Functional results and complications following conversion of hip fusion to total hip replacement

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Eighteen hip fusions were converted to total hip replacements. A constrained acetabular liner was used in three hips. Mean follow up was five years (two to 15). Two (11%) hips failed, requiring revision surgery and two patients (11%) had injury to the peroneal nerve. Heterotopic ossification developed in seven (39%) hips, in one case resulting in joint ankylosis. No hips dislocated.

Conversion of hip fusion to hip replacement carries an increased risk of heterotopic ossification and neurological injury. We advise prophylaxis against heterotropic ossification.

When there is concern about hip stability we suggest that the use of a constrained acetabular liner is considered. Despite the potential for complications, this procedure had a high success rate and was effective in restoring hip function.

Patients with longstanding hip fusion are predisposed to symptomatic degenerative changes of the lumbar spine, ipsilateral knee and contralateral hip. In such patients, conversion of the hip arthrodesis to hip replacement can provide relief of such symptoms. However, this is a technically demanding procedure associated with higher complication and failure rates than routine total hip replacement. Previous surgeries result in scarring of the soft tissues and distortion of anatomical landmarks. In addition removal of metalwork related to the fusion procedure can be difficult.

The aim of this study was to determine the early functional results and complications in patients undergoing hip fusion conversion to total hip replacement, performed or supervised by a single surgeon, using a standardised approach and mainly uncemented implants. We hypothesised that a satisfactory functional improvement can be achieved in following conversion of hip fusion to hip replacement.

Patients and methods
The study group comprised of eighteen patients who had undergone conversion of unilateral hip fusion to total hip replacement between 1996 and 2007. Data was collected by retrospective review of a prospective database. Fourteen hips underwent surgical arthrodesis (Fig. 1) and in four hips fusion was spontaneous secondary to septic arthritis during childhood. The diagnosis prior to fusion was traumatic injury in eight hips, septic arthritis in seven and developmental dysplasia in three.

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There were five men and 13 women. The mean age at the time of conversion was 53 years (21 to 77) and the mean time between fusion and conversion to hip replacement was 33 years (11 to 60). Mean follow up was 5 years (2 to 15).

Indication for surgery. In two patients, conversion of hip arthrodesis to hip replacement was performed because of an acute fracture of the proximal femur below the level of arthrodesis. In the remaining patients conversion was indicated for lumbar back pain, ipsilateral knee pain, contralateral hip pain and pain from the region of the fused hip.

Outcome measures. The Harris hip score was measured pre-operatively, at six months, 12 months and a minimum of two years post-operatively. At most recent follow up, anteroposterior and lateral radiographs of the hip replacement were examined and compared to the initial post-operative radiographs. An assessment was made of the evidence of prosthesis subsidence, pedestal formation and the presence of radiolucent and reactive lines in gruen zones 1 to 7 of the femoral stem and zones 1 to 3 of the acetabulum. Prosthesis subsidence was determined by measuring the vertical distance between the tip of the greater trochanter and superior aspect of the femoral stem. An increase in this distance 2 mm or more is consistent with femoral stem subsidence. Heterotopic ossification was graded according to Brooker et al. Clinical assessment of leg length was made post operatively to determine leg length...
discrepancy. Pre-operative leg length discrepancy was also assessed, but accuracy of true leg length measurement was compromised by the fixed position of the fused hip.

**Surgical procedure.** Urinary catheterisation was performed prior to surgery in all patients. Prophylactic antibiotics Ancef 1 g and Gentamicin 80 mg were administered intravenously prior to the skin incision. A further two doses of Ancef 1 g were then administered at eight hourly intervals. In addition Trimethoprim 200mg was administered twice daily until catheter removal. Prophylaxis against heterotopic ossification was not implemented. Subcutaneous low molecular weight Heparin was used for DVT prophylaxis for three weeks.

All procedures were performed by, or under the supervision of a single surgeon. In all cases approach to the arthrodesed hip was via a trochanteric slide osteotomy. The technique used for trochanteric slide osteotomy is modified to preserve the posterior hip capsule and has been described previously. The sciatic nerve was identified and protected throughout the procedure. An attempt was made to equalise leg length, but limb lengthening was limited to a maximum of 3 cm to avoid a stretch injury to the sciatic nerve. To aid leg length determination, a pin was placed into the iliac crest and a temporary pin which is part of an outrigger device was placed into the proximal femur adjacent to the trochanteric osteotomy site. The outrigger was then used to determine the distance between the pins and allows the intra-operative determination of changes in leg length and offset. In cases where there was difficulty in identifying anatomical landmarks, intra-operative radiographs were performed to assist in the correct placement of the acetabular and femoral components (Fig. 2).

Uncemented acetabular components were used in all cases and uncemented femoral components were used in all but two patients, in whom a hybrid hip replacement was performed at the discretion of the operating surgeon using a cemented stem and uncemented cup. In the remaining 16 hips the femoral components comprised eight ZMR modular femoral components (Zimmer, Warsaw, Indiana), four Versys proximal coated stems (Zimmer); one proximal coated Osteonics stem (Stryker, Allendale, New Jersey); one six inch porcoat stem (Zimmer); one ML taper (Zimmer) proximal coated stem and one PCA (Howmedica, Rutherford, New Jersey) proximal coated stem. The acetabular components used comprised 11 trilogy cups (Zimmer), five trabecular metal cups (Zimmer), one PCA cup (Howmedica, Rutherford, New Jersey) and one PFC (DePuy, Warsaw, Indiana) cup.

Fixation of 14 of the 18 acetabular uncemented components was augmented with between two and five screws. The prosthetic femoral head diameter was 32 mm in eight hips, 28 mm in 5 hips, 36 mm in two hips, 22 mm in two hips and 40 mm in one hip.

In three hips with abductor and soft-tissue deficiency an intra-operative decision was made to use a constrained acetabular liner (Fig. 1b). After definitive components had been inserted the greater trochanter was reduced and fixed.

![Fig. 1a](image1a.png)  ![Fig. 1b](image1b.png)  ![Fig. 2](image2.png)

Radiographs showing a) pre-operative hip fusion and b) the captive cup post-operatively.

Intraoperative radiograph to assess position of trial components.
with cerclage wires. The position of the greater trochanter was adjusted to optimise soft-tissue tension and improve joint stability, with distal displacement if indicated.

**Statistics.** The Pearson’s correlation coefficient was used to compare the association between patient age, duration of hip fusion and the Harris hip score. A comparison of hip scores between groups was made using the Student’s $t$-test.

**Results**

**Hip Scores.** The Harris hip score increased from a mean of 49.1 (36.5 to 60.5) preoperatively to 74.7 (39 to 90) at a mean of 5 years (2 to 15) $p < 0.001$. There was poor correlation between patient age, duration of hip fusion and the Harris hip score at six months, 12 months and at final follow-up of a mean of five years (Table I). Hip scores for patients who had spontaneous fusion were similar to those of patients who had undergone surgical fusion (Table II). Mean post-operative flexion, Abduction, Adduction, external rotation and internal rotation was 66° (0° to 90°), 28° (0° to 40°), 21° (0° to 30°), 20° (0° to 30°) and 18° (0° to 30°) respectively.

**Use of walking aids.** Three patients mobilised without any walking aids. The remaining 15 patients tended to use a walking aid for support, particularly when mobilising over longer distances.

**Leg length discrepancy.** The mean post-operative leg length discrepancy was -1.1 cm (-4 cm to +2 cm) shortening on the side of the operated hip. As previously mentioned, accurate clinical measurement of true leg length discrepancy pre-operatively was not possible because of the fixed position of the fused hip, but was estimated to be a mean of -3 cm (-4 cm to +1.5 cm), shortening on the side of the fused hip.

**Radiological assessment.** None of the femoral components had radiological evidence of loosening. One femoral prosthesis had a non progressive lucent line in zone 7. One PCA acetabular component was loose and had migrated at 15 years follow up. This patient was scheduled for revision surgery. One Trilogy acetabular component in which screws had been used, had a non progressive lucent line limited to zones 2 and 3. None of the three constrained acetabular liners showed evidence of loosening at a mean of 43 months follow up (37 to 54). Heterotopic ossification developed in 7 (39%) of the 18 hips. It was grade 1 in four hips, grade 2 in one hip, grade 3 in one hip and grade 4 in one hip.

**Complications.** There were no cases of prosthetic infection, dislocation or greater trochanter nonunion. One patient developed a DVT involving the popliteal vein, which was confirmed with Doppler ultrasound 11 days after surgery. Two patients, both of whom had surgical fusions, sustained neurological injury. One of these patients had marked weakness of ankle dorsiflexion and altered sensation consistent with compromise of the common peroneal division of the sciatic nerve. In this patient, there was shortening with a 4 cm leg length discrepancy before surgery, after which the leg was lengthened by 3.5 cm. Motor function improved by the second post-operative week and at most recent follow up, 32 months following surgery, had completely recovered. However, paraesthesia was persistent. Another patient developed paraesthesia in the common peroneal nerve distribution, without any motor deficit, that was persistent at the most recent follow up 12 months after surgery. This patient had pre-operative shortening with a 3.5 cm leg length discrepancy and was lengthened by 1.5 cm following hip replacement.

The patient with grade 4 heterotopic ossification developed ankylosis between the acetabulum and proximal femur resulting in complete loss of joint motion (Fig. 3). This patient underwent a reoperation to excise the heterotopic ossification 16 months after the initial hip replacement procedure. This was followed by post-operative irradiation of the operative field. Overall, there were four complications in 18 (22%) hips and two (11%) failures due to ankylosis and cup loosening.

**Table I.** Correlation between patient age, duration of arthrodesis and Harris hip scores at 6 and 12 months. ($r$ = Pearson’s correlation coefficient, $p$ = Probability; A $p$ value < 0.05 signifies statistical significance)

<table>
<thead>
<tr>
<th></th>
<th>Six month Harris Hip score</th>
<th>12 month Harris Hip score</th>
<th>Harris Hip score at final follow-up (mean 5 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient age at conversion</td>
<td>$r = 0.233$, $p=0.385$</td>
<td>$r = 0.258$, $p=0.418$</td>
<td>$r=0.535$, $p=0.151$</td>
</tr>
<tr>
<td>Duration of arthrodesis</td>
<td>$r = -0.019$, $p=0.943$</td>
<td>$r = -0.045$, $p=0.890$</td>
<td>$R=0.230$, $p=0.358$</td>
</tr>
</tbody>
</table>

**Table II.** Mean post operative Harris hip scores following conversion to total hip replacement in patients with surgical and spontaneous fusions

<table>
<thead>
<tr>
<th>Time after hip replacement</th>
<th>Mean Harris Hip score</th>
<th>Surgical fusion</th>
<th>Spontaneous fusion</th>
<th>p value* (Student’s $t$-test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Six months post operation</td>
<td>68.33</td>
<td>65.12</td>
<td>0.702</td>
<td></td>
</tr>
<tr>
<td>12 months post operation</td>
<td>69.30</td>
<td>64</td>
<td>0.785</td>
<td></td>
</tr>
<tr>
<td>Final follow-up (mean five years)</td>
<td>75.02</td>
<td>61.367</td>
<td>0.338</td>
<td></td>
</tr>
</tbody>
</table>

* significant at the $p < 0.01$ level
Discussion

The long term results of hip fusion conversion to total hip replacement have previously been described in the literature. In this study we report our experience with this procedure, focusing on peri-operative complications and the early functional results. We found trochanteric slide osteotomy to be useful in these challenging cases in which the anatomy of the hip joint is often distorted. As well as facilitating exposure of the acetabulum, trochanteric osteotomy improves access to the proximal femur allowing the operating surgeon to establish the correct entry point for insertion of the femoral stem. Another advantage of trochanteric slide osteotomy is that it allows preservation of the scarred abductor musculature which is usually deficient in such patients and the greater trochanter can be advanced to adjust abductor soft-tissue tension, which can aid hip stability.

Harris hip scores improved in all patients by six months follow-up, but most patients required the use of a walking aid for mobilising over longer distances, even though many had not required a walking aid pre-operatively. Dependency on walking aids after conversion of a fused hip to a mobile hip has previously been described. It is therefore important that this issue is discussed with patients pre-operatively.

We found that patient age, type of arthrodesis (surgical or spontaneous) and duration of arthrodesis did not correlate with hip scores at six or 12 months. These results contrast with other studies where longer duration of arthrodesis has been linked to poorer functional results and surgical fusions had higher complication rates than spontaneous fusions.

Conversion of hip arthrodesis to hip replacement has been associated with complication rates of up to 24%. Two (11%) patients in our study had major complications. One patient had peroneal nerve injury with motor involvement and the other patient developed ankylosis of the hip replacement due to heterotopic ossification.

Heterotopic ossification is common following total hip replacement, but is symptomatic in a minority of patients. When severe it can result in hip ankylosis. Risk factors include male gender, males with bilateral hypertrophic arthritis, post traumatic arthritis, previous heterotopic ossification, diffuse idiopathic skeletal hyperostosis and ankylosing spondylitis.

Joshi et al reported a 13% incidence of heterotopic ossification in a series of patients undergoing conversion of arthrodesis to cemented hip arthroplasty, but none had functional compromise. In our study, the rate of heterotopic ossification was higher, occurring in six of the 18 patients (33%). However, this was of functional significance in only one patient who developed a complete osseous bridge between the pelvis and proximal femur that was later excised to restore hip motion.

Peri-operative irradiation has been proven to be effective in reducing heterotopic ossification in high risk groups but is not widely available. Non-steroidal anti-inflammatory drugs (NSAIDs) reduce the incidence of heterotopic ossification by one half to two thirds. Indomethacin is a popular choice, typically in a dose of 25 mg three times per day for six weeks.
We believe that prophylaxis against heterotopic ossification should be considered in patients undergoing conversion of hip fusion to hip replacement patients, particularly if additional risk factors are present. However, prophylaxis needs to be balanced against the theoretical risk that post-operative irradiation and NSAIDs may impair uncemented implant osseointegration and bone healing if a trochanteric osteotomy has been performed.20

One of the challenges of surgery is maintaining hip stability in the presence of deficient hip abductors. In the cases we describe, constrained acetabular liners were used in three hips. The decision to use a constrained acetabular liner was made intra-operatively when soft tissues were deemed to be deficient to a degree that hip stability was compromised.

None of the hips had dislocated at the time of most recent review which compares favourably with other studies where dislocation rates of 0% to 5% have been reported.4,7,9 We believe our low dislocation rate is due to the correct orientation of implants facilitated by the use of intra-operative radiographs in select cases; reestablishment of soft-tissue tension when the greater trochanter is reattached and the use of constrained acetabular components when soft-tissue deficiency compromised hip stability.

Nerve injury is a potentially serious complication of hip replacement surgery. The incidence of symptomatic nerve injury after primary hip replacement is generally less than 1%21 but rates up to 7% have been reported during revision surgeries.22

Nerve injury can occur as a result of compression by retractors, laceration, haematoma and thermal injury from electrocautery or bone cement. Other factors which have been associated with peri-operative nerve deficits include female gender, developmental dysplasia, post-traumatic arthritis, and cementless femoral fixation.23 Reports of the influence of surgical approach and sciatic nerve injury have been inconsistent. Farrel at al21 found an association between nerve palsy and the posterior approach but this has not been found in other studies.24

Most injuries involve the peroneal branch of the sciatic nerve which is more susceptible to injury than the tibial branch. Tethering of the peroneal nerve at the fibular neck increases its susceptibility to traction injury. Furthermore, the peroneal nerve has more densely packed fascicles and less connective tissue than the tibial branch which may increase its susceptibility to compression and transection.25

Two of the eighteen patients we report sustained a neuro-praxia of the ulnar nerve, with motor function impaired only in one patient (6%), which resolved completely. This incidence is similar to other studies where rates of 1.85% to 7.2% have been reported.4,7-9

It is recognised that limb lengthening can put the sciatic nerve at risk of traction injury. A total of 3 cm to 4 cm is considered by some authors as the maximum permissible lengthening to avoid sciatic nerve injury,26 however, in many cases the cause of nerve injury cannot be identified and the threshold length at which nerve injury occurs for individual patients remains unknown.

Limb lengthening was not excessive in the two patients in our study who developed common peroneal nerve dysfunction, and the cause of nerve injury was not identified.

To reduce the risk of nerve injury, it is our practice to identify the sciatic nerve intra-operatively and limit limb lengthening to a maximum of 3 cm. We believe that this approach reduces the risk of inadvertent nerve injury and may explain the low incidence of clinically significant nerve injury in our cohort of patients.

Conversion of hip arthrodesis to hip fusion was effective in restoring hip function but carries a risk of major complication. We suggest that consideration be given to the use of constrained implants based on intra-operative assessment of stability. In addition we recommend the use of prophylaxis against heterotopic ossification. In addition to avoiding over-lengthening, direct visualisation of the nerve and nerve conduction monitoring are strategies that can be implemented to reduce the risk of nerve injury.

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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References