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# A comparison of three lateral approaches in primary total hip replacement

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**Summary.** *Three different lateral approaches for a Charnley total hip replacement were studied in 264 operations. The transtrochanteric approach was used in 94, the Liverpool in 88 and the Hardinge in 82. The mean follow up was 2.6 years (range 2 to 3 years). The clinical result was the same in each group. Radiographs showed that alignment of the femoral stem was significantly better in the transtrochanteric group. Grade III socket demarcation was more frequent with the Liverpool approach. There was no difference in cement distribution between the 3 groups, except the acetabular cement distribution was poor with the Hardinge approach. There was no increase in Trendelenburg gait after the Hardinge or Liverpool approach compared with the transtrochanteric approach. Dislocation was a problem after the transtrochanteric approach and risk factors were retroversion of the acetabular cup and detachment of the trochanter. Severe heterotopic bone formation was 5 times more common after the Liverpool, compared with the other two, approaches.*

**Résumé.** *Les effets de trois voies d'abord latéral pour arthroplastie totale de la hanche cimentée de Charnley ont été étudiés sur 264 hanches. La voie de Hardinge fut utilisée chez 82 patients, la voie trans-trochantérienne chez 94 et la voie de Liverpool chez 88. Le recul moyen est de 2,6 ans (2 à 3 ans). Les résultats cliniques globaux sont similaires dans les 3 groupes. L'étude radiologique a montré que le positionnement de la tige fémorale était significativement meilleur dans le groupe de l'approche trans-trochantérienne. Un liseré cotyloïdien de grade III apparaissait plus fréquemment après voie de Liverpool. Il n'y avait pas de différence dans la distribution du ciment fémoral dans les 3 abords, mais dans la voie de Hardinge, la distribution du ciment cotyloïdien était de moins bonne qualité. Il n'y avait pas de majoration de la boiterie de Trendelenbourg après les voies de Hardinge ou de Liverpool comparée à la voie trans-trochantérienne. Les luxations étaient assez fréquentes après l'approche trans-trochantérienne. Les facteurs de risques étaient la rétroversion cotyloïdienne et le démontage trochantérien. Des ossifications hétérotopiques apparurent 5 fois plus fréquemment après la voie de Liverpool que dans les deux autres groupes.*

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## Introduction

Charnley emphasised the importance of removal of the trochanter in total hip replacement (THR) and suggested that this approach provided excellent exposure and better placement of the prosthesis [4]. He used stainless steel wire to re-attach the trochanter; subsequently many different methods have been described [1, 4, 8, 19, 48].

McFarland and Osborne introduced a direct lateral approach in which the trochanter is not removed [30]; modifications produced the Liverpool approach and the Hardinge approach [18] which are widely practised in the United Kingdom. The criticism is that the abductor muscles may be

**Table 1.** Mean improvement in the Charnley Score

| | | Transtro-chanteric | Liverpool | Hardinge |
|---|---|---|---|---|
| 1. Pain: | Pre-op | 2.6 | 2.7 | 2.6 |
| | Post-op | 5.8 | 5.8 | 5.8 |
| | Mean difference | 3.2 | 3.1 | 3.2 |
| 2. Walk: | Pre-op | 2.9 | 2.7 | 2.8 |
| | Post-op | 5.5 | 5.6 | 5.7 |
| | Mean difference | 2.6 | 2.9 | 2.9 |
| 3. Rom: | Pre-op | 3.0 | 3.0 | 3.1 |
| | Post-op | 5.8 | 5.7 | 5.8 |
| | Mean difference | 2.8 | 2.7 | 2.7 |

chi-square test = 0.024 (4df); $P > 0.2$

damaged leading to postoperative weakness and limp [33]. Horwitz compared the transtrochanteric with the Hardinge approach and found no significant difference in the clinical results [22].

This prospective study was undertaken to determine the short term consequences of the three approaches, comparing the early clinical results, radiological changes and the incidence of complications.

## Patients and methods

From January 1987 until October 1989, 354 Charnley THRs were performed by three consultant surgeons at Clatterbridge Hospital, Wirral, England. Of these, 264 operations for primary osteoarthritis were selected for study, using the three approaches: transtrochanteric in 94; Liverpool in 88 and Hardinge in 82. Patients with secondary osteoarthritis, previous hip operations and infected THRs were excluded.

Using Charnley's categories [4] 136 hips were graded A (unilateral hip disease, no other disabilities, 81 grade B (bilateral hip disease and no other functional disability), and 47 grade C (hip disease with systemic disease or other disabilities).

*Approaches.*

(1) Transtrochanteric [48]. The trochanter is cut with a Gigli saw to make a biplane osteotomy, and is fixed back with a single horizontal and a double vertical wire.

(2) Liverpool [42]. The gluteus medius is reflected anteriorly in continuity with vastus lateralis. A slither of bone is taken with the gluteal flap to allow better fixation of the flap to the greater trochanter during closure. The conjoint tendon with gluteus miminus and the capsule is elevated as a flap.

(3) Hardinge [18]. This is similar to the Liverpool approach, except that a slither of bone is not taken.

*Surgical technique.* The Charnley hip prosthesis was fixed with methylmethacrylate (Palacos) and the same cementing technique was used in every case. Multiple drill holes were made in the floor of the acetabulum. When using the Liverpool approach, the acetabulum was reamed to expose the subchondral cancellous bone, but this was not done in the other two approaches.

The femoral component was inserted by broaching the medullary canal with removal of all loose cancellous bone, followed by irrigation and then drying the canal. A distal intramedullary plug and vent tubes were used. Cement was packed manually and femoral components of the same size were used in every case.

An abduction pillow was placed between the legs after operation and intravenous antibiotics were given for 24 h. Physiotherapy was begun on the first day and walking with crutches was allowed on the second day.

The patients were followed up at 6 weeks, 6 months and one year after operation. Clinical outcome was assessed by the Charnley 1–6 grading system separately for pain function and range of movement (6 is the best possible result) (Table 1). Results were grouped into excellent, good, fair and poor using Wejkner's criteria [46]. Further assessment included gait, power of abduction and the Trendelenburg test (Table 2). Complications such as wound infection, haematoma, dislocation, deep vein thrombosis, neurological and vascular problems, and heterotopic bone formation were noted.

**Table 2.** The functional capacity in the three approaches

| | | Transtro-chanteric | Liverpool | Hardinge |
|---|---|---|---|---|
| 1. Stairs: | | | | |
| | No problem | 39 | 35 | 38 |
| | With difficulty | 53 | 51 | 42 |
| | Unable | 2 | 2 | 2 |
| | | | | $P > 0.2$ |
| 2. Car: | No problem | 91 | 86 | 80 |
| | With difficulty | 3 | 2 | 2 |
| | | | | $P > 0.2$ |
| 3. Foot care: | | | | |
| | Easy | 88 | 78 | 80 |
| | With difficulty | 6 | 10 | 2 |
| | | | | $P > 0.1$ |
| 4. Limp: | | | | |
| | Normal gait | 65 | 55 | 51 |
| | Mild limp | 22 | 27 | 26 |
| | Moderate/ gross limp | 7 | 6 | 5 |
| | | | | $P > 0.1$ |
| 5. Support: | | | | |
| | No support | 67 | 53 | 63 |
| | Cane for long distance | 17 | 24 | 9 |
| | One cane | 10 | 11 | 10 |
| | | | | $P > 0.1$ |
| 6. Trendelenburg test: | | | | |
| | Normal | 73 | 68 | 65 |
| | +ve delayed response | 8 | 7 | 9 |
| | No elevation of pelvis | 6 | 3 | 3 |
| | Drooping | 4 | 2 | 2 |
| | Nonvalid response | 3 | 8 | 3 |
| | | | | $P > 0.2$ |

**Table 3.** Alignment of the components in the three approaches

| | Transtro-chanteric (94) | Liverpool (88) | Hardinge (82) |
|---|---|---|---|
| Cup | | | |
| a. Acetabular angle | | | |
| 30°–50° | 85 | 76 | 68 |
| <30° | 9 | 12 | 12 |
| >50° | 0 | 0 | 2 |
| | | ($P$ = 0.34) | |
| b. Version | | | |
| Anteversion <10° | 67 | 69 | 61 |
| Anteversion >10° | 3 | 4 | 7 |
| Retroversion >0° | 4 | 6 | 6 |
| Version not assessed | 20 | 9 | 8 |
| | | ($P$ = 0.25) | |
| c. Height | | | |
| <1 cm | 67 | 58 | 63 |
| >1 cm | 27 | 30 | 19 |
| | | ($P$ = 0.34) | |
| d. Depth | | | |
| <5 mm | 60 | 43 | 66 |
| >5 mm | 34 | 45 | 16 |
| | | ($P$ = 0.001) | |
| Stem | | | |
| a. Alignment | | | |
| Normal (within 5°) | 87 | 77 | 65 |
| Varus 5° | 5 | 2 | 16 |
| Valgus 5° | 2 | 9 | 1 |
| | | ($P$ = 0.03) | |
| b. Version | | | |
| Normal Version (0–10° Anteversion) | 64 | 53 | 54 |
| Anteversion >10° | 10 | 21 | 21 |
| Retroversion >0° | 2 | 1 | 1 |
| Version not assessed | 18 | 13 | 6 |
| | | ($P$ = 0.04) | |

*Radiological assessment.* Anteroposterior and lateral radiographs were taken in all 264 patients. Standard lateral views were obtained with the patient flat and the limb held in neutral rotation; the film was then placed above the greater trochanter at 45° to the leg so that it was parallel to the neck of the femur.

Six variables were measured by the author to evaluate the position of the components (Table 3):

(1) Acetabular angle was assessed by drawing a line through the medial and lateral margins of the equatorial marker and a horizontal line through the lowest part of the ischial tuberosities (acceptable 30° to 50°).

(2) The version of the cup in a lateral radiograph is the angle formed by a line tangential to the face of the acetabulum and one perpendicular to the horizontal [47]. An acceptable angle is from 0–10°, but this is an approximation.

(3) The depth of the cup is normal when the most medial part of the semicircular wire is flush with the lateral border of the tear drop (N = <1 cm).

(4) The height of the cup is the vertical distance from the centre of the head of the prosthesis to a horizontal line passing through the lower part of both tear drops.

**Table 4.** Distribution of the cement in the three approaches

| | Transtro-chanteric | Liverpool | Hardinge |
|---|---|---|---|
| Cup | | | |
| Grades | | | |
| I (All zones >5 mm) | 58 | 48 | 30 |
| II (2 zones >5 mm) | 33 | 34 | 37 |
| III (1 zone >5 mm) | 3 | 6 | 15 |
| | chi-sq. test = 18.4 | $P$= <0.001 | |
| Stem | | | |
| a. Lateral cement | | | |
| (>3 mm) | 63 | 62 | 57 |
| (<3 mm) | 31 | 26 | 25 |
| | chi-sq. test = 0.26 | $P$ >0.2 | |
| b. Medial cement | | | |
| (>3 mm) | 77 | 81 | 71 |
| (<3 mm) | 17 | 7 | 11 |
| | Chi-sq. = 4.08 | $P$ >0.1 | |
| c. Inferior cement | | | |
| (>10 mm) | 92 | 85 | 75 |
| (<10 mm) | 2 | 3 | 7 |
| | Chi-sq. = 4.53 | $P$ >0.1 | |

**Table 5.** Complications

| | Transtro-chanteric | Liverpool | Hardinge |
|---|---|---|---|
| 1. Superficial infection | 2 | 3 | 4 |
| 2. Deep infection | 1 | 1 | 2 |
| 3. Dislocation | 5 | 3 | 1 |
| 4. Proximal vein thrombosis | 3 | 1 | 1 |
| 5. Pulmonary embolism | 1 | 0 | 1 |
| 6. Trochanteric tenderness | 5 | 2 | 1 |
| 7. Heterotopic bone: | | | |
| Grade 0 | 60 | 31 | 62 |
| Grade I | 21 | 28 | 16 |
| Grade II | 11 | 19 | 2 |
| Grade III | 2 | 9 | 2 |
| Grade IV | 0 | 1 | 0 |
| | Chi-sq. = 38.1 | $P$ <0.001 | |
| a. Stem (at risk factors) | | | |
| Lateral separation of the stem (one mm or more) | 2 | 1 | 1 |
| Demarcation at tip | 1 | 2 | 1 |
| Endosteal cavitation | 1 | 1 | 2 |
| Fracture of cement | 0 | 0 | 1 |
| b. Cup | | | |
| Overall demarcation | 29 | 35 | 47 |
| Type I | 13 | 12 | 29 |
| Type II | 9 | 9 | 11 |
| Type III | 7 | 14 | 7 |
| | Chi-sq. = 10.6 | $P$ = 0.03 | |

**Table 6.** Factors influencing dislocation

| | Dislo-cation | No disloca-tion | Statistics |
|---|---|---|---|
| Cup retroversion >5° | | | |
| Present | 6 | 10 | chi-sq. = 50.8 |
| Absent | 3 | 208 | $P$ <0.0001 |
| Stem anteversion >10° | | | |
| Present | 4 | 48 | chi-sq. = 2.46 |
| Absent | 5 | 170 | $P$ >0.2 |
| Combined malalignment (Cup retroversion >5° & Stem anteversion >10°) | | | |
| Present | 5 | 1 | chi-sq. = 87.94 |
| Absent | 4 | 217 | $P$ <0.0001 |
| Trochanteric detachment | | | |
| Detachment | 3 | 2 | chi-sq. = 31.35 |
| No Detachment | 2 | 87 | $P$<0.0001 |

$P$ = Fisher's exact p value
Note: In 37 patients, version of the cup and stem could not be assessed due to poor quality radiographs

(5) The varus/valgus alignment of the stem is the angle between its long axis and the diaphysis of the femur; 0–5° of varus or varus is acceptable.

(6) The version of the stem is the angle between the long axis of the neck of the prosthesis and the coronal plane as seen on a lateral film [14]. This is plotted against the neck-shaft angle to determine anteversion (0–10°).

The thickness of the cement mantle was measured (Table 4) and any radiological demarcation at the bone-cement interface recorded (Table 5). On the acetabular side, three zones were assessed [9]. The appearance of the socket after operation was divided into 4 types [21]: type 1 – demarcation of the outer third only; type 2 – demarcation of the outer and middle thirds; type 3 – complete demarcation; type 4 – migration. The changes round the femoral stem were recorded in 7 zones [16].

Heterotopic bone formation was assessed [3] as grade I with islands of bone in the soft tissues, grade II which had spurs from the proximal part of the pelvis or femur; grade III with new bone occupying more than half the gap between the femur and the pelvis and grade IV which showed bony ankylosis.

All variables between the three approaches were analysed statistically by comparing various parameters with resultant p values with 95% confidence intervals. Chi-square testing (Saber Software) was performed to determine statistical significance and evaluate the data. When appropriate, Fisher's exact test was used.

## Results

There were no significant differences between the three approaches with regard to pre- and post-operative Charnley scores for pain, function and range of movement (Table 1). Using Wejkner's criteria [46], the percentages of good to excellent results were 96%, 95% and 95%. No significant differences were found between the approaches in abductor efficiency using the standardised Trendelenburg test [17] (Table 2).

Differences in prosthetic alignment are shown in Table 3. Differences in cup alignment in the three approaches were not statistically significant, but stem alignment was significantly better in the transtrochanteric and Liverpool approaches.

There was no significant difference in cement distribution (Table 4) on the femoral side, but socket distribution was better in the transtrochanteric and Liverpool groups; in the Hardinge group, there were 15 cases in which the cement mantle was more than 5 mm in one zone only.

Demarcation at the tip of the femoral stem was found in 4 hips, lateral separation in 4, fracture of the cement in 1 and endosteal cavitation in 4 (Table 5), and these were uniformly distributed in the three approaches. In the Liverpool approach, there were twice as many sockets with type 3 demarcation as in the other approaches and this was statistically significant ($P$ = 0.03).

Of the 94 cases in the transtrochanteric group, 82 (87%) had bony union and there were only 5 complete detachments. Nonunion occurred in 13 (15%) cases with the Liverpool approach. The number of dislocations in the three approaches was 5 in the transtrochanteric, 2 in the Liverpool and 1 in the Hardinge (Table 5). Dislocation occurred when retroversion was more than 5° in 6 patients. In 4, there was malalignment of both cup and stem (Table 6) which was significant ($P$ <0.0001). Trochanteric detachment occurred in 3, and 7 of the dislocations were recurrent.

Heterotopic ossification was present in 36% of transtrochanteric, 65% of Liverpool and 24% of the Hardinge approaches (Table 5), and was severe in 11% of the Liverpool group compared to 2% in the other two approaches.

## Discussion

This paper presents the clinical and radiological difference in three different lateral approaches to the hip. Although the follow up is for only 2 years, the importance of short term follow up has been emphasised [9, 24, 34]. No differences were found between the three approaches as far as clinical improvement is concerned [23, 35, 39, 44].

The Hardinge approach avoids complications attributed to detachment of the trochanter and provides excellent exposure. There is a risk of gluteal weakness since the superior gluteal nerve could be damaged. There was, however, no difference between the three groups in the occurrence of a positive Trendelenburg test after operation, but 10–15% of patients will have some gluteal weakness irrespective of the approach [37].

Extreme malalignment of the components can affect the long term results [2, 6, 27, 45]. In this series, alignment of the stem was better with the transtrochanteric approach, but there were no differences in the alignment of the cup. Dislocation was more common when the cup was retroverted, particularly when associated with anteversion of the stem [38].

The femoral stems with a cement mantle 2–5 mm thick in the proximal and medial area had a better outcome than those with a mantle either thinner or thicker than the optimum 5 mm [7, 10, 23, 29]. There were no differences in the distribution of femoral cement between the approaches, but the Hardinge showed less good distribution of cement around the cup.

Long-term fixation of the cemented cup remains a problem [19], and early radiological changes may predict future loosening [9, 21]. In this series, grade III cup demarcation was twice as common in the Liverpool approach, but in these cases the subchondral bone was removed and it is suggested that when this layer is preserved, fixation is better [12, 28].

Stem failure was recognised by progression of subsidence, demarcation, separation from the cement, cement fracture or endosteal cavitation [34]. An isolated finding of one of these signs was evenly distributed between the approaches and cannot be blamed for failure when it does not progress [12, 27].

The complications of trochanteric osteotomy are local tenderness, nonunion and total detachment, a poor gait, dislocation [5, 44], and broken wires, which were found in 44 hips (47%) with fracture of the horizontal spring wire occurring frequently. Nonunion has been reported as between 0.8% and 32% [1, 8, 20, 32, 48] and was 13% in this study. The effect of displacement on abductor function has been described [1, 32, 37].

Infection, deep vein thrombosis and pulmonary embolism were the same in the three groups. Thromboembolism may occur more often with the transtrochanteric approach because of the longer operation, but it has not been possible to confirm this.

Many factors may be responsible for dislocation [11, 13, 25], and the risk was greater with the transtrochanteric approach when there was malalignment. A six-fold increase in hip instability has been reported with nonunion of the trochanter [31]. In this series alignment was better in the transtrochanteric group, but dislocation occurred more often.

Several factors have been put forward to explain the pathogenesis of heterotopic ossification [9, 15, 26, 40, 41], but there have been only a few studies about its association with the operative approach [36, 43]. The incidence was 42% in this study and a severe form occurred 5 times more frequently with the Liverpool approach than with the other two.

Good visualisation can be obtained with the Liverpool and Hardinge approaches. The transtrochanteric approach is more demanding, and recurrent dislocation remains a problem. Because of the high incidence of heterotopic ossification with the Liverpool approach, the Hardinge approach is better for primary hip replacement.

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