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Hip function after total vs. surface replacement

Kinesiologic measurements were made in two groups of 20 men before and 6 and 24 months after resurfacing or conventional replacement. Before surgery the group to have resurfacing was younger, had less pain, slightly more hip motion, greater muscle strength, walked faster, and used fewer assistive devices during walking than the group to have the conventional replacement. After surgery, the group with resurfacing maintained its advantage in muscle strength and walking velocity.

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Recent studies agree that surface-replacement hip arthroplasty provides results comparable to those of conventional total hip arthroplasty in terms of range of hip motion, pain, function and walking ability (Herberts et al. 1983, Amstutz et al. 1984, Capello et al. 1984). With the exception of range of motion, these comparisons have been based on subjective rating scales. We have compared numeric functional parameters of patients with surface replacement and patients with conventional hip replacement.

Patients and Methods

Twenty-seven men were referred for kinesiologic testing before and after surface-replacement arthroplasty (resurfacing) of the hip. Seven did not complete their follow-up tests: three refused, two moved out of state, one had a revision to a total hip replacement secondary to loosening of the prosthetic components, and one had medical problems unrelated to the hip procedure. Eleven of the 20 men who completed the postoperative tests had bilateral lower limb disability, including one with bilateral hip resurfacing. The remaining nine had no contralateral lower limb disability.

For comparison, a group of 29 men were chosen from among patients with uncomplicated conventional total hip replacement who were tested previously in the laboratory. The subjects with conventional replacement were selected randomly from among subjects in the same age range as the patients with resurfacing and in the same ratio of unilateral versus bilateral disability. Patients with bilateral disability were matched by extent of disability (contralateral hip pain, bilateral knee pain, etc.). The mean age of the group with conventional replacement was 7 years higher than that of the group with resurfacing (Table 1). Three types of resurfacing components were used (Amstutz et al. 1978, Capello et al. 1978, Wagner 1978). Most of the patients with resurfacing were operated through an anterolateral approach, while approximately half in the group with conventional arthroplasty had the anterolateral approach and half the posterior approach.

Tests of functional performance were conducted before surgery and 6 and 24 months after surgery. These included measurements of range of hip motion, hip abductor and adductor-muscle strength during maximum isometric contraction, cane or crutch force during walking, average weight distribution between the feet during 1 min of standing, and multiple aspects of free-speed and fast walking performance obtained using interrupted-light photography. In addition, each patient's complaints of hip pain were rated according to Lazansky, and each

Table 1. Patient information

	Type of hip arthroplasty	
	Resurfacing	Conventional
Mean age (range)	55 (45–72)	62 (48–74)
Mean height, cm (range)	176 (163–185)	173 (161–183)
Mean weight, kg (range)	91 (72–123)	81 (65–96)
Pre-operative diagnosis (no. of hips)		
Degenerative joint disease	19	16
Avascular necrosis	2	5
Surgical approach (no. of hips)		
Posterior without osteotomy	3	11
Anterolateral with osteotomy	5	6
Anterolateral without osteotomy	13	4
Type of reconstruction	Indiana – 12 Wagner – 5 THARIES – 4	Bechtol I – 10 Series II – 4 Muller – 7

patient rated the current status of the hip as compared with that before surgery. The measurement techniques have been described previously (Murray et al. 1964, American Academy of Orthopaedic Surgeons 1965, Lazansky 1967, Murray & Sepic 1968, Seireg et al. 1968, Murray & Peterson 1973).

A multiple classification analysis of variance and Newman-Keuls test (Steel & Turrie 1960) were used to assess the significance of the differences between the pre- and postoperative measurements of range of motion, muscle strength, and gait, and to assess the significance of the differences between these measurements for the two groups. Measurements of walking performance and strength of both groups of patients were also compared to standards of normal variability (Murray & Sepic 1968, Murray et al. 1969).

Results

Pain. Prior to surgery, complaints of moderate or severe pain were more frequent in the group scheduled for conventional replacement than in the group scheduled for the resurfacing procedure. After surgery, all patients in both groups experienced pain relief: 19/21 with the resurfacing procedure and 18/21 with the conventional hip replacement stated that they had little or no pain.

Range of motion. Before surgery the group scheduled for the resurfacing procedure had greater mean range of hip motion than the group scheduled for conventional replacement, but the difference was not significant. After surgery the group with conventional replacement improved ($P<0.01$) in all motions except outward rotation. The group with resurfacing improved in flexion ($P<0.05$), and in abduction, adduction and inward rotation ($P<0.01$). Two years after surgery, range of motion was similar for the two groups except that the group with resurfacing had more outward rotation than the group with conventional replacement ($P<0.01$).

Hip muscle strength. The group with resurfacing had stronger abductor and adductor muscle torque than the group with conventional replacement, both before and 2 years after surgery. Six months post-operatively, the difference in abductor muscle strength between the groups was not significant (Table 2). The amount of improvement in adductor muscle strength was greater for the group with conventional replacement ($P<0.01$) than for the group with the resurfacing procedure ($P<0.05$). Average strength values for the two patients groups were still below the normal range of variability 2 years postoperatively.

Weight distribution between the feet was measured in those with unilateral hip surgery and no other disability. Patients with conventional replacement bore an average of 37 per cent of their body weight on the affected limb before surgery as compared to 45 and 47 per cent 6

Table 2. Hip muscle strength in kg-cm (mean ± SE)

Muscle group	Pre-op.	6 mo	2 yr
Abductors[a]			
Resurfacing	826±58	819±54	961±69
Conventional	517±60	744±47	781±55
Adductors[b]			
Resurfacing	1005±63	1107±67	1234±80
Conventional	600±64	817±59	943±63

[a]Normal men: 1225±74 kg-cm.
[b]Normal men: 1553±94 kg-cm.

Table 3. Use of canes or crutches before and after resurfacing (R) and conventional (C) total hip replacement

No. of canes or crutches	Pre-op.		6 mo		2 yr	
	R	C	R	C	R	C
Two	3	2	—	—	—	—
One	5	14	8	9	2	4
None	12	4	12	11	18	16
Average force applied (kg)[a]	17	9	8	5	13	7

[a]By those who used assistive devices.

months and 2 years after surgery. The group with the resurfacing procedure bore an average of 41 per cent of body weight on the affected limb before surgery as compared to 43 and 46 per cent at the two postoperative tests.

Use of assistive devices during walking. A majority of the patients in the group to have the resurfacing procedure walked without support before surgery, while most with the conventional replacement used an assistive device (Table 3). Two years after surgery all but two with the resurfacing procedure and four with conventional replacement walked without support. The average forces applied to the assistive devices decreased for both groups between the pre- and 6-month postoperative test (Table 3). One patient with resurfacing and two with conventional replacement had higher forces 2 years postoperatively than before surgery; one of these started using a cane for balance and the other two had problems with joints other than the operated hip.

Components of free-speed and fast walking. Before surgery, both groups walked with abnormalities typical of patients with hip disability; that is, they walked with subnormal velocity, stride lengths and cadence, and limited use of hip flexion-extension on the affected side. Measurements at the head showed excessive lateral motion and faster forward motion but less vertical motion during weight-bearing on the affected as compared to the opposite limb. The pre-operative abnormalities in velocity and its derivatives were more pronounced in the group scheduled for conventional replacement ($P<0.01$) (Figure 1). Other differences between the groups pre-operatively were not significant (Table 4).

As a result of surgery, all the components of walking mentioned improved ($P<0.01$) for both groups of patients at both walking speeds with the exception of lateral head motion. Lateral head motion improved during free-speed walking for both groups ($P<0.01$), but during fast walking improvement was found only for the group with conventional replacement ($P<0.05$).

Two years after surgery the group with resurfacing continued to have faster walking velocity than the group with conventional replacement ($P<0.01$). The faster speed resulted from longer stride lengths and faster cadences than for the group with conventional replacement. The postoperative walking speed of the group with resurfacing approached the lower limits of the range of variability for normal men defined by two standard errors below the mean (Figure 1). In other gait components, there were no differences between the groups 2 years after surgery.

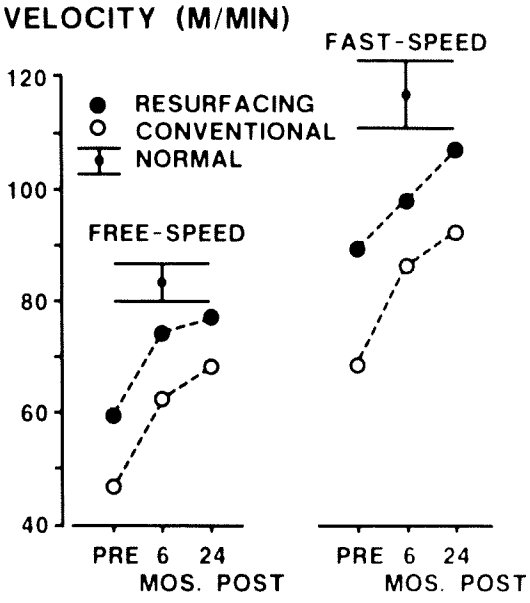

Figure 1. Mean measurements of velocity for 20 men with hip resurfacing and 20 men with conventional total hip replacement. The normal ranges of variability for men represent two standard errors above and below the mean.

Table 4. Average measurements of walking performance

Gait component	Free-speed			Fast walking		
	Pre-op.	6 mo	2 yr	Pre-op.	6 mo	2 yr
Hip flex-ext used (deg)[a]						
Resurfacing	27	29	34	31	33	40
Conventional	21	30	35	23	35	39
Lateral head motion (cm)[b]						
Resurfacing	11.3	9.4	8.6	9.2	8.1	8.5
Conventional	11.7	8.5	7.6	9.5	7.6	7.4

[a]Normal men: 46±1 degree, free-speed; 50±1 degree, fast walking.
[b]Normal men: 6.0±0.2 cm, free-speed; 5.2±0.2 cm, fast walking.

Discussion

With our objective measurements of function, we found a few significant differences between the groups, both before and after surgery. It is not surprising that there were pre-operative differences between the groups, since the resurfacing procedure tends to be done on the younger patient with less affection of the hip joint.

Pre-operatively, the group with resurfacing had less pain, used fewer assistive devices, walked faster, had greater hip muscle strength, slightly better hip motion, and slightly better weight distribution between the feet than the group with conventional replacement. Post-operatively, the group with resurfacing maintained the advantages of greater strength and faster walking velocity. In other respects the groups functioned similarly.

Muscle strength was not evaluated in previous reports comparing the two procedures. An interesting finding in this study was that, despite the greater average strength value for the group with resurfacing, nine of the 21 hips with this procedure had lower abductor-muscle strength 2 years postoperatively than pre-operatively. In our experience with studies of patients with conventional hip replacement, this seemed disappointing. In all nine patients who lost strength, the anterolateral approach was a common factor. Only three patients with resurfacing had the posterior approach; while their average abductor strength was below the group average before surgery, it was well above 2 years after surgery. In a previous study comparing patients with total hip replacement operated through posterior and anterolateral approaches, we found a tendency for abductor-muscle strength to be stronger postoperatively in men operated through the posterior approach (Gore et al. 1982). The lack of improvement in hip abductor-muscle strength by so many patients with resurfacing probably explains the failure of the group with resurfacing to show a greater decrease in lateral lurching after surgery.

More outward rotation for the group with resurfacing was the one significant difference in range of motion which we found between the groups. This one difference is probably also related to the fact that the anterolateral approach was used more often for the group with resurfacing than for the group with conventional replacement (Gore et al. 1982).

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