DAMAGE TO THE SUPERIOR GLUTEAL NERVE
AFTER THE HARDINGE APPROACH TO THE HIP

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We studied prospectively 81 consecutive patients undergoing hip surgery using the Hardinge (1982) approach. The abductor muscles of the hip in these patients were assessed electrophysiologically and clinically by the modified Trendelenburg test. Power was measured using a force plate. We performed assessment at two weeks, and at three and nine months after operation.

At two weeks we found that 19 patients (23%) showed evidence of damage to the superior gluteal nerve. By three months, five of these had recovered. The nine patients with complete denervation at three months showed no signs of recovery when reassessed at nine months. Persistent damage to the nerve was associated with a positive Trendelenburg test.

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The direct lateral approach to the hip was described by Hardinge in 1982 and is based on the observation made by McFarland and Osborne (1954) that the gluteus medius and vastus lateralis are in functional continuity through the thick tendinous periosteum covering the greater trochanter. This approach involves splitting the gluteus medius and retracting a portion of the muscle anteriorly in continuity with the vastus lateralis. It avoids trochanteric osteotomy, but the neurovascular supply of gluteus medius and tensor fascia lata is vulnerable (Bos et al 1994). The function of the abductors may be impaired after operation if there is damage to the superior gluteal nerve or if the muscle flap is reattached inadequately to the trochanter.

We investigated the incidence of clinical and electrophysiological evidence of damage to the superior gluteal nerve after this approach.

PATIENTS AND METHODS
We studied prospectively 81 patients undergoing hemiarthroplasty in Southlands Hospital, Shoreham-by-Sea and Cork University Hospital after fracture or arthroplasty of the hip. Patients with pre-existing neuromuscular abnormality or preoperative immobility were excluded. There were 62 women and 19 men with a mean age of 71.6 years (61 to 94). Hemiarthroplasty after a fracture of the neck of the femur was performed in 51 and total hip replacement for arthritis in 30.

In all cases we used the direct lateral approach as described by Hardinge (1982). The gluteus medius was detached from the trochanter anteriorly in continuity with the vastus lateralis. The incision was extended proximally from the apex of the greater trochanter and the fibres of gluteus medius were split taking care to remain within 4 cm of the tip of the greater trochanter (Fig.1). To improve

![Fig. 1](image-url)

The line of incision in gluteus medius and vastus lateralis and the surface landmarks for insertion of needle electrodes into gluteus medius and tensor fascia lata.
exposure a retractor was placed deep in the gluteus medius flap but excessive retraction was avoided and care was taken that the split in the muscle did not extend proximally. During closure, the tendinous portion was reattached securely with interrupted non-absorbable sutures. After operation all patients were assessed clinically and by electrophysiological studies.

Clinical assessment. We performed the modified Trendelenburg test as described by Hardcastle and Nade (1985). The patient stood behind a Zimmer frame and was able to use only the weight-bearing side for balance. He or she was asked to stand on the operated side and lift the opposite leg by flexing the hip to between neutral and 30° and flexing the knee enough to lift the foot from the ground. The examiner observed the patient from the back and studied the line of the iliac crests. The appearances were classified as follows:

1) Normal. The pelvis on the non-weight-bearing side can be elevated high and maintained for 30 seconds.
2) Abnormal. Elevation of the pelvis is present but not the maximum.
3) Abnormal. The pelvis is elevated but cannot be maintained in this position for 30 seconds.
4) Abnormal. There is dropping of the pelvis on the non-weight-bearing side.

Force-plate assessment. All patients had an objective analysis of the power of the abductor muscles using a vertically-mounted electronic scale which was placed laterally at the level of the knee. The patient abducted the hip with the knee straight while the opposite leg was held immobilised to act as a counter balance. The average of three readings was taken as the abductor power of the hip in kilograms. Clinical and force-plate assessments were performed at three and nine months after operation.

Electrophysiological assessment. This was undertaken by a neurotechnician (NMcc) under the guidance of a neurologist. We used the Medelec-sapphire 2M portable EMG machine (Medelec, Woking, UK) with concentric needle electrodes which were inserted into gluteus medius and tensor fascia lata. The surface landmark for the site of insertion of the needle for gluteus medius was 5 cm below the iliac crest on a line drawn vertically down from a line joining the anterior and posterior iliac spines (Perotto 1994) (Fig. 1). Recordings were taken at two other sites in gluteus medius each 1 cm apart. Tensor fascia lata was studied by inserting the needles at the junction of a line drawn vertically downwards from the anterior superior iliac spine and a horizontal line drawn from the greater trochanter (Fig. 1). Two other sites 1 cm apart in the tensor fascia lata were also sampled. The normal contralateral side was examined first in both relaxation and voluntary contraction to obtain a normal EMG pattern. The diagnosis of acute denervation required the presence of fibrillation and positive sharp waves. Electrophysiological examination was performed on all patients two weeks after operation; when an abnormality was detected the tests were repeated at three and nine months.

RESULTS

Electrophysiological studies. Nineteen patients (23%) showed EMG evidence of acute denervation at two weeks after operation. Further studies at three months showed that

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**Fig. 2**

The outcome in 81 patients studied clinically and by electrophysiological tests following the Hardinge approach to the hip.
nine (11%) remained denervated and five had evidence of reinnervation; five patients were lost to follow-up. At nine months, the five with evidence of reinnervation at three months had fully recovered, but the nine with denervation at three months showed no evidence of recovery.

**Clinical assessment.** All nine patients with persistent EMG evidence of denervation had a positive Trendelenburg test (with dropping of the pelvis on the opposite side) at three months which remained positive at nine months. By contrast, the five with electrophysiological evidence of some reinnervation had a positive Trendelenburg test at three months but this had recovered at nine months.

Of the 62 patients who showed no EMG evidence of denervation, 25% of the 44 examined at three months had a positive Trendelenburg test (Fig. 2). At nine months one-third of these had become Trendelenburg-negative. Of those who remained positive, one showed dropping of the pelvis and the remainder were not able to achieve maximal elevation or could not sustain it for 30 seconds. The presence of a positive modified Trendelenburg test with dropping of the pelvis correlated with electrophysiological evidence of damage to the superior gluteal nerve (Fisher’s exact test, p < 0.01).

Using force-plate analysis, we calculated the mean value for the difference in abductor power between the operated and normal hips in the patients with and without evidence of acute denervation (Table I). When these values were compared at three months using the two-sample, two-tailed t-test, patients with EMG evidence of damage to the superior gluteal nerve were shown to have less abductor power than those with normal EMG findings (p < 0.0001).

There was a slightly higher incidence of nerve damage after total hip replacement than after hemiarthroplasty, but the numbers were too small to establish statistical significance. The level of experience of the surgeon (three consultants, one senior registrar, one registrar) did not appear significantly to affect the incidence of nerve damage.

**DISCUSSION**

The superior gluteal nerve leaves the pelvis through the greater sciatic foramen above the piriformis and runs horizontally and forwards beneath the posterior border of gluteus medius. It is a motor nerve and supplies gluteus medius, gluteus minimus and tensor fascia lata (Brash 1955). The patterns of branching and distribution of the branches with respect to the greater trochanter have been studied (Jacobs and Buxton 1989). The main nerve terminates in the middle third of the gluteus medius, and two patterns of branching have been described. There is reported to be a 5 cm ‘safe zone’ above the greater trochanter, but Bos et al (1994) found a more inferior branch 1 cm closer to the tip of the trochanter. Baker and Bitounis (1985) dissected nine cadavers and found that anteriorly the inferior branch of the superior gluteal nerve may be as close as 3 cm to the tip of the greater trochanter. Foster and Hunter (1987) reported a mean distance of 7.82 cm between the nerve and the tip of the trochanter.

The risk of damage to the inferior branch of the nerve was recognised by Hardinge (1982) who cautioned against excessive retraction of the gluteal flap. Manual retraction is considered to be safer than the use of a self-retaining retractor (Jacobs and Buxton 1989). Traction injury was also observed by Baker and Bitounis (1985) who studied 29 patients after a direct lateral approach. They found evidence of denervation in ten patients at two weeks after operation; five had recovered by three months. Hardy and Synek (1988) found EMG evidence of mild neurogenic changes in the tensor fascia lata and gluteus medius in one patient in a series of seven. Abitbol et al (1990) reported subclinical but abnormal findings on EMG studies in 77% of 45 patients at six weeks after operation; this reduced to only 40% at 52 weeks.

In our study, 19 of 81 patients showed evidence of nerve damage at two weeks after operation, and nine of the 14 studied remained denervated at nine months and showed positive modified Trendelenburg tests. Electrophysiological evidence of recovery at three months appeared to predict a full return of function, but persistent denervation suggests complete loss of conduction.

A persistently positive Trendelenburg test in the absence of EMG evidence of denervation may be explained by avulsion of the gluteal flap after operation (Baker and Bitounis 1985). Failure of reattachment of the aponeurosis has been studied using metal markers and radiographs: elongation of the sutured aponeurosis by more than 2.5 cm is associated with a Trendelenburg gait (Svensson, Skold and Blomgren 1990).

The Hardinge approach provides good exposure of the hip for arthroplasty, but we have been able to demonstrate persisting damage to the superior gluteal nerve in 11% of patients after this approach.

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**REFERENCES**


