Bone growth into a revised porous-coated patellar implant

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A noncemented and clinically stable porous-coated patellar component (PCA™) was removed from a patient after 11 months because of infection. It was sectioned and examined histologically in undecalcified, thin-ground sections. The bone ingrowth into the porous space was measured at eight levels. Each histologic section was quantified by a conventional point-counting method using a square grid.

There was inhomogeneous, but extensive, bone ingrowth, often extending to the core of the patellar component, with direct contact between bone and porous coating without any interstitial fibrous membrane.

Histomorphometric and other quantitative analyses of bone ingrowth into noncemented porous-coated knee implants have been limited. Previous studies have demonstrated bone ingrowth into porous implants both in humans (Brooker et al. 1984, Bobyn et al. 1980, 1987, Pilliar 1980, Pilliar et al. 1986) and in animals (Cameron et al. 1973). Case reports have demonstrated from 0 to 30 percent ingrowth (Cook et al. 1988, Okada et al. 1988, Vigorita et al. 1989). An early report showed only fibrous-tissue ingrowth into a PCA™ patellar component (Cook et al. 1986). We have measured the amount of bone ingrowth into a retrieved PCA™ patellar component.

Case report

A 35–year-old, 70-kg, active woman with posttraumatic arthrosis in the right knee had previously had a noncemented total knee prosthesis inserted.

Postoperative radiographs revealed good alignment of the knee and correct position of all three components. Eleven months postoperatively, there were signs of infection with growth of *Staphylococcus aureus*.

The prosthesis was removed, and a knee fusion was performed. All the components were stable, and required careful removal with osteotomes.

Material and methods

The patellar component was immediately immersed in 10 percent, neutral-buffered formalin solutions, followed by serial dehydration in graduated ethanol solutions from 70 to 100 percent.

After dehydration, the component was embedded in toto in epoxy resin (Epofix®, Struers, DK).

Eight randomized sections were cut in the lateromedial direction. The saw cuts were approximately 200 µm thick. The saw used was a Al_2O_3 wheel. Liquid was continuously applied directly to the cut to avoid overheating (Wallin et al. 1985).

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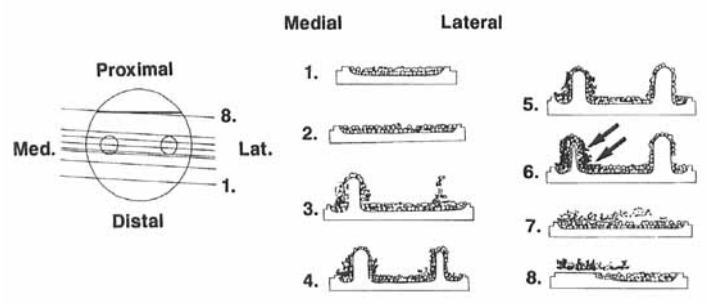


Figure 1. Sections of the patellar component were cut from eight areas selected at random (left). Histologic maps were made of each section demonstrating the amount of bone ingrowth (right). The arrows indicate the areas from which Figures 2 A–C were taken.

Table 1. Porosity and bone ingrowth in different histologic sections. Ingrowth is expressed as the percentage of the porous space occupied by bone (Okada et al. 1988)

Section	Porosity[a]			Bone ingrowth[b]		
	Med.	Mid.	Lat.	Med.	Mid.	Lat.
1	37	–	30	20	–	11
2	34	–	29	23	–	56
3	40	–	34	41	–	30
4	47	36	45	52	53	38
5	55	38	42	56	47	30
6	33	39	50	85	48	26
7	35	–	44	12	–	12
8	–	35	–	–	16	–

[a] percentage of porous space available for bone ingrowth.
[b] percentage of actual bone ingrowth in available pores.
– sections not divided into three segments.

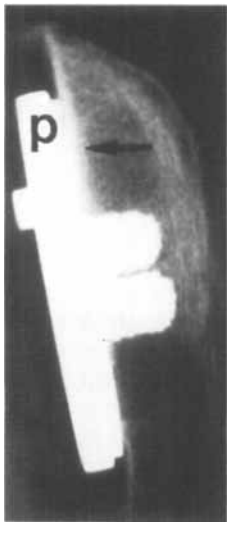


Figure 2. A clear sclerotic line (arrow) in the proximal (P) area 11 months postoperatively.

Four sections were made through the fixation pegs (Figure 1). The sections were ground to 50 µm on a grinding machine (Knuth-rotor®, Struers, DK) using silicone-carbide paper. The sections were stained with Stevenel's blue and van Gieson's picrofuchsin (Maniatopoulos et al. 1986).

The sections were examined qualitatively and quantitatively by transmitted light microscopy. The amount of bone growth into the available pore volume was determined using a point-counting technique. Only bone that was within the porous-coated area was defined as ingrowth.

Each histologic section was traced using the Leitz tracing device® based on the coincident image principle. Histologic maps were produced (Figure 1). On each map a mean of 1,946 (891–2,779) grid points were counted.

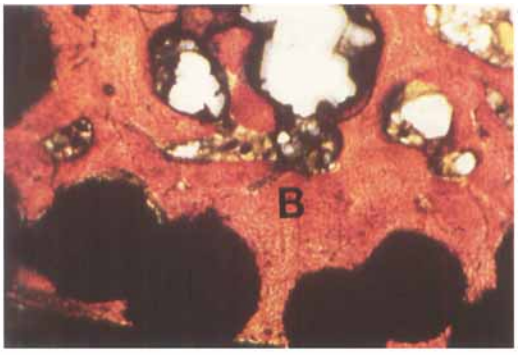
Ingrowth was measured at three segments of the patellar component: the medial, middle, and lateral segments.

Results

Macroscopic examination of the porous surfaces of the patellar and femoral components revealed adherence of bone. No bone was seen at the tibial component.

The bone ingrowth into the porous space showed different magnitudes on the sections (Table 1). The most extensive bone ingrowth was seen adjacent to the pegs. The mean porosity of the patellar component was 38 (29–55) percent. The mean ingrowth was 33 percent with 41 percent medially and 29 percent laterally.

In the radiosclerotic zone seen on the radiograph (Figure 2), the mean bone ingrowth was 14 (12–16) percent.



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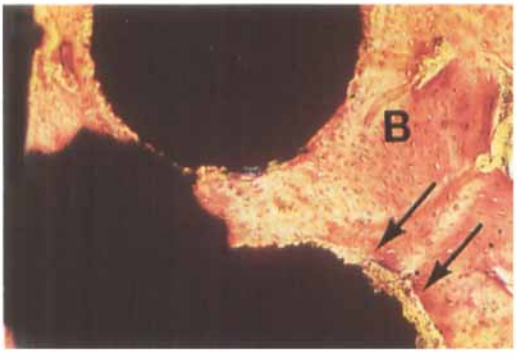

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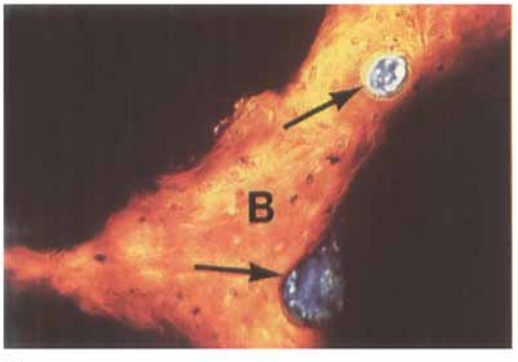

C

Figure 3. The interface region between the medial segment of the patellar implant and the bone from section No. 6, stained with Stevenel's blue and van Gieson's picro-fuchsin.

A. Bone (B) is stained red and is clearly visible between the beads in the porous implant surface (I; ×40).

B. Areas with direct bone-to-implant contact are seen, but a few areas with fibrous tissue in contact with the implant can also be recognized (arrows; ×100).

C. Bone (B) with a cortical structure and with haversian canals (arrows), which are seen between the implant beads (×200).

The qualitative examinations showed no signs of inflammation, bone necrosis, or loose beads. Ingrowth of bone into the porous coating often extended to the core of the implant (Figure 3). Some of the beads seemed to be totally surrounded by bone with direct bone-to-implant contact and only a few areas with fibrous contact. The fibrous tissue in contact with the beads had the fibrils orientated along the beads.

The structure of the bone around the implant beads had a cortical appearance, with osteocytes and haversian canals between the beads (Figure 3).

Discussion

In our case, there was a high degree of bone ingrowth in the patellar component, previously only seen in animals. Earlier studies have shown only fibrous tissue in proximity to the prosthesis (Cook et al. 1986, 1988, Hainau et al. 1989). Although these authors found no osseointegration, the patients were doing well at the time of revision, without any clinical suspicion of loosening. The authors therefore posed the question whether bone ingrowth was necessary for clinical success.

Other studies, however, have shown direct contact between metal and bone, which seems to give better fixation and long-term results than fibrous-tissue ingrowth (Brånemark et al. 1977, Albrektsson et al. 1981, Lintner et al. 1986, Engh et al. 1987, Linder 1989).

In our case, bone ingrowth was demonstrated histologically into an area that exhibited a sclerotic line on the radiographs. Therefore, the radiographic evaluation used by Engh et al. (1987) for noncemented hips may not be applicable to the knee.

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