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Enhanced fixation of uncemented knee replacement with hydroxyapatite

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Introduction

Early results with bioactive coatings on arthroplasty prostheses have been encouraging [1]. Most information to date however concerns total hip arthroplasty, with few reports regarding the knee. Although the published results of cemented knee arthroplasty are good [2-4], growing concerns with cement fixation have lead to an increasing trend for cementless fixation [4-7]. Simple press-fit total knee prostheses however have not demonstrated enough intrinsic stability, and ingrowth into porous coated implants is inconsistent, possibly because of inexact bone cuts.

Preliminary reports by Epinette [8] have suggested that hydroxyapatite (HA) coated implants may improve stability & fixation of total knee arthroplasty (TKR), but no studies to date have examined the bone prosthesis interfaces by accurate, screened radiology. The purpose of this study was to prospectively examine the role of HA in promoting osseointegration into knee prostheses.

Material and Methods

Standardized radiographs of patients receiving the uncemented HA coated prosthesis (HAP) were compared to those taken of patients receiving the non-HA coated implant (non-HAP). Both systems have similar geometry making comparison between groups possible. The HA prosthesis is coated using a splutter coating technique (crystallinity 75%, Porosity 20%, thickness 70 microns). The distal surface of the femoral prosthesis and tibial plate are coated with heat-sintered beads (size 0.4-0.6mm).

We examined standardized radiographs of 203 patient receiving 312 knee replacements. 105 patients with 161 uncemented knees formed the HAP group and received HA coated total knee replacements performed sequentially. 67 (64%) patients were male, receiving a total of 71 implants (44% of prostheses). The mean age was 68.8 years (range 51-88). The comparison non-HAP group of 98 patients received 151 cementless implants. 57 (58.1%) patients were male, receiving a total of 73 implants (48.3%). The mean age was 70.1 years (range 51-83).

All patients were operated on by a single surgeon using a consistent operative technique. All knees were uncemented regardless of diagnosis, age of patient and bone quality. No patients were excluded as being unsuitable for cementless fixation.

Surgical Technique

Bone cuts are made with the manufacturer's jigs and any bone defects grafted with autogenous bone salvaged from the off-cuts. After sizing and trial insertion, the definitive components are press fitted onto femur and tibia. Four screws are used to obtain immediate stabilization of the tibial tray.

All patients are mobilized fully weight bearing on the second postoperative day and then begin active flexion and extension exercises. Patients are permitted to discard any walking aids whenever they feel confident.

Radiographic Assessment

Being an uncemented prosthesis, the quality of the fixation is of paramount importance. In order to examine this, screened views of the bone-prosthesis interface were taken under fluoroscopic positioning at 2 years postoperatively. To our knowledge few studies have examined the interfaces in this way [5,9,10]. Because of the minor malpositioning that invariably occurs a true anteroposterior (AP) or lateral view of the knee is unlikely to be a true AP or lateral of the prosthesis itself. An apparently true lateral x-ray, for example, when screened into perfect position may then show lucent lines [10] (fig. 1). In the few published series, many of the radiographs illustrated are not in fact true laterals or true AP views under close scrutiny and this may hide lucencies.

In a further attempt to standardize the radiographs, the same two experienced radiographers examined all patients in the same fluoroscopy suite. Screened radiographs having been obtained, the position and presence of lucent and also sclerotic lines were noted independently by two independent orthopaedic surgeons unconnected with either the development of the prosthesis or with the clinical management of the patients. A line was said to be present if noted by *either* of the two observers ensuring the false negative rate was as low as possible.

The lucent lines seen were assigned to zones as suggested by the Knee Society [11] (fig. 1).

Results

The radiographic results are summarised in figure 2. It is easily seen that the number of lucent lines are greatly reduced in the HAP group when compared to the non-HAP group (femoral zones, $p<0.05$; tibial zones, $p<0.001$; paired samples t-test).

A small number of sclerotic lines were noted in the HA coated prostheses. These occurred principally in the anterior and posterior zones of the femur. None were seen in relation to the tibial component.

Discussion

The goal of cementless TKR is to obtain optimum bone–prosthesis fixation by osseointegration of the components. Despite meticulous surgical technique and ever improving instrumentation gaps will inevitably be present after the press-fit application of a cementless implant.

The presence of lucent lines may be benign. They do not necessarily indicate either osteolysis or component loosening but do signify a failure of osseointegration. From this study it is seen that HA coating does decrease the number of lucent lines significantly 2 years postoperatively. This is true of both the tibial and femoral components. While in itself this does not mean that long term clinical results will be improved, it does indicate enhanced prosthetic fixation and therefore stability.

The findings of this paper provide radiographic support for the work of Onsten [1], which concluded that HA improves the fixation of the tibial component. It provided evidence that excellent early clinical results can be obtained with the unselected use of a cementless implant when augmentation with HA is used, although it is accepted that these results are no better than many published results with cemented prostheses.

The sclerotic lines noted around some of the HA coated femoral prostheses have been noted in previous studies [8]. Epinette suggested they represent "an adaptation of host bone to the altered stress transfer pattern" because of an elasticity gradient between bone and implant.

There has been suggestion [8] that HA coating of a beaded surface can lead to bead shedding and possible third body wear. None has been seen in this study, although it was specifically examined for. The prosthesis used has beads only on the distal femoral surface, where there should be no shear, and the authors therefore believe that a coated, beaded distal surface should not pose a problem. A retrieval specimen that has been obtained shows osseointegration within the beaded surface (Fig. 3).

Obviously with the excellent long-term clinical results obtained with cemented TKR this study can only really be evaluated fully many years down the line. It is not yet known whether HA will have a detrimental effect in the long term but we are encouraged by these early results.

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Figure 1. a) and b) Zone Location as recorded by the knee society total knee arthroplasty roentgenographic evaluation and scoring system.

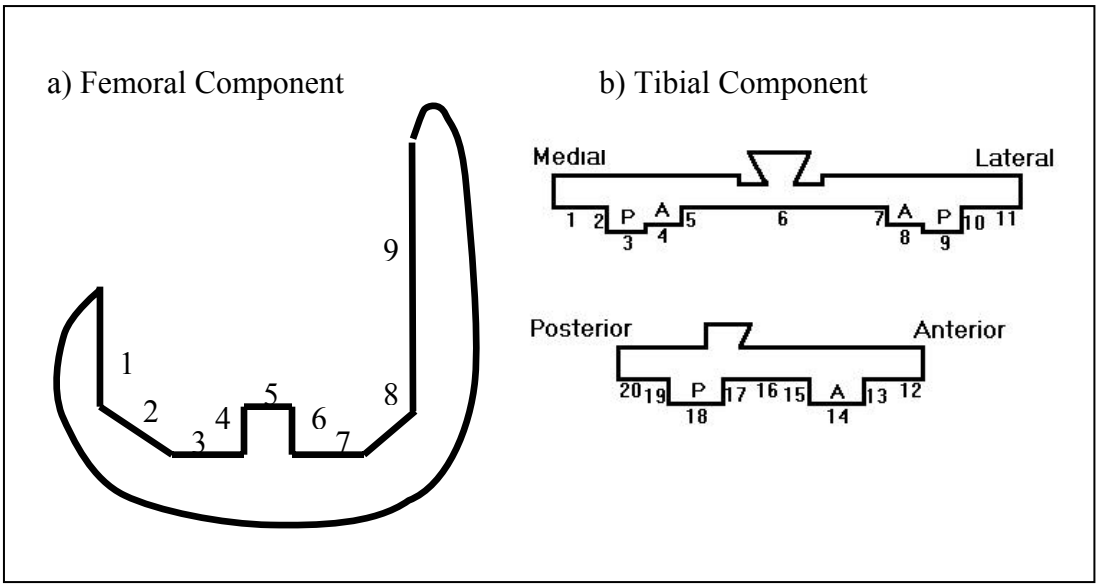

Figure 2. Presence of lucent lines

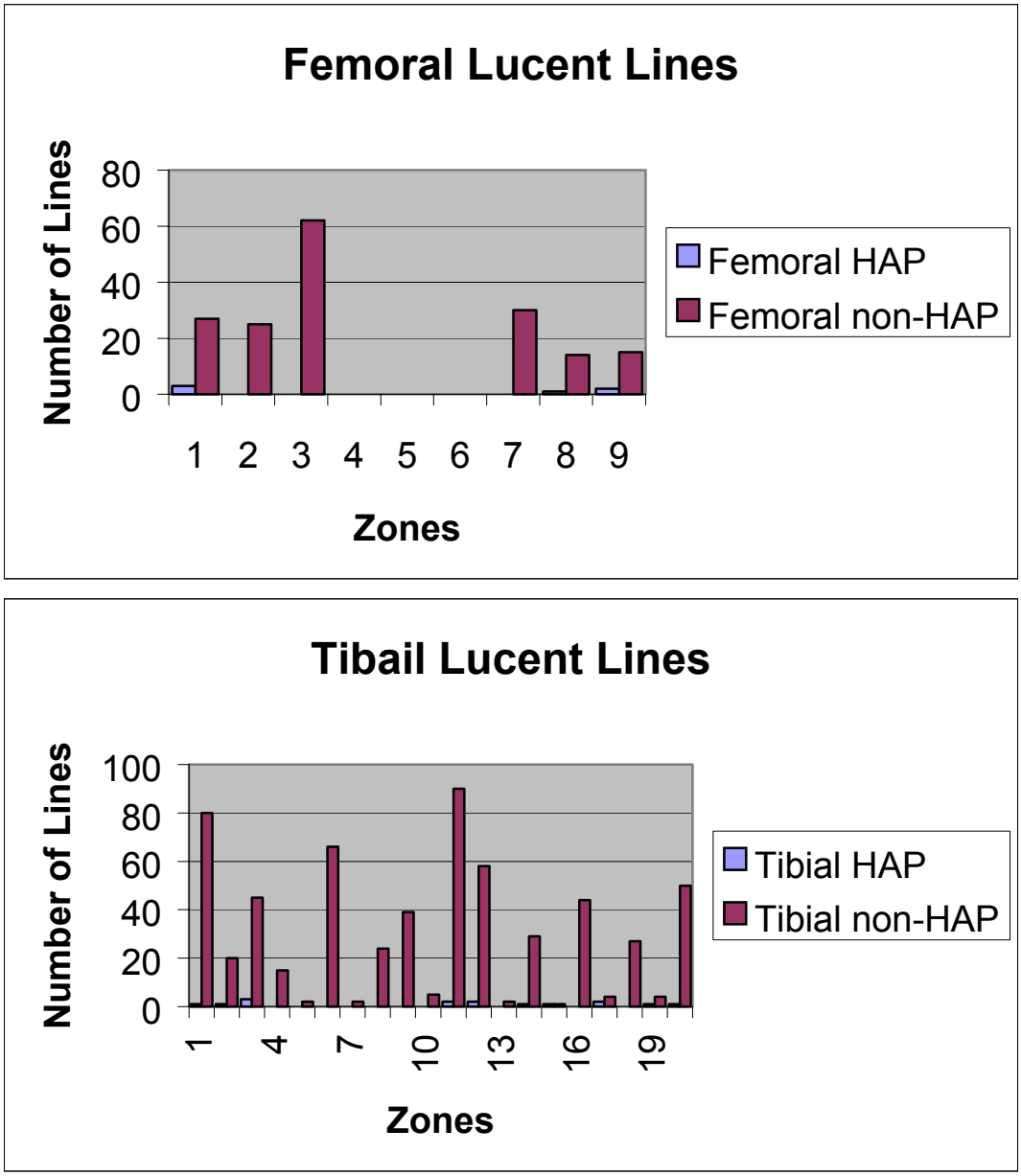

Figure 3. Osseointegration within the beaded surface