Chapter 7
Cementless Total Knee Arthroplasty

Aaron A. Hofmann and David F. Scott

INTRODUCTION
Cementless total knee arthroplasty presently enjoys a success rate equal to cemented designs. Clinical results of early cementless total knee replacements had both design and development problems, similar to early cemented systems. Some early cementless knee series had suboptimal results, especially with metal-backed patellas. Likewise, just as cemented total knee designs and clinical results improved, so too have the evolution and clinical results of cementless total knee replacements. Cemented and cementless total knee arthroplasty are similar in respect to requirements for alignment, ligament balancing, and precise bone cuts. In order to achieve durable fixation, cementless fixation may require greater surgical precision than cemented TKA, and is optimized by certain prosthetic design modifications. Cementless fixation may provide several advantages, especially for the younger and more active patient. With increasing life expectancy, a more durable interface would be desirable, especially if bone rather than fibrous tissue attachment could be reproducibly assured. If porous-coated stems and pegs are avoided in the majority of primary total knee replacements, potential future revisions are more bone-sparing.

A number of recent reports indicate that excellent results can be obtained with cementless total knee arthroplasty, especially if design considerations are coordinated with surgical technique. The authors’ 7- to 11-year experience demonstrates that primary cementless fixation in an appropriately selected patient group provides results comparable to cemented TKA with the advantage of conserving bone stock and eliminating the potential problems of methylmethacrylate fixation.

CEMENTLESS IMPLANT DESIGN
There are several important design and surgical considerations for cementless total knee arthroplasty components. These include biological issues such as the type of coating utilized to promote bone
ingrowth, the routine use of morselized autogenous bone chips, and careful patient selection. Other considerations include the geometry of the components, and their alignment and kinematics after implantation.

CEMENTLESS IMPLANT DESIGN: BIOLOGIC CONSIDERATIONS

Patient Selection
We treat a relatively young (average age of TKA patient: 64 years) and very active patient population with osteoarthritis or well-controlled rheumatoid arthritis, and consequently select almost 90% for cementless fixation. Older, sedentary patients with poor bone quality or major medical problems are selected for cemented fixation.

Porous Coating
Although some early designs included femoral components fabricated from treated titanium alloy with a titanium alloy-polyethylene articulation, most femoral components are now fabricated from cobalt chrome for improved polyethylene wear and resistance to third body wear. Our choice for the porous coating is commercially pure titanium sintered to a cobalt chrome alloy substrate. This has been shown to provide excellent bone ingrowth.\textsuperscript{19} Our preference for the femoral component is a bimetal design, combining the superior wear properties of cobalt chrome with polyethylene, and the biocompatibility of titanium.\textsuperscript{20} This coating has an average pore size of 400\textmu m and a porosity of 55%, compared to a beaded surface porosity of about 35% regardless of bead size.

Porous-coated pegs and stems are avoided to minimize stress-shielding of the interface and improve bone preservation during revision. Porous-coated pegs may cause a starburst pattern of bone ingrowth, which stress shields the remaining interface and causes significant bone loss if revision is required.

Autogenous Bone Chips as a Biologic Cement
Analysis of the resected proximal tibia reveals that the cortical bone surface area is an average of 6% of the total tibial surface, and that cancellous bone accounts for 18% of the total area, with bone marrow space comprising 76% of the remaining surface area.\textsuperscript{21} The implication is that some form of “cement” is required to increase the surface attachment between the tibial component and the resected cancellous bone, and thus eliminate loosening and subsidence and provide durable fixation. The authors advocate the