Hip abductor strength following total hip arthroplasty

A prospective comparison of the posterior and lateral approach in 100 patients

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ABSTRACT – We studied the hip abductor strength and Trendelenburg test prospectively in 100 patients undergoing total hip replacement via a lateral or posterior approach. In 49 patients, we used the lateral approach to implant the Charnley total hip replacement, and in 51 patients, the posterior approach to implant the Exeter total hip.

Isometric abductor strength was measured with the kinetic communicator device and the Trendelenburg test was recorded preoperatively and at 3 and 12 months postoperatively. Of the original 100 patients, 83 were available for study at 3 months and 73 at 12 months.

Hip abductor strength and the Trendelenburg test improved postoperatively in both groups, but we found no difference in hip abductor strength recovery at 3 and 12 months between the lateral approach and the posterior approach. Similarly there was no difference in the Trendelenburg test between the two groups 3 and 12 months following hip replacement.

Total hip replacement is most commonly performed via a posterior or a lateral approach. The relative merits of these two approaches are debated. A concern with the lateral approach is that it violates the abductor muscle mass, which can lead to permanent sequelae, including postoperative limp and weakness. This may occur either through denervation of the abductors by damage to the superior gluteal nerve (Baker and Bitounis 1989, Ramesh et al. 1996, Kenny et al. 1999) or by failure to reattach the muscle mass securely to the greater trochanter (Baker and Bitounis 1989). Advocates of the posterior approach suggest that postoperative hip abductor weakness is less common with this.

We prospectively compared the hip abductor strength of two groups of patients undergoing total hip replacement with the kinetic communicator (KINCOM) device. One group received a Charnley total hip replacement via the lateral approach; the other group was given an Exeter total hip replacement via the posterior approach. In addition, the Trendelenburg clinical test for hip abductor strength was prospectively measured and correlated with the hip abductor strength measurements.

Patients and methods

All patients undergoing primary total hip replacement for primary osteoarthritis between May 1995 and February 1997 under one of three consultants were considered for entry into the study. Exclusion criteria were previous surgery on the hip, previous hip fracture, hip dysplasia, a diagnosis other than primary osteoarthritis without predisposing cause, and severe intercurrent illness. The first 100 consecutive suitable patients who were willing to participate were included in the study. The criteria with respect to severity of arthritis, for performing total hip replacement, were identical in the two groups. Approval for the study was obtained from the Hospital Ethics Committee and written consent was given by the patients.

Patients underwent either Charnley total hip

replacement via the lateral Hardinge type (Hardinge 1982) approach or Exeter total hip replacement via the posterior approach, according to the usual practise of the surgeon to whom they had been referred. Referral to each consultant was not randomised, but was according to the usual practise of the local general practitioners. All the patients originated from the same regional hospital catchment area. One consultant performed an Exeter total hip replacement via the posterior approach; the other two consultants did a Charnley total hip replacement via the lateral approach. Both groups consisted of consecutive suitable patients referred to the participating consultants. Each surgeon therefore performed his accustomed approach, thus removing possible bias in selecting a less favoured or less familiar approach. All the operations were performed by the consultants themselves or by one of six trainees, under the direct supervision of one of the three consultants. Of the 100 patients recruited, 55 were female. The age range was 41–83 years. The lateral approach was used in 49 cases, the posterior approach in 51. A standardised postoperative in- and outpatient physiotherapy regimen was used for all patients.

All the hip abductor strength measurements and Trendelenburg tests were performed by a physiotherapist (KC) who was blinded as to the approach used and the consultant in charge of the case. All abductor strength measurements were performed on the same kinetic communicator (KINCOM) machine and the Trendelenburg test was done as described by Hardcastle (Hardcastle and Nade 1985), with a negative result being recorded only after 30 seconds single leg stance.

The KINCOM machine is a hydraulically-driven, micro-computer-controlled device, which accurately and reproducibly measures isometric hip abductor strength with the patient in the physiological erect position (Farrell and Richards 1986). A standardised protocol of positioning and measurement was used in all cases. Maximum effort isometric abductor strength in both hips was measured at 0 degrees and 15 degrees of abduction (to minimise the possible effect of variation in range of hip movement) and the average of three readings (to minimise the effect of variation on effort) used on each occasion. The precise settings of the machine were recorded for each patient and reproduced for each subsequent set of readings. Strength measurements and Trendelenburg tests were performed preoperatively and at 3 and 12 months postoperatively.

Table 1. Preoperative patient characteristics

	Posterior approach	Lateral approach
Study population, n	49	51
Age, mean (range)	67 (41–83)	65 (42–83)
Female, n	25	30
Male	24	21
Other hip status, n	33	34
Uninvolved	9	10
Arthritis	8	7

Results

Of the 100 patients in the study, 17 patients were excluded at 3 months and 10 more patients excluded at 12 months. Of these 27 patients, 12 did not attend for follow-up, 4 dislocated (3 in the lateral approach group), 4 developed substantial medical problems, 1 sustained a periprosthetic fracture, 1 died, 4 developed problems with the other hip and 1 patient was non-weight bearing. Thus, 83 patients were available for assessment at 3 months and 73 at 1 year. Gender and other hip status were similar in the two groups (Table 1).

The Trendelenburg test was recorded in 90 patients preoperatively (45 in each group) (Table 2). The KINCOM measurements were not normally distributed and the results were therefore analysed using non-parametric tests. There were no statistically significant differences preoperatively between the two groups on either the operated side at 0° and 15° (Mann Whitney U-test at 0°, $p = 0.99$; at 15°, $p = 0.92$) or the unoperated side at 0° and 15° (at 0°, $p = 0.34$; at 15°, $p = 0.27$). We also found marked abductor weakness in the arthritic hip (negative scores), when compared to the normal, contralateral hip.

The strength of the operated leg (measured at 0° and at 15°) had improved in both groups at 3 months, following hip replacement and this improvement was maintained at 12 months (Table

Table 2. Preoperative Trendelenburg and KINCOM results

	Posterior approach n 49	Lateral approach n 51
Trendelenburg test		
Positive, n	35	37
Negative	10	8
Operated leg		
0° abduction (N)		
median	70	73
range	18–215	21–190
interquartile range	62	68
15° abduction (N)		
median	53	46
range	10–244	12–197
interquartile range	37	68
Unoperated leg		
0° abduction (N)		
median	78	97
range	22–271	29–352
interquartile range	59	63
15° abduction (N)		
median	60	73
range	11–270	16–253
interquartile range	73	72
Patients with uninvolved unoperated leg only, difference between operated and unoperated hip at		
0° abduction (N) , n	30	34
median	-16.5	-8
range	-121–97	-87–33
interquartile range	47	44
15° abduction (N), n	31	34
median	-15	-19.5
range	-154–26	-107–37
interquartile range	43	43

Table 3. The change in hip abductor strength at 3 and 12 months after hip replacement

	Posterior approach (N)	Lateral approach (N)	P-value
Operated hip at 0° abduction			
3 months (n 83), n	45	38	
median	13	21	0.89
interquartile range	52	40	
12 months (n 73), n	40	33	
median	16	19	0.68
interquartile range	39	48	
Operated hip at 15° abduction			
3 months (n 83), n	45	38	
median	10	13	0.98
interquartile range	60	38	
12 months (n 73), n	40	33	
median	19	19	0.75
interquartile range	48	43	

Table 4. The change in the abductor strength measurements in the unoperated hip

	Posterior approach (N)	Lateral approach (N)	P-value
Unoperated hip at 0° abduction			
3 months (n 82), n	45	38	
median	3.5	–2	0.8
interquartile range	56	60	
12 months (n 73), n	40	33	
mean	18	0.5	0.07
interquartile range	37	29	
Unoperated hip at 15° abduction			
3 months (n 83), n	45	38	
median	8	1	0.5
interquartile range	56	51	
12 months (n 73), n	40	33	
median	17	-11	0.2
interquartile range	61	43	

3). There were no significant differences between the two groups (Mann-Whitney U-test).

The change in strength of the unoperated hip was also measured at 3 and 12 months (Table 4). There was no clear trend in the change in hip abductor strength on the unoperated hip side. 12 months after hip replacement, the median change in strength of the patients in the lateral group was lower than that of patients in the posterior approach group, although there were no statistically significant differences between the two groups (Mann-Whitney U-test).

There was a marked improvement in the results of the Trendelenburg test in both groups at 3 months, which improved further at 12 months (Table 5). There were no significant differences between the two groups preoperatively and at 3 and 12 months after total hip replacement (chi-squared test). These results correlate with the hip abductor strength measurements, the Trendelenburg test becoming negative as the abductor strength improved.

The subgroup of patients with uninvolved contralateral hips was analysed further. The difference in strength between the operated and contralateral hips was calculated preoperatively and at 3 and 12 months. The abductor strength in both groups was

Table 5. Results of the Trendelenburg test in the two groups

	Posterior approach n	Lateral approach n	P-value
Preoperative, n	45	45	
positive	35	37	0.6
negative	10	8	
3 months, n	43	37	
positive	5	5	0.8
negative	38	32	
12 months, n	40	33	
positive	2	2	0.9
negative	38	31	

Table 6. The change in the difference in strength between the operated hip and contralateral uninvolved hip

	Posterior approach (N)	Lateral approach (N)	P-value
Hip at 0°			
3 months, n	29	28	
median	26	24	0.6
interquartile range	36	34	
12 months, n	27	25	
median	8	19	0.2
interquartile range	53	58	
Hip at 15°			
3 months, n	29	28	
median	14	20	0.7
interquartile range	47	48	
12 months, n	27	25	
median	31	38	0.8
interquartile range	81	68	

better, compared to the normal contralateral side, but there were no significant differences between the two groups (Mann-Whitney U-test) (Table 6).

Discussion

Many alternative surgical approaches are used in total hip replacement. Two of the most popular are the posterior and the lateral (Hardinge type) approaches. We studied these since they are the two most commonly performed in our unit and both provide adequate exposure for total hip replacement. The relative merits of these approaches are debated, although no study has conclusively demonstrated an advantage of one over the other. Critics of the lateral approach suggest that the violation of the hip abductor mass may lead to delay in recovery of abductor strength and late Trendelenburg gait. Mulliken et al. (1998), in a review of 770 total hip replacements via the lateral approach, found a 10% incidence of moderate or severe limp at 2 years, but there was no comparative posterior approach group. Obrant et al. (1989) compared the direct lateral and lateral transtrochanteric approaches in 27 patients and found reduced abductor strength in the direct lateral group. Baker and Bitounis (1989) found more positive postoperative Trendelenburg tests after the lateral approach than after the posterior one and considered that this weakness was due to detachment of the gluteal flap, although they did not quantify abductor strength. In addition, violation of the 'safe zone' (Comstock et al. 1994) within 5 cm of the greater trochanter may damage the superior gluteal nerve and thus further risk of abductor muscle weakness (Ramesh et al. 1996, Baker and Bitounis 1989). However, the role of nerve injury in the production of postoperative abductor weakness is not clear as Kenny et al. (1999) found that EMG evidence of acute nerve injury does not correlate with the clinical findings of weak abduction. In our prospective study of the two approaches, we found no significant differences in recovery of hip abductor strength at 3 or 12 months. In both groups of patients, the abductor strength improved following hip replacement, presumably due to loss of the effect of pain inhibition.

In 1897, Friedrich Trendelenburg described a clinical test for hip abductor function (Hardcastle and Nade 1985), which is widely used to assess patients before and after total hip replacement. Many different ways of performing this test have been reported but, by having one investigator perform all the tests in a standardised way, we sought to minimise this source of variation in our results. This study demonstrates a close relationship between the hip abductor strength, as measured by the KINCOM machine, and the results of the Trendelenburg test. We have also been unable to show any significant difference in results of the Trendelenburg test between the two approaches.

The use of the KINCOM device to measure isometric hip abductor strength accurately in total

hip replacement patients has not been previously reported. However, the reliability and validity of the device have been extensively analysed and established (Farrell and Richards 1986). All KINCOM measurements were made by a single operator with experience of this device, using a standardised protocol, thus minimising measurement variability.

We appreciate that many variables influence the force generated by the abductors and measured by the KINCOM device. These include severity of arthritis, range of movement of the affected hip and patient effort. However, we believe our method for measuring and comparing both normal and affected hips within the groups and the two groups themselves minimises these influences.

We did not randomly allocate the patients to the care of the two groups of surgeons (and therefore to the surgical approach) and are aware that this may introduce systematic differences between the two groups. However, we could not identify specific differences, but accept that this possibility weakens the conclusions of our study. The demographic characteristics of the two groups were very similar, and the criteria for performing total hip replacement (in terms of severity of arthritis) were identical in both groups. Thus it is likely that the distribution of severity of arthritis was similar in the study population. This view is supported by the finding that when we studied the subgroup of patients with contralateral normal hips, and compared the difference in preoperative KINCOM measurements of the arthritic and normal sides, the findings were similar in the two study groups. By measuring isometric force generated at zero and fifteen degrees of abduction, we have minimised the influence of variation in range of movement of the hips on the results. The repetition of each measurement also minimises the influence of patient effort on the results.

We found that the abductor strength measurements were widely spread in the two groups (wide interquartile range-reflecting the wide normal variation in hip abductor strength), and although statistical analysis showed generally high p-values (far from statistical significance), a significant type 2 error (inability to detect a small but relevant difference) may be associated with our conclusions. This could be minimised by further study with larger patient groups.

Small differences between the two groups could have been made larger by studying the role of fatigability on abductor strength, and that by doing this, differences between the two groups mighthave been revealed. Unfortunately we did not include this in the protocol of ourstudy, but the addition of retesting after a standardised exercise should be part of our further investigation of this question. All the Trendelenburg tests were performed in a standardised manner and a negative test was recorded only after 30 seconds of single leg stance, which we believe increases the sensitivity of this test by introducing the factor of muscle fatigue. Whether a small difference in measured abductor strength is relevant clinically is not clear, which is another question warranting study. Although further evaluation of an accurate instrument, such as the KINCOM machine, may show a small difference between the two approaches, this is not relevant clinically unless it leads to adverse consequences, such as gait abnormality.

Another possible criticism of this study is that different prostheses were used in the two groups. It seems likely that the offset of the prosthesis affects the hip abductor strength (McGrory et al 1995). Most of the Charnley stems used had a 38 or 40 mm offset, and many of the Exeter stems a 37.5 or 44 mm offset. However, when we analysed the postoperative radiographs it became clear that there were many other variables, which could influence the abductor strength. These included the leg length (abductor tension), varus or valgus alignment of the stem, size of acetabular component and the depth of insertion of the acetabular component. We therefore believe that the effect of a small difference in the dimensions of the implant on the results is negligible.

To our knowledge this is the first prospective study of hip abductor strength using a validated measuring device and comparing the normal and arthritic sides pre- and postoperatively. The (somewhat surprising) good results in our lateral group may be due to the experience of the surgeons who performed their usual approach—an advantage of the ‘randomisation by surgeon’ protocol. Clearly, postoperative abductor weakness has many causes and we believe good surgical technique and awareness of the anatomy of the nerve supply are key factors in preserving good abductor strength.

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