Long-term results of conventional varus half-wedge proximal femoral osteotomy for the treatment of osteonecrosis of the femoral head

We have previously described the mid- to long-term results of conventional simple varus intertrochanteric osteotomy for osteonecrosis of the femoral head, showing that 19 of the 26 hips had good or excellent results. We extended the follow-up to a mean of 18.1 years (10.5 to 26) including a total of 34 hips in 28 patients, with a mean age at surgery of 33 years (19 to 53). There were 18 men and ten women and 25 hips (74%) had a satisfactory result with a Harris hip score ≥ 80. In all, six hips needed total hip replacement (THR) or hemiarthroplasty. The collapse of the femoral head or narrowing of the joint space was found to have progressed in nine hips (26%). Leg shortening after osteotomy was a mean of 19 mm (8 to 36). With conversion to THR or hemiarthroplasty as the endpoint, the ten-year survival rate was 88.2% (95% confidence interval (CI) 82.7 to 93.7) and the 20-year survival rate was 79.7% (95% CI 72.1 to 87.3); four hips were converted at ten years and other two hips were converted at 20 years.

Shortening of the leg after osteotomy remains a concern; however, the conventional varus half-wedge osteotomy provides favourable long-term results in hips with less than two-thirds of the medial part of the femoral head affected by necrotic bone and with normal bone superolaterally.

Intertrochanteric varus wedge osteotomy was initially described by Pauwels for the treatment of osteoarthritis of the hip and later adapted for the management of osteonecrosis of the femoral head. Several studies have reported good results using this technique in hips in which a lateral intact area of the femoral head can be placed into the acetabular weight-bearing portion following osteotomy.

We have performed simple varus intertrochanteric osteotomy for osteonecrosis of the femoral head since 1979, using a half-wedge-shaped bone resection instead of a complete wedge to minimise limb shortening.

We conducted a retrospective study to analyse the long-term results of this procedure with a follow-up of up to 26 years. We also assessed the maintenance of the radiological joint space and function of the hip.

Patients and Methods

Between 1979 and 2001, conventional varus intertrochanteric half-wedge osteotomy was performed in 47 hips in 41 patients with osteonecrosis of the femoral head, which included steroid-induced, alcohol-associated and idiopathic causes. Two patients (two hips) died before a minimum follow-up of ten years. We were unable to follow 11 patients (11 hips) as a result of refusal to participate, deterioration of health precluding return for assessment, or loss to follow-up. We were able to follow 28 patients (34 hips, 72%) for more than ten years, six of whom had undergone a bilateral procedure and 22 a unilateral procedure. In these 28 patients, 17 patients were included whose outcome was previously reported. There were 18 men and 10 women, with a mean age at the time of surgery of 33 years (19 to 53). The left hip was treated in 17 patients and the right hip in 17, and the mean follow-up was 18.1 years (10.5 to 26).

The diagnosis of osteonecrosis was made on the clinical history, physical examination and radiological evaluation. In 19 patients (68%) there was a history of steroid use for the management of systemic lupus erythematosus in ten patients, for nephrotic syndrome in two, hepatitis in two, bronchial asthma in two, idiopathic thrombocytopenic purpura in two and multiple sclerosis in one. In five patients (18%) there was a history of alcohol abuse, and in the remaining four patients (14%) no risk factors for osteonecrosis could be identified. At the time of the operation all patients had severe hip pain while walking. No previous operation had been performed in any hip. To be considered for osteotomy, the patients...
had to have a range of hip movement of at least 90° for the flexion–extension arc and 25° of abduction. Necrotic lesions of the femoral head were radiologically assessed on pre-operative anteroposterior views and Lauenstein lateral views. The stage and location of the necrotic lesion were classified according to the criteria of the Japanese Investigation Committee of Health and Welfare (Fig. 1): six hips were stage 2, indicating a femoral head without collapse, 21 were stage 3A, indicating collapse of the femoral head by < 3 mm, and seven were stage 3B, indicating collapse of ≥ 3 mm. In order to evaluate stage 3 hips a radiological template with concentric circles was used to measure the amount of collapse, as recommended by the Japanese Investigation Committee of Health and Welfare (Fig. 2). From 1985 we used MR imaging to confirm the diagnosis. The stage and location of the necrotic lesion were evaluated only by plain radiographs in 13 hips (ten patients) before the adoption of MRI.

The surgical technique and post-operative regime have been described previously. Briefly, after exposing the lesser trochanter and the lateral surface of the femoral shaft, two Kirschner wires were inserted as osteotomy guides (Fig. 3a); one perpendicular to the femoral shaft distal to the lesser trochanter and the other in the femoral

Fig. 1
The Japanese Investigation Committee of Health and Welfare classification of the types of osteonecrosis of the femoral head.

Fig. 2
Radiological templates with concentric circles for use in the evaluation of stage 3 hips.
neck in the direction of the seating chisel. A transverse osteotomy was undertaken from the lateral cortex of the femur at the level of the lesser trochanter. A second osteotomy was performed in the proximal fragment from the centre of the mediolateral osteotomy directed proximally to the superior aspect of the lesser trochanter, and a half-wedge-shaped bony fragment resected from the proximal fragment (Fig. 3b). As little as possible of the lateral part of the distal aspect of the proximal fragment was resected in order to minimise shortening of the leg. A spline or Wainwright–Hammond plate (Zimmer, Bridgend, United Kingdom) was used for fixation in the initial seven hips, and an AO 90° double-angle blade-plate (Robert Mathys, Bettlach, Switzerland) was used in the other 27 hips. Correction of flexion and extension was not generally taken into account and only simple varus correction was performed. The necrotic area was moved away from the weight-bearing portion of the femoral head to the medial–inferior part. The osteotomy was designed to increase the lateral head index (LHI) assessed on the radiographs by 25% or more (Fig. 4).\textsuperscript{5,10} Partial weight-bearing was started four to six weeks after the operation and full weight-bearing was usually allowed eight to 12 weeks after the operation.

Clinical evaluation was performed according to the Harris hip score (HHS).\textsuperscript{11} Pre- and post-operative clinical data were collected from the medical records. The stage and type of the necrotic lesion, the amount of varus correction, the pre- and post-operative LHI,\textsuperscript{5,10} and the progression of collapse or joint space narrowing at follow-up were analysed radiologically by an author (HI).

**Statistical analysis.** Univariate analyses included the chi-squared test, Mann-Whitney U test, Kruskal-Wallis test, and Wilcoxon’s signed ranks test where appropriate.
Kaplan-Meier survival analysis with 95% confidence intervals (CI) was performed, with conversion to total hip replacement (THR) or hemiarthroplasty as an endpoint. Survival between the two groups as grouped by post-operative LHI (≥ 25% versus < 25%) was determined by log-rank test. A p-value < 0.05 was considered significant. Statistical analyses were performed using SPSS software v.19.0 (SPSS Inc., Chicago, Illinois).

Results
The mean pre-operative HHS was 51 points (26 to 75), which had improved to a mean of 81 (45 to 100) at the most recent follow-up or just before THR (Wilcoxon’s test, p < 0.001). Overall, 25 hips (74%) had satisfactory results with an HHS ≥ 80 (Table I; Fig. 5). Of these 25 hips, 23 had a post-operative LHI ≥ 25%, which was significantly higher than four of nine hips with HHS < 80 (chi-squared test, p = 0.002). In the nine hips with HHS < 80, six needed THR or hemiarthroplasty at a mean of 7.9 years (1 to 19) post-operatively.

The mean varus correction was 23° (15° to 43°) and the mean shortening of the leg was 19 mm (8 to 36). The mean pre-operative LHI was 17.8% (0% to 45%), which improved to 38.7% (0% to 75%) post-operatively.
(Wilcoxon’s test, p < 0.001). The pre-operative location of the necrotic lesion was type B in six hips, type C1 in 22 and type C2 in six. The location was significantly improved post-operatively: type A in five hips, type B in 17, type C1 in seven and type C2 in five (chi-squared test, p < 0.001).

Progression of collapse or joint space narrowing was found in nine (26.5%) hips, with post-operative location (chi-squared test, p = 0.019) and pre- and post-operative LHI (Mann-Whitney U test, p = 0.041 and p = 0.049, respectively) being significant factors.

With conversion to THR or hemiarthroplasty as the endpoint, we found a survival rate at ten years of 88.2% (95% CI 82.7 to 93.7) and a 20-year survival rate of 79.7% (95% CI 72.1 to 87.3); the ten-year survival rate in hips with a post-operative LHI ≥ 25% and those with a post-operative LHI < 25% was 96.3% (95% CI 92.7 to 99.9) and 57.1% (95% CI 75.8 to 38.4), respectively, and the 20-year survival rate was 89.9% (95% CI 82.8 to 97.0) and 42.9% (95% CI 24.2 to 61.6), respectively (log-rank test, p = 0.002) (Fig. 6).

There were no intra-operative complications. Two patients developed nonunion at the osteotomy site, one of whom underwent revision and bone grafting one year post-operatively with subsequent union. The other underwent a THR. There were no other significant complications, such as deep infection or pulmonary embolism.

Discussion
When introduced, the purpose of osteotomy in the treatment of osteonecrosis of the femoral head was to remove the necrotic part of the femoral head from the load-bearing area and replace it with an intact portion. In 1965, Merle d’Aubigné et al reported good results with Pauwels’ varus or combined varus and rotation osteotomy. In necrotic hips with normal lateral bone the main weight-bearing portion was almost covered with medially displaced normal bone following the varus osteotomy. They concluded that the osteotomy arrested the progress of collapse and recommended it for hips without marked collapse and with normal superolateral bone. We believe our study represents the cohort with the longest follow-up of intertrochanteric varus osteotomy for osteonecrosis of the
femoral head, finding that it was effective for a mean of 18.1 years post-operatively.

The success of the osteotomy is closely related to the extent and location of the necrotic lesions.2-7,10,12-17 Zhao et al.7 in a study evaluating 73 hips in 62 patients treated with a transtrochanteric curved varus osteotomy, reported that the cut-off point of the post-operative intact ratio to prevent the progression of collapse was 33.6%, and that the cut-off point to prevent both the progression of collapse and joint-space narrowing was 41.9%. In our study, post-operative LHI and the location of the lesion were significant factors for determining the progression of collapse or joint space narrowing. Locations A and B were almost equivalent to an intact ratio of > 33% in terms of successful outcome. In 22 hips with post-operative location types A and B, 20 hips showed no progression of collapse or joint space narrowing, which mirrors the findings of Zhao et al.7

Sugioka12 and Sugioka, Hotokebuchi and Tsutsui13 described a transtrochanteric anterior rotational osteotomy and reported excellent clinical results. Several studies have reported successful results with this technique.10,14,15 However, this osteotomy has been described as technically demanding.16,17 The varus osteotomy is less invasive and less technically demanding than the transtrochanteric rotational osteotomy.4-7,18 When the intact area is located in the lateral portion of the femoral head, we believe that varus osteotomy is preferable to a transtrochanteric rotational osteotomy.

Shortening of the femur is the main complication after the conventional varus half-wedge osteotomy. The curved intertrochanteric varus osteotomy has the advantage of reducing this shortening, and good mid-term results have been reported.4,6,7 Bombelli19 reported a mean shortening of the femur of 24 mm after a 20° varus osteotomy and 38 mm after a 30° varus osteotomy with complete removal of a wedge of femur, but this was reduced to a mean of 18 mm after 20° varus and 29 mm after 30° varus osteotomy when only a partial wedge was removed from the femur. In order to minimise shortening of the leg, a half-wedge-shaped bony fragment should be removed rather than a complete wedge (Fig. 3b). Excessive varus correction is related to a high incidence of post-operative limp because of abductor muscle weakness and shortening of the leg. This should therefore be avoided and the correction angle should be limited to 25° for a conventional varus half-wedge osteotomy.3 When a varus correction of > 25° is required we recommend a curved varus osteotomy or a transtrochanteric anterior or posterior rotational osteotomy.

The demarcation between ischaemic and normal bone is best seen on MRI, which is therefore the most accurate technique for diagnosing osteonecrosis of the femoral head. One limitation of this study is that the stage and location of the necrotic lesion were evaluated only by plain radiographs initially in 13 hips of ten patients before the adoption of MRI.

Our findings indicate that the survival rate was superior in hips with a post-operative LHI of ≥ 25% compared with those with < 25% LHI. If necrotic lesions are restricted to the medial part of the femoral head and the lateral part is intact, good long-term results can be obtained with a conventional varus half-wedge osteotomy. Limb shortening is a disadvantage after this osteotomy, and the curved varus osteotomy seems preferable as it produces less shortening. However, we conclude that a small to medium-sized necrotic lesion located medially in the presence of an intact superolateral portion with a post-operative LHI ≥ 25% is best indication for a conventional varus half-wedge osteotomy.

Supplementary material

A table detailing the relationship between progression of collapse or joint space narrowing and various factors is available with the electronic version of this article on our website www.jbjs.org.uk

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References


