesic intake and blood loss were not measured, whereas for some authors the benefit of the anterior approach is found in the early postoperative period, especially in terms of pain [23,32]. Intraoperative injections further biased the early results, masking the postoperative pain induced by the respective approaches. Over the first 3 weeks, however, other authors reported no functional superiority according to approach

[21,24]. In the short term, these benefits are thus far from certain. 4) The groups were not comparable for cup characteristics in terms of the proportion of dual-mobility models, and it can therefore not be affirmed with certainty that the results depended entirely on the approach, especially as regards dislocation. On the other hand, the wide diameter of dual-mobility cups did not seem to impact walking kinematics [33] or functional improvement [34,35].

5. Conclusion

The study hypothesis was confirmed: early functional results in THA with Hueter's anterior approach were comparable to those for a posterior approach in non-obese patients. The supposed functional advantages of the anterior approach seem uncertain. If they exist, they are slight, early and transient. It would therefore be worth undertaking a prospective randomized study comparing results between the two approaches during the first 3 postoperative weeks. The choice of approach seems finally to be a matter of the individual surgeon's experience.

Disclosure of interest

The authors declare that they have no competing interest.

Elsewhere, P Mertl receives fees from Stryker, DePuy, Zimmer, X-Nov and Adler and A Gabrion from X-Nov.

Funding

None.

Contribution

Gautier Bon performed study design and data collection, analysis and interpretation, and wrote the article. Elias Ben Kacem contributed to study design and data collection, analysis and interpretation. Pierre Marie Lepretre contributed to study design, provided the measuring equipment and training in its use, and contributed to data analysis and interpretation. Thierry Weissland contributed to study design, and provided equipment and training in its use. Patrice Mertl contributed to study design and revised the article. Massinissa Dehl contributed to study design, data analysis and interpretation and article revision. Antoine Gabrion contributed to study design and to revising the article.

RCB ID n°: 2017-A02875-48.

IRB approval registered with the Clinical Research and Innovation Delegation: PI2017-843-0023.

References

[1] Caton J, Papin P. Typologie et épidémiologie des prothèses totales de hanche en France. E-Mém. Acad Natl Chir 2012;11:1–7, http://www.bium.univ-paris5.fr/acad-chirurgie (accédé 1/7/2018).
[2] Higgins BT, Barlow DR, Heagerty NE, Lin TJ. Anterior vs. posterior approach for total hip arthroplasty, a systematic review and meta-analysis. J Arthroplasty 2015;30:419–34.
[3] Auvinet B, Berrut G, Touzard C, Moutel L, Collet N, Chateil D, Barrey E. Reference data for normal subjects obtained with an accelerometric device. Gait & Posture 2002;16:124–34.
[4] Auvinet B, Barrey E, Chaleil D. Gait analysis in coxarthrosis using an accelerometric device. Annals of the Rheumatic Diseases 2004;63:365–6.
[5] Auvinet B, Chaleil D, Barrey E. Analyse de la marche humaine dans la pratique hospitalière par une méthode accélérométrique. Rev Rhum 1999;66:447–57.
[6] Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. J Bone Joint Surg Am 1969;51:737–55.
[7] Merle D'Aubigné R. Numerical classification of the function of the hip. Rev Chir Orthop 1990;76:371–4.
[8] Delaunay C, Epinette JA, Dawson J, Murray D, Jolles BM. Cross-cultural adaptations of the Oxford-12 HIP score to the French speaking population. Orthop Traumatol Surg Res 2009;95:89–99.
[9] Dawson J, Fitzpatrick R, Carr A, Murray D. Questionnaire on the perceptions of patients about total hip replacement. J Bone Joint Surg Br 1996;78:185–90.
[10] Lequesne MG. The algofunctional indices for hip and knee osteoarthritis. J Rheumatol 1997;24:779–81.
[11] Rathod PA, Orishimo KF, Kremenic IJ, Deshmukh AJ, Rodriguez JA. Similar improvement in gait parameters following direct anterior & posterior approach total hip arthroplasty. J Arthroplasty 2014;29:1261–4.
[12] Maffiuletti NA, Impellizzeri FM, Widler K, Bizzini M, Kain MSH, Munzinger U, et al. Spatiotemporal parameters of gait after total hip replacement: anterior versus posterior approach. Orthop Clin North Am 2009;40:407–15.
[13] Reininga IHF, Stevens M, Wagenmakers R, Boerboom AL, Groothoff JW, Bulstra SK, et al. Comparison of gait in patients following a computer-navigated minimally invasive anterior approach and a conventional posterolateral approach for total hip arthroplasty: a randomized controlled trial. J Orthop Res 2013;31:288–94.
[14] Ward SR, Jones RE, Long WT, Thomas DJ, Dorr LD. Functional recovery of muscles after minimally invasive total hip arthroplasty. Instr Course Lect 2008;57:249–54.
[15] Taunton MJ, Trousdale RT, Sierra RJ, Kaufman K, Pagnano MW. John Charnley Award: Randomized Clinical Trial of Direct Anterior and Miniposterior Approach THA: Which Provides Better Functional Recovery? Clin Orthop Relat Res 2018;476:216–29.
[16] Zhao HY, Kang PD, Xia YY, Shi XJ, Nie Y, Pei FX. Comparison of early functional recovery after total hip arthroplasty using a direct anterior or posterolateral approach: A randomized controlled trial. J Arthroplasty 2017;32:3421–8.
[17] Van Driessche S, Billuart F, Martinez L, Brunel H, Guiffault P, Beldame J, et al. Short-term comparison of postural effects of three minimally invasive hip approaches in primary total hip arthroplasty: Direct anterior, posterolateral and Röttinger. Orthop Traumatol Surg Res 2016;102:729–34.
[18] Bernard J, Razanabola F, Beldame J, Van Driessche S, Brunel H, Poirier T, et al. Electromyographic study of hip muscles involved in total hip arthroplasty: Surprising results using the direct anterior minimally invasive approach. Orthop Traumatol Surg Res 2018;S1877-0568:3012.
[19] Rykov K, Reininga IHF, Sietsma MS, Knobben BAS, Ten Have BLEF. Posterolateral vs Direct Anterior Approach in Total Hip Arthroplasty (POLADA Trial): A randomized controlled trial to assess differences in serum markers. J Arthroplasty 2017;32:3652–8.
[20] Christensen CP, Jacobs CA. Comparison of patient function during the first six weeks after direct anterior or posterior total hip arthroplasty (THA): A randomized study. J Arthroplasty 2015;30:94–7.
[21] Rodriguez JA, Deshmukh AJ, Rathod PA, Greiz ML, Deshmane PP, Hepinstall MS, et al. Does the direct anterior approach in THA offer faster rehabilitation and comparable safety to the posterior approach? Clin Orthop Relat Res 2014;472:455–63.
[22] Taunton MJ, Mason JB, Odum SM, Springer BD. Direct anterior total hip arthroplasty yields more rapid voluntary cessation of all walking aids: a prospective, randomized clinical trial. J Arthroplasty 2014;29:169–72.
[23] Barrett WP, Turner SE, Leopold JP. Prospective randomized study of direct anterior vs postero-lateral approach for total hip arthroplasty. J Arthroplasty 2013;28:1634–8.
[24] Cheng TE, Wallis JA, Taylor NF, Holden CT, Marks P, Smith CL, et al. A prospective randomized clinical trial in total hip arthroplasty-comparing early results between the direct anterior approach and the posterior approach. J Arthroplasty 2017;32:883–90.
[25] Martin CT, Pugely AJ, Gao Y, Clark CR. A comparison of hospital length of stay and short-term morbidity between the anterior and the posterior approaches to total hip arthroplasty. J Arthroplasty 2013;28:849–54.
[26] Sugano N, Takao M, Sakai T, Nishii T, Miki H, Nakamura N. Comparison of mini-incision total hip arthroplasty through an anterior approach and a posterior approach using navigation. Orthop Clin North Am 2009;40:365–70.
[27] Maratt JD, Gagnier JJ, Butler PD, Hallstrom BR, Urquhart AG, Roberts KC. No difference in dislocation seen in anterior vs posterior approach total hip arthroplasty. J Arthroplasty 2016;31:127–30.
[28] Malek IA, Royce G, Bhatti SU, Whittaker JP, Phillips SP, Wilson IRB, et al. A comparison between the direct anterior and posterior approaches for total hip arthroplasty: the role of an "Enhanced Recovery" pathway. Bone Joint J 2016;98:754–60.
[29] Goulding K, Beaulé PE, Kim PR, Fazekas A. Incidence of lateral femoral cutaneous nerve neuropraxia after anterior approach hip arthroplasty. Clin Orthop Relat Res 2010;468:2397–404.
[30] Patton RS, Runner RP, Lyons RJ, Bradbury TL. Clinical outcomes of patients with lateral femoral cutaneous nerve injury after direct anterior total hip arthroplasty. J Arthroplasty 2018;33:2919–26.
[31] Ropars M, Morandi X, Huten D, Thomazeau H, Berton E, Darnault P. Anatomical study of the lateral femoral cutaneous nerve with special reference to minimally invasive anterior approach for total hip replacement. Surg Radiol Anat 2009;31:199–204.
[32] Zawadsky MW, Paulus MC, Murray PJ, Johansen MA. Early outcome comparison between the direct anterior approach and the mini-incision posterior approach for primary total hip arthroplasty: 150 consecutive cases. J Arthroplasty 2014;29:1256–60.

[33] Zagra L, Anasetti F, Bianchi L, Licari V, Giacometti Ceroni R. No difference in gait recovery after THA with different head diameters: a prospective randomized study. Clin Orthop Relat Res 2013;471:3830–7.
[34] Allen CL, Hooper GJ, Frampton CMA. Do larger femoral heads improve the functional outcome in total hip arthroplasty? J Arthroplasty 2014;29:401–4.
[35] Delay C, Putman S, Dereudre G, Girard J, Lancelier-Bariatinsky V, et al. Is there any range-of-motion advantage to using bearings larger than 36 mm in primary hip arthroplasty: A case-control study comparing 36-mm and large-diameter heads. Orthop Traumatol Surg Res 2016;102:735–40.