Case 11

Femoral Neck Augmentation

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Overview

The incidence of hip fractures worldwide is expected to almost quadruple in the next 60 years (1). In addition to the acute limitations associated with a hip fracture, most patients continue to suffer from difficulties in performing activities of daily living (2), and their related mortality is high. One third of patients do not survive beyond the first year after fracturing their hip. The risk of dying from a hip fracture equals that of dying of breast cancer (3). Osteoporotic fractures are associated with pain, limitation of mobility, and social dependency.

Osteoporotic fracture patients occupy 1% to 1.5 % of all hospital beds in Europe at any one time. This figure is expected to more than double during the next 50 years (4). Frailty of any population increases with longevity. Consequently, the present projections of fracture occurrence appear to be too conservative. The annual hip fracture incidence in Asia in 2050 might pass 10 million rather than the hitherto forecasted 3.2 million (5). Therefore, hip fracture prevention is of major importance. Protective devices have been developed in order to prevent fractures from a simple fall. Their effectiveness has been demonstrated in several studies; however, there is poor long-term compliance with their use (6–9). Energy-absorbing flooring, designed to prevent hip fractures, has been evaluated and shown to be cost effective (10). These measures and more will undoubtedly be increasingly employed in an attempt to stem the tide of increasing numbers of hip fractures.

Results

Based on the experience of reinforcement of osteoporotic vertebra (11–14), the potential of reinforcing the proximal femur was evaluated in an in vitro study. The technical feasibility was demonstrated, and the mechanical effect turned out to be significant (15) (Case Figure 11.1 and Case Table 11.1). However, the amount of polymethylmethacrylate (PMMA) needed to achieve a sufficient filling was on the order of

A B

Case Figure 11.1. **(A)** Specimen photograph following percutaneous femoral neck augmentation with PMMA (black arrows). **(B)** Specimen radiograph shows the distribution of the PMMA within the femoral neck (white arrows).

36 mL (range, 28–41). This produced a substantial amount of heat, with the surface temperature of the femoral neck increased an average of 22°C (range, 18°–30°C). This increase endangers the blood supply of the femoral head. Therefore, the use of PMMA in clinical applications should be limited until less exothermic materials are available.

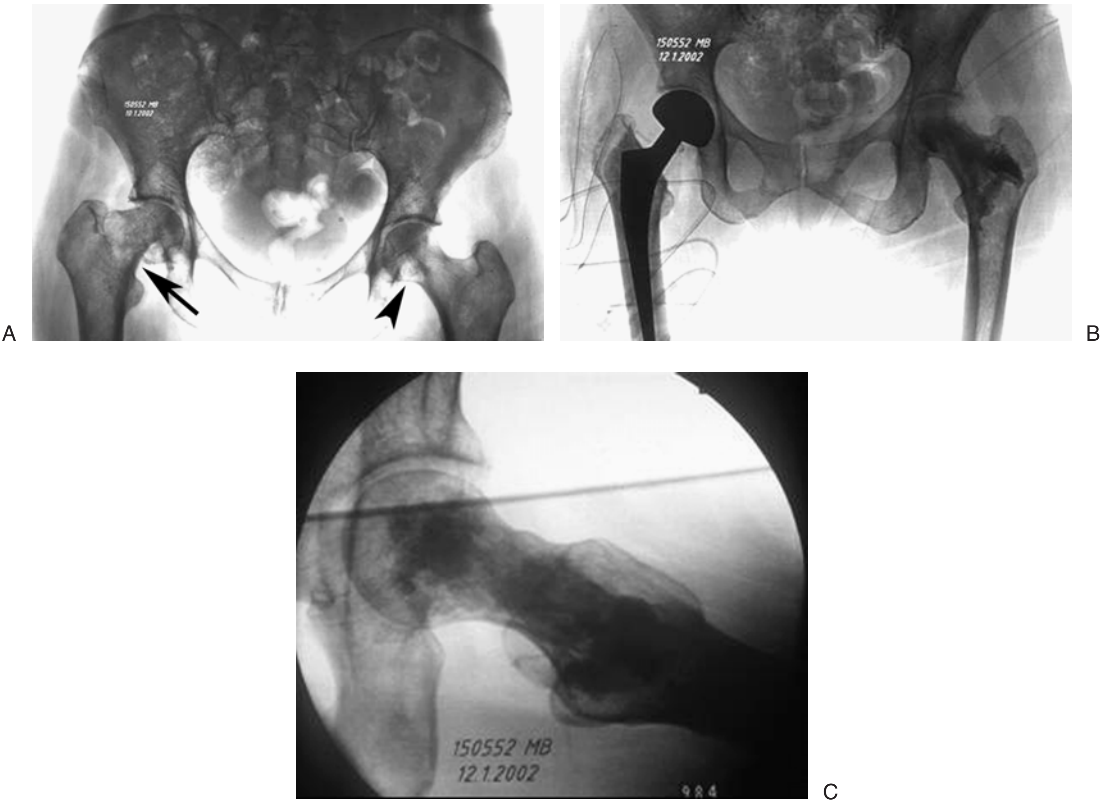
Discussion

Because of the problems mentioned, percutaneous augmentation of the femoral neck has been performed only in selected cases. In our series, this procedure was performed as prophylactic protection for patients with metastatic disease.

The demonstration case used prophylactic reinforcement in a non-fractured hip that had obvious metastatic involvement. This patient presented with a right hip fracture secondary to myeloma (Case Figure

Case Table 11.1. Average Failure Load of Native and Reinforced Femurs.

	Failure Load (Newtons)		
Load Application Type	Control (N = 5 for each type)	Reinforced (N = 5 for each type)	Difference %, Statistics
Single leg stance	5,764	6,986	21% $p < 0.002$
Simulated fall	2,499	4,548	82% $p < 0.002$



Case Figure 11.2. **(A)** Radiograph of the pelvis in a patient with myeloma. There is fracture of the right femoral neck (black arrow). Pathologic erosion of a portion of the left femoral neck is seen as well (black arrowhead). **(B)** A hemiarthroplasty was performed on the right. Percutaneous augmentation with PMMA was accomplished on the left. **(C)** An additional radiographic projection of the left femoral neck again shows the intramedullary PMMA.

11.2A). A hemiarthroplasty was performed on the right hip (Case Figure 11.2B). Percutaneous augmentation of the left hip was accomplished with PMMA and subsequently followed with radiation therapy (Case Figure 11.2D). This patient tolerated the procedures well and was able to resume ambulation after a period of rehabilitation.

New, low exothermic bone cements are in use (Cortoss, Orthovita, Malvern, PA) that have strength characteristics exceeding those of PMMA. These advances may allow this technique to be used in the prophylactic treatment of hips at risk because of osteoporosis.

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