THE EFFECTS OF TROCHANTERIC OSTEOTOMY ON ABDUCTOR POWER

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A series of 167 patients with Charnley-type total hip replacements were studied retrospectively to determine the incidence of trochanteric non-union, the degree of postoperative trochanteric displacement, and the relation between these two complications. The power in the hip abductor muscles, measured with a load-cell device, was significantly reduced if the trochanteric fragment had displaced proximally by more than 3 cm; 12% of those studied fell into this group and, as a consequence, had a poorer result. It was concluded that displacement of the trochanter was of greater importance than bony union in determining function in the replaced hip. Because these unwanted problems may compromise an otherwise successful operation, it is suggested tentatively that trochanteric osteotomy should be abandoned except for difficult primary operations or for revision procedures.

Trochanteric osteotomy gives excellent exposure of the acetabulum and many surgeons consider it to be an important step in total hip replacement. However, union of the osteotomised fragment does not always occur; the rate of non-union has been variously reported to be between 5% and 32% (Charnley and Ferreira 1964; Volz and Brown 1977; Amstutz and Maki 1978; Clarke, Shea and Bierbaum 1979). Strong abductor muscles are essential for a normal gait, and clearly any impairment of their function after total hip replacement could compromise an otherwise successful operation.

When non-union of the osteotomy occurs, there may or may not be proximal migration of the trochanteric fragment. It would seem reasonable to assume that a strong fibrous union might develop when the displacement of the trochanter is small, but this would be unlikely when the separation is wide. It follows that the function of the hip abductor muscles may not be greatly impaired with minimal displacement, but may be markedly reduced if displacement is considerable.

The aims of this study were to identify the incidence of non-union after trochanteric osteotomy, to determine the degree of any subsequent displacement, and to assess any possible effects that this displacement might have on the function of the abductor muscles.

Two alternative methods of wiring the trochanter back into position were examined. The technique described by Charnley (1972), using one double and one single transverse wire was used between 1974 and 1979 (Fig. 1), but subsequently, because of the poor rate of union, a modification of this technique was employed. The modified technique used two double vertical wires in a cross-over manner, together with a single transverse wire (Fig. 2).

Figure 1: Original method of trochanteric wiring (Charnley 1972). Figure 2: Modified method.
MATERIALS AND METHODS
We studied 167 Charnley-type hip replacements in 145 patients. Their average age at operation was 61.7 years. There were 123 hips with primary idiopathic osteoarthritis, 9 with secondary degenerative osteoarthritis, and 25 with rheumatoid arthritis; a further 10 hips had previously been replaced by other types of arthroplasty and were converted at revision to the Charnley type.

The patients were assessed for non-union and displacement of the trochanter, and for strength of the abductor muscles at least six months after operation. Non-union was assumed if there were no bony trabeculae between the trochanter and femur six months after operation, and if the bone on the adjacent surfaces of the osteotomy was sclerotic. Displacement was measured from the inferior edge of the trochanter to the most lateral point of the trochanteric bed.

The patients were allocated initially into five groups depending on the amount of trochanteric displacement: undisplaced; displacement up to 1 cm; displacement between 1 and 2 cm; displacement between 2 and 3 cm; and displacement over 3 cm. It was found that all the trochanters which were displaced by less than 1 cm united; therefore, for the purpose of this study, these were grouped with those in which no displacement had occurred, leaving four groups for study.

When reviewed, the patients were observed walking in their usual footwear, and any significant dipping of the pelvis when bearing weight on the affected leg was considered to be a lurching gait.

The power in the hip abductor muscles was measured by a load-cell device attached to a strap passed around the leg at the level of the malleoli (Fig. 3). Weight was taken on the leg which was not being tested, and by pushing against the strap, the patient abducted the hip under examination as strongly as possible; the measurements (in newtons) were given on a digital read-out meter. The average of three consecutive readings was taken.

The abductor power was calculated from the formula:

\[ T_m = \frac{F_e \times d_e}{d_m} \]

where \( T_m \) is the abductor power, \( F_e \) is the force in newtons, \( d_e \) is the leg length from the estimated centre of the hip to the medial malleolus (Johnston and Smidt 1969), and \( d_m \) is the length of the lever arm (Jensen, Smidt and Johnston 1971). \( d_m \) is measured from a standard standing radiograph of the hip with a radio-opaque ruler included in the film; a line drawn on the radiograph from the anterior superior iliac spine to the superolateral aspect of the trochanter represents the resultant vector of hip abductor power; a perpendicular from this line to the estimated centre of the head of the prosthesis is the lever arm distance, the length being measured against the radio-opaque rule, thus compensating for any radiographic magnification (Fig. 4).
with that in an equal number of patients without displacement who were matched as far as possible for age, pre-operative diagnosis and general health.

RESULTS

Non-union. The trochanter failed to unite in 29 (17.4%) of the 167 hips. Twenty-one (20.8%) of the 101 trochanters fixed by the original wiring technique (Charnley 1972) failed to unite, while non-union occurred in only 8 (12.1%) of the 66 hips fixed with the modified wiring system. Bony union occurred in some patients despite wide displacement of the trochanter and, indeed, in three hips it occurred when the displacement was greater than 3 cm. Displacement. The trochanter had displaced by more than 1 cm in 47 (28.1%) of the 167 hips; the incidence of displacement in relation to the pre-operative diagnosis is shown in Table I.

Thirty-two (31.7%) of the 101 trochanters attached by the original wiring method were displaced by more than 1 cm; in 15 (14.9%) the displacement was greater than 3 cm (Table II).

Table I. Incidence of trochanteric displacement related to pre-operative diagnosis

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Number of hips</th>
<th>Trochanteric displacement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percentage</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary osteoarthritis</td>
<td>123</td>
<td>37</td>
</tr>
<tr>
<td>Secondary osteoarthritis</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td>25</td>
<td>8</td>
</tr>
<tr>
<td>Revision</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>167</td>
<td>47</td>
</tr>
</tbody>
</table>

Table II. Degree of trochanteric displacement related to the technique of wiring and lurching gait

<table>
<thead>
<tr>
<th>Degree of displacement</th>
<th>Method of wiring</th>
<th>Lurching gait and positive Trendelenburg's sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>(cm)</td>
<td>Original</td>
<td>Modified</td>
</tr>
<tr>
<td>0 to 1</td>
<td>69  (0)</td>
<td>51 (0)</td>
</tr>
<tr>
<td>1 to 2</td>
<td>6   (3)</td>
<td>5  (1)</td>
</tr>
<tr>
<td>2 to 3</td>
<td>11  (6)</td>
<td>5  (2)</td>
</tr>
<tr>
<td>&gt; 3</td>
<td>15  (12)</td>
<td>5  (5)</td>
</tr>
<tr>
<td>Total</td>
<td>101 (21)</td>
<td>66 (8)</td>
</tr>
</tbody>
</table>

The number of non-unions are indicated in brackets

In the 66 trochanters fixed with the modified technique, 15 (22.7%) had displaced by more than 1 cm, but in only 5 (7.6%) was the displacement greater than 3 cm (Table II). It appeared that although displacement did occur in these hips, in general it was less than in those in which the original wiring method had been used.

Hip abductor power. The power of the abductor muscles was measured in all the 47 hips with displaced trochanters, and the values compared with 47 hips with undisplaced trochanters. Twenty-four (51.1%) of the hips with displaced trochanters had a positive Trendelenburg’s sign with a lurching gait; in 16 of these the trochanters were displaced by more than 3 cm, in 6 the displacement was between 2 and 3 cm, and in 2 it was between 1 and 2 cm (Table II). Trendelenburg’s sign was positive in only one hip in the control group.

The power of the abductor muscles related to the amount of trochanteric displacement is shown in Figure 5. The mean value in the control group was 1224 newtons.

Graph showing the mean hip abductor power (± standard deviation) plotted against the amount of trochanteric displacement.

With 1 to 2 cm of displacement the mean was 1013 newtons, with 2 to 3 cm it was 965 newtons, and where displacement was greater than 3 cm the mean power was 872 newtons. Statistical analysis (Student’s t test) revealed no significant difference between the power in the controls and in those with 1 to 2 cm or 2 to 3 cm of displacement, but there was a significant difference between the controls and those with trochanters displaced by more than 3 cm ($P < 0.05$).

DISCUSSION

Trochanteric osteotomy provides excellent exposure of the acetabulum and the proximal femur in total hip replacement. It is generally accepted that the osteotomy and the subsequent reattachment of the trochanter increases both the operating time and the blood loss (Harris 1975; Parker et al. 1976; Wiesman et al. 1978), but many surgeons consider that these advantages are outweighed by the very accurate positioning of both the acetabular and femoral components which the osteotomy allows (Charnley 1970; Mallory 1974; Lazansky 1974).

The purpose of this study was to identify the incidence of non-union of the trochanteric fragment, and more importantly, to assess the effect of any displacement on the power of the hip abductor muscles.
The incidence of non-union has been reported to be between 5% and 32%, with many differing techniques described for relocating and holding the trochanter (Charnley and Ferreira 1964; Coventry 1973; Bechtol, Crickenberger and O'Rourke 1977; Harris and Crothers 1978; Clarke et al. 1979). In this series, the overall rate of non-union was 17.3%; with the original wiring technique the rate was 20.8%, and with the modified method, using two double vertical wires, it was 12.1%.

However, this study has shown that the degree of proximal migration of the trochanter is of greater importance than non-union in the overall function of the replaced hip. Bony union occurred in a few patients even in the group where the trochanter had migrated by more than 3 cm, but the mean value of hip abductor muscle power in this group was 872 newtons, compared with the control group value of 1224 newtons. This difference was statistically significant.

Twenty-four (51.1%) of the 47 patients with displaced trochanters who were studied had some impairment of gait which could be related to poor abductor power, and 16 of these had proximal migration of more than 3 cm. The modified wiring system seemed to be of some benefit in this respect, as there was a smaller proportion of patients with migration of more than 3 cm, and consequently fewer patients with a lurching gait.

Unfortunately, it is not possible to predict before operation the patients in whom the trochanter is likely to displace. The pre-operative diagnosis appeared to be unrelated to trochanteric migration. Indeed, in some with bilateral replacements, the trochanter united in an anatomical position on one side, and displaced widely on the other. A lurching gait, necessitating permanent use of a stick, was often the only complaint after an otherwise successful operation; this lurch was, of course, entirely due to the osteotomy of the trochanter.

Our study has shown clearly that displacement of the trochanter of less than 1 cm will almost invariably leave the power of the hip abductor muscles unimpaired. However, when the displacement is greater than 1 cm, they are likely to be weak, whether bony union occurs or not. The greater the displacement, the more likelihood there is of an unsatisfactory lurching gait, and of a generally poorer result.

If trochanteric displacement is to be avoided, it would seem that a more efficient and regularly reproducible method of fixation must be found. The use of the trochanter cable-grip system (Dall and Miles 1983) might appear to be the technique of choice at the present time.

Alternatively, perhaps it would be wise to abandon trochanteric osteotomy for routine cases, reserving it for particularly difficult cases or for revision operations.

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REFERENCES


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