The calcar femorale in cemented stem fixation in total hip arthroplasty

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The calcar femorale is a vertical plate of bone lying deep to the lesser trochanter and is formed as a result of traction of the iliopsoas which separates the femoral cortex into two distinct layers, the calcar femorale and the medial femoral cortex. They fuse together proximally to form the medial femoral neck. A stem placed centrally will abut against the calcar femorale with little or no space for cement. Clearing of the calcar will offer space for a cement layer, which will support the stem proximally on the posterior aspect. We compared two consecutive groups of Charnley low-friction arthroplasties, with and without clearing of the calcar.

In 330 patients who had an arthroplasty without clearing the calcar, there were ten revisions for aseptic loosening of the stem and six other stems were considered ‘definitely loose’, giving a rate of failure of 4.8%. In 111 patients in whom the calcar was cleared there was only one revision for aseptic loosening and no stems were classed as ‘definitely loose’, giving a rate of failure of 0.9%.

Survivorship analysis has again shown the need for long-term follow-up; the differences became clear after ten years but because of the relatively small numbers, statistical analysis is not yet applicable.

We now clear the calcar femorale routinely and advocate optimal access to the medullary canal and insertion of the stem in the area of the piriform fossa.

In a previous publication we described the technique of closing the medullary canal with a cancellous bone block to improve fixation of the stem with cement in the Charnley low-friction arthroplasty (LFA).1 The early results were encouraging. In a prospective study of 611 consecutive LFAs with a mean follow-up of 2.75 years (1 to 5.5) there were two cases of radiological loosening of the stem, and five others were considered to be at risk.

More recently, in a further prospective study of a group of 441 LFAs in young patients with a mean age of 41 years (17 to 51) and a mean follow-up of 13.4 years (1 to 21), using the same technique, the survivorship was 99.2% at ten years and 94.35% at 15 and 20 years.2

We have now directed our attention to the anatomy of the proximal femur since the calcar femorale may have a bearing on the long-term outcome of the cement fixation. Garden3 gave a very detailed account of both the structure and function of the proximal femur, describing the calcar femorale as “a vertical plate of bone lying deep to the lesser trochanter”. He also quoted Bigelow4 who described it as “the true neck of the femur”. Noble et al5 examined 200 cadaver femora in an attempt to offer an anatomical basis for the design of the femoral component and concluded “...that although statistically significant correlations were present between the endosteal dimensions, prediction of one dimension from any other was not possible to the level of accuracy useful in implant design (typically 1 to 2 mm).” In their detailed analysis of variables there was no mention of the calcar femorale.

Theoretical considerations. If central alignment of the stem within the medullary canal is to be achieved, a good guide for access is the entry point used for an intra-medullary nail in the vicinity of the piriform fossa.6 If the medullary canal is exposed correctly to allow neutral alignment of the stem, without anteversion, two features become apparent. First, a sizable gap will appear between the stem and the anterior cortex of the femoral neck7 while the posterior surface of the stem will come to rest against the posterior cortex. The second and less obvious feature, which at this stage of the operation becomes obscured by the stem, is the contact of the posterior surface of the stem with the calcar femorale, with little or no space for cement (Fig. 1). If the exposure and access to the medullary canal are restricted to the neck of the femur only, the tip of the
stem will be directed towards the posterior cortex, thus separating the cement mantle into two distinct layers with a posterior proximally, and an anterior distally (Fig. 2). Such a distribution of cement may invite the mechanism of failure of fixation of the stem. The role of the calcar femorale has not been studied in this context.

In the development of the proximal femur, the lesser trochanter is formed by traction of the iliopsoas which separates the medial femoral cortex into two distinct layers, the outer cortex and the inner calcar. The two join together proximally to form the medial femoral neck which commonly, but erroneously, is often referred to as the ‘calcar’. With advancing age and declining function the medullary canal enlarges by thinning of the inner aspect of the femoral cortex. The calcar femorale may then become thin or disappear. It contributes to the strength of the femoral neck by resisting torsion, and its resorption and loss play a significant part in the increasing incidence of fracture of the neck of the femur with typical posteromedial comminution.

We present the results of a study of Charnley LFAs in which the calcar femorale has been deliberately cleared, posteromedially, within the medullary canal, although not fully into the lesser trochanter. This manoeuvre allows for a layer of cement to support the stem on its posteromedial aspect thereby resisting the effects of bending and torsion of the stem thereby improving long-term survivorship. We compared the results with cases in which the surgical
technique was identical except that the calcar femorale was not cleared.

**Patients and Methods**

There were 358 patients (441 LFAs) in the study. Although prospective, the study was not randomised, but consecutive. In the ‘calcar cleared’ group of 111 LFAs, 92% were carried out by the senior author (BMW). In the 330 LFAs in which the calcar was not cleared, 255 (77%) were carried out by the senior author. For this study we have selected patients aged 50 years or younger at operation, who are part of a larger indefinite follow-up group. The details of the two groups are shown in Table I. There were no deaths within one year of surgery and all patients were available for follow-up.

A lateral approach with a trochanteric osteotomy was used routinely. The medullary canal was entered through the sectioned neck of the femur using a hand-held Charnley reamer, with the reamer directed at the lateral cortex just distal to the trochanteric bed. The bridge of cortical bone between the femoral neck and the trochanteric bed was removed with bone nibbling forceps. The reamer was directed down the medullary canal after checking alignment in both the vertical and the horizontal planes with respect to the femoral shaft to open up the canal. Cancellous bone and fibrofatty marrow were cleared with gentle curettage. An appropriate stem was selected for a trial reduction. With the stem in a neutral position there was a space anteriorly between it and the femoral cortex. Posteriorly, the stem was directed on the cortex of the femoral neck and was apposed to the calcar femorale within the medullary canal. If the calcar femorale was thin it was removed with gentle curettage, if thick and strong Charnley gouges were used in order to remove the cortical bone of the calcar without excavating the lesser trochanter. The area between the piriform fossa and the posterior cortex of the femoral neck was also cleared. In all cases, the medullary canal was closed off with a cancellous bone block, and was washed and brushed. The cement was packed digitally with proximal venting and pressurised with a thumb before inserting the stem, while maintaining the pressure on the cement medially between the stem and the medial femoral neck. Charnley stems with matt surfaces were used in all cases. Patients were usually mobilised, on the second postoperative day, and encouraged to use elbow crutches for weight-bearing for six weeks.

The follow-up was at three months, one year after surgery, and thereafter every one or two years. The radiological assessment of fixation of the stem was as described by Harris, McCarthy and O’Neill with loosening defined as ‘definite’, ‘probable’ or ‘possible’. In the survivorship analysis the endpoint was taken as revision for aseptic stem loosening or ‘definite’ in the Harris classification. We have continued our policy of early revision.

**Results**

There was only one revision for aseptic loosening in the ‘calcar cleared’ group, a rate of failure of 0.9%. Three stems were classified as ‘possibly’ loose but none as ‘probably’ or ‘definitely’ loose (Table I). The revision was in a man aged 37 years at the time of the original operation who weighed 109 kg. Although the injection of cement appeared excellent the stem was inserted through the femoral neck and not the area of the piriform fossa; the tip of the stem was directed towards the posterior femoral cortex. The stem subsided between the two layers of cement. The posterior femoral cortex was eroded with endosteal cavitation.

In the group in which the calcar had not been cleared there were ten revisions for aseptic loosening and six were ‘definitely’ loose giving a failure rate of 4.8%. One other stem was classified as ‘probably’ loose and 21 stems were ‘possibly’ loose (Table I).

Once the importance of the calcar was recognised the surgical technique was changed.

**Discussion**

The importance of long-term follow-up has once again been shown; the benefits of clearing the calcar to provide an adequate cement mantle proximally and posteriorly became apparent after ten years.

We now recommend routine clearing of the calcar when
performing a Charnley LFA. We emphasise the importance of correct access and exposure of the medullary canal and the insertion of the stem, not through the open neck of the femur, but in the area of the piriform fossa. The site used for entry of an intramedullary nail gives a good indication of the entry point for the stem.

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References