INTRODUCTION

The earliest studies of hydroxyapatite (HA) coatings had shown that implants obtain stable fixation as a result of a dynamic response by the host bone (1). The osteoconduction brought about by HA manifests itself in early bone formation, with rapid contact being achieved between the host bone and the implant; the intimate bond thus formed will firmly anchor the implant in the bone (2, 3, 4).

Under physiological conditions, bone is constantly being remodeled, which allows it to adapt itself to the stresses to which it is exposed. Removing the femoral head and neck, and replacing these anatomical structures with a femoral and an acetabular component, will considerably alter the physiological stress transfer pattern.

The introduction of the metallic implant will result in a dynamic mechanical adaptation of the bone structure in the hip bone and in the femur. On the evidence of the studies cited above, it may be assumed that sound biological fixation of the implant in the host bone may have a beneficial influence on the process of adaptation to the new stress pattern.

The design, in 1987, of a new femoral component was intended to reflect the lessons learnt from the frequent failures of cementless implants (5, 6, 7) as well as the hopes raised by the introduction of HA coatings. The device thus produced was the PRA stem, which has been in clinical use since 20 January, 1988.

The early results were very encouraging, and were published in the literature (8,9). Readers were, however, warned that longer follow-up would be required before a final verdict could be given. By now, more than 13 years have passed since the first implantations of this device, and the time has come to take stock and see what the follow-up, at more than ten years, of the patients managed with a PRA stem has shown.

MATERIAL AND METHODS

The PRA Stem

The PRA stem (fig. 1) is characterized by its pronounced proximal flare and distal taper. In the coronal plane, the stem is straight. The neck-shaft angle is 130°. The anterior and posterior aspects of the stem have grooves bordered crests with a quarter-circle section, to provide excellent contact with the cancellous host bed over a large developed surface. This produces less stress per unit of sur-
face area at the implant-bone interface than is the case with stems that do not feature a macrointerlock. The PRA stem is collarless. The HA coating involves only the proximal one-third of the stem, while the rest of the stem has a mat surface. The device (Fournitures Hospitalières Industrie, Quimper, France) is made of grit-blasted anodized titanium alloy.

The implant design features were based upon the following considerations:

1) Stress should be transferred in the metaphysis. The metaphyseal flare given to the stem ensures optimal metaphyseal fill, and leaves a layer of cancellous bone standing around the implant. This design feature derives from studies (10, 11, 12) of the stress transfer patterns in implanted femurs.

2) The distal part of the stem should be excluded as much as possible from the transfer of stresses, so as to prevent the thigh pain reported (13) with some cementless implants fitting to tightly in the reamed canal.

3) The stresses per unit surface area should be reduced. This was why the stem was designed with grooves, which increase the contact surface area and thereby decrease stress (12). However, it was essential to ensure that the depth and the shape of the grooves were such as to allow complete contact with the host bone.

4) Initial fixation of the implant should be in the metaphysis. For this reason, the HA coating was confined to the proximal one-third of the stem, so as to obtain osseointegration in the metaphysis before any fixation might occur in the more distal part of the stem. With this pattern, the host bone’s adaptation to the new stress transfer pattern starts in the metaphysis.

Prior to the insertion of PRA stem, the bone bed must be carefully prepared with broaches, to prevent any tendency of the implant to go into varus as a result of the pronounced superolateral contour of the intraosseous portion of the device. The stem is then press-fitted into the femur. With this technique, excellent rotational stability has always been obtained, and the shape of the stem rules out distal migration of the implant. The excellent primary stability thus produced means that sound secondary osseointegration should consistently be obtained.

Postoperatively, the only specific precaution to be observed is the avoidance of full weight-bearing (walking without a walking aid). The osseointegration of the implant is preceded by the fracture of bony trabeculae. This means that the very firm seating obtained at surgery is followed by an initial phase of slightly reduced stability, which accounts for the slight distal migration of the implant during the first three postoperative months described by Scott & Freeman (14) and by Søballe et al. (15). Because of this phenomenon, patients are required to use two aids for the first five weeks, so as to partially unload the operated hip. As shown by histological studies of retrieved specimens (16), this period corresponds to the time during which bone will be laid down on the implant surface. After five weeks, full weight-bearing may be resumed. This policy has never resulted in any problems. The maximum distal migration seen on the customary radiographs has been 1mm.

The PRA stem has very many indications. However, it is very rarely used in cylindrical femurs with thinned-out and poorly vascularized cancellous bone, whose potential for restoration is uncertain.

Implants Used

On the acetabular side, a variety of implants were used. HA-coated cups did not become available until 21 October 1988, which is why, in the first half of 1988, non-HA-coated cups were used. Of the 32 cementless non-HA-coated cups implanted, 12 were threaded patterns, eleven were press-fit, and nine were expansion cups. The 53 HA-coated cups used were all of the threaded type. Two PRA stems were used at revision arthroplasties in which the cup was left in situ.

PRA stems

The stem was available in six sizes (numbered 3 to 8). Size 3 was used only once, in a dysplastic femur. Size 8 was used only once as a primary device. In the other two instances, it was used at revision THR; in one case, it was not large enough to guarantee stable fixation. The other sizes (nine times Size 4, 17 times Size 5, 30 times Size 6, 27 times Size 7) reflect the usual spread of dimensional patterns encountered in the femur.

Femoral heads and necks

All the femoral heads used in this series were made of alumina ceramic. Initially, 32-mm diameter heads were used. This policy was subsequently changed in favour of 28-mm heads, which have