The Calcar Femorale

An Anatomic, Radiologic, and Surgical Correlative Study

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In order to define the anatomy of the calcar femorale, a radiologic and surgical study was done on ten paired cadaver femurs. After radiography and computed tomographic (CT) scans, the specimens were subjected to medullary reaming by an experienced orthopedist, simulating total hip arthroplasty procedures. The imaging studies were repeated and compared with the prereaming studies. The calcar femorale was dissected from surrounding medullary bone, and sections of this structure were examined histologically. The calcar femorale is a condensation of cancellous bone. It is not affected by the reaming procedure but may play a role in guiding the reamer. This structure is separate from the calcar area described in relation to bone resorption after hip arthroplasty.

Key words: femur; hip; arthroplasty.

The calcar femorale has been precisely defined anatomically for more than 100 years. The first detailed description was by Merkle in 1874; however, the structure had been described earlier in 1869. This structure is a thin plate of condensed cancellous bone oriented vertically within the medullary canal of the proximal portion of the femur, deep to the lesser trochanter. Radiographically, it is best seen on lateral views where it is viewed in tangent. This plate of bone originates from the posterosmedial portion of the femoral shaft and radiates laterally through the cancellous tissue toward the greater trochanter. This structure is not visible at birth. As the proximal femoral neck and trochanter regions become ossified, however, the calcar becomes visible. This may represent a plate of bone formed from the original proximal femoral diaphysis that is enveloped by cancellous bone as the trochanters form.

Despite studies in the orthopedic literature defining the calcar femorale anatomically, the terms calcar, calcar femorale, and calcar area are misused frequently. This term is applied commonly to the very thick cortical bone of the medial femoral cortex near the level of the lesser trochanter on anteroposterior (AP) radiographs. This thick cortical bone generally is in contact with collared prostheses used in hip arthroplasty. This is the medial femoral cortex. The term calcar resorption is applied frequently to resorption of the medial femoral cortex related to stress shielding in patients examined after hip arthroplasty.

The current study attempts to define precisely the anatomy of the calcar femorale on radiographs and computed tomographic (CT) scans with anatomic correlation, and to ascertain the relation of the anatomic calcar femorale with proximal femoral arthroplasty components.

Materials and Methods

Ten paired cadaver femurs were used in the current study. The specimens were stripped of all soft tissue. AP and lateral radiographs, and transverse CT (5 mm thick slices, Technicare 2010 scanner, Solon, OH) were done on all of the specimens. An orthopedist experienced in the hip arthroplasty procedure (FRC) performed femoral neck osteotomies and medullary reaming of the specimens in the laboratory, simulating the techniques used in arthroplasty procedures for placement of proximal femoral com-
Figs. 1A–1C. Radiographic anatomy of the calcar femorale. (A) Specimen radiograph, AP projection. The calcar femorale is seen vaguely en face located roughly between the two large arrows not seen clearly in AP projection. The two small arrows point to the medial femoral cortex. This is not the calcar femorale but is referred to by that term frequently. (B) Specimen radiograph, lateral projection. The calcar femorale is seen in profile (black arrows). (C) Patient radiograph, frog lateral projection. Calcar femorale seen in profile (arrow).
Results

Figure 1 shows the radiographic anatomy of the calcar femorale. Figure 2 shows the gross anatomy of the calcar femorale on sections through the proximal portion of the femur. Note the difference between the medial femoral cortex and the true anatomic calcar femorale.

Figure 3 shows the calcar femorale on specimen CT scans before and after medullary reaming. In the two specimens shown, as in all of the specimens, the medullary reamer...
Figs. 3A and 3B. Computed tomographic (CT) anatomy of the calcar femorale, premedullary and postmedullary reaming procedure. (A) Prereaming and (B) postreaming CT appearance of calcar femorale (arrow).

Figs. 4A and 4B. Appearance of calcar femorale after dissection of gross specimens. (A) Through a posterolateral cortical window, the calcar femorale is seen as a plate of dense bone (arrows) that was dissected easily from the softer surrounding medullary bone. (B) Femoral prosthesis in place passing anterior to the calcar femorale.
passed anterior to the calcar femorale, causing essentially no damage to the structure. This occurred although the surgeons took no special precautions to spare the calcar during the reaming. Figure 4 shows the gross anatomy of the calcar femorale after dissection.

Histologic sections of bone from the calcar femorale showed it to have microscopic characteristics of condensation of cancellous bone rather than true lamellar bone.

Discussion

The current study defines the gross and radiologic anatomy of the calcar femorale and indicates the common misuse of the term calcar when used in orthopedic publications that discuss resorption of the medial femoral cortex after hip arthroplasty due to stress shielding. This misuse of the term has been common. Studies by Harty and Griffin published in the orthopedic surgery literature have mentioned this misuse specifically.

Additionally, the current study determines the relation of the calcar femorale to hip arthroplasty procedures. It shows that the calcar femorale is not affected by the surgical procedure itself. This dense plate of bone may play a role in guiding the medullary reamer through a path of least resistance in the proximal femoral medullary canal because every specimen reamed showed the reamed intramedullary defect to be formed directly anterior to the calcar. The relation between proximal femoral prostheses and the calcar femorale is shown. The role of the calcar femorale in stress shielding, bone prosthesis contact, or later femoral component loosening cannot be determined from the current study.

Based on the current data and the reports of Harty and Griffin, the thick bone referred to as the calcar or calcar femorale in recent studies that evaluate hip arthroplasty induced bone resorption is not truly the anatomic calcar femorale. All of the studies except one reported bone loss in the medial femoral cortex seen on AP views of the hip after arthroplasty, and referred to this loss as calcar resorption. The remaining study referred to calcar unloading of strain measured by strain gauges placed on the outside cortex of cadaveric proximal femoral specimens. The current authors' results show that calcar strain can only be measured from an intramedullary location.

A limitation of the current study is that only an older collared Charnley-type femoral prosthesis component was tested. Furthermore, only one type of medullary reamer was used. Since the initial performance of these experiments, many new types of hip prostheses and associated surgical tools have been developed. Additional experimentation with new devices will be required to elucidate their relation with the true calcar femorale. However, any study that proposes to evaluate the relation of the calcar femorale to hip arthroplasties will have to examine an intramedullary plate of bone rather than the outer surface of the medial femoral cortex, as has been done in previous studies.

In summary, the current study shows the true gross and radiographic anatomy of the calcar femorale and defines the relation of the calcar to the hip arthroplasty surgical procedure for placement of a collared arthroplasty device.

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References


Announcements


The "Hanns-Langendorff-Preis" is designed for the progress of radiation protection. The award is given to young scientists who have accomplished outstanding work in the field of medical radiation protection. The prize is DM 10,000 and can be split. Deadline for submitting papers is December 31, 1991. Applications should be addressed to the: Vorsitzender der Vereinigung Deutscher Strahlen- schutzarzte, Prof. Dr. Chr. Reiners, Klinik und Poliklinik für Nuklearmedizin der Universität-GHS-Essen, Hufelandstr. 55, D-4500, Essen 1.