ABDUCTOR FUNCTION AFTER TOTAL HIP REPLACEMENT

AN ELECTROMYOGRAPHIC AND CLINICAL REVIEW

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Electromyographic and clinical studies were performed on patients undergoing total hip replacement by the modified direct lateral (29 hips), the direct lateral (29 hips) and the posterior approaches (21 hips). Assessments were made three months after operation.

The Trendelenburg test was positive (Grade II) in eight cases operated upon by the direct lateral route, but in only one of each of the other two groups. Denervation occurred in only five of the 28 hips with abductor weakness without statistical difference between the groups. In the modified direct lateral group, radiological evidence of union of the trochanteric sliver was associated with significantly better abductor function than in those with malunion or non-union.

The lateral approaches to the hip described by McFarland and Osborne (1954) and by Hardinge (1982) have two main advantages: they avoid the complication of trochanteric non-union associated with the Charnley technique (1970), and postoperative dislocation is less likely than with the posterior approach (Robinson, Robinson and Salvati 1980). However, there is a possible danger. The lateral approach requires reflection of the anterior fibres of gluteus medius and minimus from the greater trochanter, and one of the complications of this procedure is postoperative weakness of hip abduction. This may occur either through denervation of the gluteal flap, following damage to the inferior branch of the superior gluteal nerve, or by failure to establish re-attachment of the flap to the greater trochanter. Hardinge (1982) was aware of these problems and cautioned against excessive retraction of the gluteal flap. Dall (1986) described a modification of the technique, in which a sliver of trochanteric bone is taken with the gluteal flap so as to allow better fixation of the flap to the greater trochanter during closure. Unfortunately he does not report the postoperative abductor function of his patients.

In a prospective study we sought to investigate the incidence and cause of abductor weakness in patients undergoing total hip replacement by the lateral approach. Three groups of patients were compared: after Dall's modified lateral approach (1986), after a standard Hardinge (1982) approach, and, as a control group, after a posterior approach.

MATERIALS AND METHODS

Cadaveric studies. Nine cadaveric dissections were performed to identify the course of the inferior branch of the superior gluteal nerve, its relationship to the proximal pole of the greater trochanter, and its proximity to the operative incision.

Clinical studies. Patients were grouped according to the operative approach used for total hip replacement. Dall's modified direct lateral (MDL) approach was used in 29 hips. In these cases the gluteal flap was raised with a sliver of greater trochanter (Fig. 1) and fixation was performed by a double wire technique. Two 20 gauge stainless steel wires were passed around the trochanteric sliver and through drill holes in the proximal femur. Hardinge's direct lateral (DL) approach, with a soft tissue flap, was used in 29 hips, and the posterior (P) approach in 21 hips. Altogether a total of 79 hips in 69 patients were examined.

Pain was assessed on a visual analogue scale with scores from zero (no pain at all) to 10 (the most severe pain imaginable). Abductor power was measured by a

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© 1989 British Editorial Society of Bone and Joint Surgery
0301-620X/89/1026 \$2.00
J Bone Joint Surg [Br] 1989;71-B:47-50.

modified Trendelenburg test (Hardcastle and Nade 1985). The patient was asked to stand behind a Zimmer frame which he or she could use for balance by finger support only. The patient was then asked to stand on one leg, flexing the other leg at the knee, while keeping the hip in extension. The examiner knelt in front of the patient to observe pelvic tilt. The test was negative when the unsupported pelvis was raised normally while standing on one leg, and held there for at least 30 seconds. Two positive grades were recorded. In Grade I the unsupported pelvis either remained horizontal or could not be elevated. In Grade II the unsupported pelvis dropped below the horizontal line.

Electromyography. All patients had electromyography (EMG) by needle puncture of the tensor fascia lata between 14 and 21 days after operation. The diagnosis of gluteal denervation requires the detection of fibrillation potentials (Fig. 2) (Clippinger, Goldner and Roberts 1962) in three areas of the tensor fascia lata at least 1 cm apart. The unoperated side was examined first in order to establish the normal EMG pattern and then on three sample sites in the tensor fascia lata of the operated side. Needles were inserted approximately two finger-breadths anterior and medial to the greater trochanter. All patients with evidence of denervation, or with unsatisfactory initial examinations, had their EMG examinations repeated at the time of clinical assessment three months later.

Radiography. Radiographs were taken of 28 patients in the MDL group three months postoperatively to assess the state of union of the trochanteric osteotomy.

Analysis. Statistical analysis was performed by means of the Fisher Exact Test.

RESULTS

Anatomical dissections confirmed that the inferior branch of the superior gluteal nerve follows an oblique course anteriorly and caudally from above piriformis in a sagittal plane within the substance of gluteus medius. Posteriorly it lies between 6 and 8 cm proximal to the tip of the greater trochanter and anteriorly between 3 and 5 cm from that point (Fig. 3).

The electromyographic results are shown in Table I. One patient with bilateral hip replacements in the DL group died during the follow-up period. Denervation of the glutei had been recorded in one hip of this patient at two weeks after operation. At two weeks, the EMG revealed denervation in three MDL, 10 DL and three P hips; this showed a significantly higher incidence in the DL group compared with the MDL ($p < 0.001$), and the P group ($p < 0.05$). At three months follow-up, however, the incidence of denervation was lower and there was no significant difference between the three groups.

Peritrochanteric pain was not significantly different in either the MDL or the DL groups compared with the P group (Table I).

Abductor power was assessed in the 72 patients with normal EMG patterns (Table II). In this group, abductor weakness, with a Grade II positive Trendelenburg test, was found in seven DL cases, in one of the MDL group ($p < 0.01$), and in none of the control group ($p < 0.01$). Five of the seven patients with evidence of denervation at three months had positive Trendelenburg signs; two were Grade II positive.

Fig. 1

Diagram of the femoral head and neck showing the line of oblique trochanteric osteotomy.

Follow-up radiographs in 28 patients of the MDL group showed evidence of trochanteric malunion or non-union in 11 cases (Table III). In four hips the trochanteric wires had broken, in two there was proximal migration of the trochanteric sliver and in nine hips the sliver was undisplaced but ununited. Hip abductor function was significantly better in the 17 hips with radiological evidence of trochanteric union than in the 11 hips with trochanteric malunion or non-union ($p < 0.05$).

DISCUSSION

Denervation of the gluteal flap was presumed from EMG analysis of the tensor fascia lata. This muscle is the end supply of the inferior branch of the superior gluteal nerve, which supplies the muscles of the gluteal flap through more proximal branches (Brash 1955). Although the incidence of denervation two weeks after operation was significantly higher in the DL group than in either the MDL or P groups, this difference was much less three months later. This suggests that a traction injury to the nerve occurred in the DL group but that it was significantly less common with the technique used in the MDL group.

All patients in the MDL group were operated on by

Fig. 2

Electromyogram showing denervation. Initially, an interference pattern is produced by adjacent muscles as the patient flexes the hip against gravity. Then at rest, spontaneous electrical activity is detected as fibrillation potentials.

d=6-8cms (posteriorly)
d=3-5cms (anteriorly)
(9 dissections)

Fig. 3

Posterior view of the hip showing the course of the inferior branch of the superior gluteal nerve.

Table I. Number of hips with evidence of denervation and with pain

	Surgical approach		
	Direct lateral	Modified direct lateral	Posterior
Total number of hips studied	29	29	21
Number with evidence of denervation at two weeks	10	3	3
at three months	5	1	1
Number of hips with significant trochanteric pain (≥ 3)	7	2	3

the same surgeon and particular care was taken to protect the nerve. For the lateral approach, therefore, proximal gluteal splitting should be kept to a minimum and any extension of the exposure should be obtained by distal splitting of the vastus lateralis. Three hips showed evidence of denervation at the initial examination after the posterior approach, which indicates that the inferior branch of the superior gluteal nerve can be injured during this approach, presumably by injudicious retraction.

Table II. Results of the Trendelenburg test performed at three months on 72 hips without evidence of denervation

	Surgical approach		
	Direct lateral	Modified direct lateral	Posterior
Negative	15	20	18
Positive, Grade I	2	7	2
Grade II	7	1	0
Total	24	28	20

We tried to quantify abductor muscle power using a wall mounted tensiometer (Nutton and Checketts 1984), but found the readings inconsistent and therefore used the modified Trendelenburg test. In all, 17 patients had a Grade I positive and 11 a Grade II positive Trendelenburg test, yet only five of these patients had evidence of denervation on EMG. This suggests that abductor weakness after a direct lateral approach to the hip is usually due to detachment of the anterior gluteal flap

Table III. Radiographic appearance at three months in 28 cases operated upon using the modified direct lateral approach

	Union	Non-union or malunion
Trendelenburg Negative	16	4
Trendelenburg Positive, Grade I	1	5
Grade II	0	2

from its re-attachment to the greater trochanter. This complication can be reduced by taking a sliver of trochanteric bone with the gluteal flap. Among the patients in the MDL group, abductor weakness occurred only in those in whom trochanteric fixation was inadequate. Sliver osteotomy may create problems when the bone is of poor quality or when, after a low neck osteotomy, the posterior trochanteric remnant is frac-

tured. In these circumstances a smaller sliver of trochanter should be taken with the gluteal flap.

In a follow-up to the main study, Trendelenburg tests were performed 12 months after operation for 27 of the 28 patients with positive tests at three months. Of these, 15 patients still had positive Trendelenburg tests; eight were Grade II positive, of which two were in the MDL group and six in the DL group.

Conclusions. The use of the direct lateral approach to the hip can cause abductor weakness. If the inferior branch of the superior gluteal nerve is protected, the incidence of

denervation is low and abductor weakness is caused mainly by avulsion of the anterior gluteal flap from the greater trochanter. Even at 12 months, 56% of hips with abductor weakness at three months still showed positive Trendelenburg tests.

The authors would like to thank Dr Alan Hedges, BSc, PhD, of the Department of Microbiology, University of Bristol for his help with the statistical analysis.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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