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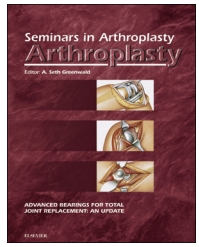

Cemented femoral stems: An invaluable solution

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ABSTRACT

The use of cemented femoral stem fixation has declined in North America despite numerous favorable long-term outcomes reported. Cemented stems offer some advantages over cementless fixation and should therefore remain part of every orthopedic surgeon's armamentarium. Long-term survival, versatility, low periprosthetic fracture risk, decreased risk of infection, and the cement within cement revision technique are all advantages of cemented fixation. Surgeons should be knowledgeable of different cemented stem designs including both the composite-beam and taper-slip philosophies, and must avoid mixing their principles in order to achieve durable clinical success.

1. Introduction

Cemented femoral stems were the initial method of fixation for hip arthroplasty; however, North American surgeons have moved away from this method over time in favor of cementless fixation. There are several hypotheses as to why this trend has occurred which include: the introduction of "cement disease" misnomer [1], and poor outcomes seen after "design improvements" aimed to decrease cemented stems subsidence [2]. Cemented femoral stem usage has decreased dramatically in North America [3] despite the excellent outcomes seen in registries. Even with the most robust indications for cemented stem fixation, such as the elderly hip fracture patient with osteoporosis, cemented fixation is falling out of favor [4]. In Australia, United Kingdom and other European countries, decreased utilization is occurring as well, but not at the rate seen in the United States [5–12].

Cemented femoral stem fixation should not be abandoned, but rather coexist as an alternative and often preferred to cementless fixation in the appropriate clinical scenario. Before choosing a stem design, a thorough patient assessment must be done, with an emphasis on the patient's age, sex, bone quality, and anatomy of the proximal femur. The femoral stem fixation should, therefore, be selected to best accommodate each patient's clinical needs.

Cemented femoral stem fixation has proven excellent survivorship and entails several additional advantages that make it ideal for many patients by providing versatile fixation in various pathologic bone disorders and bone geometries, a lower periprosthetic fracture risk, potential for decreased periprosthetic joint infections with the use of prophylactic antibiotic loaded bone cement, a generally more forgiving technique and a simple revision technique. This article reviews the cemented femoral stem philosophies, and the reasons why it should remain an invaluable option in contemporary hip replacement surgery.

2. Design philosophies

Two fundamental philosophies of cemented femoral stem fixation exist taper slip and composite beam. The *taper slip* philosophy, exemplified by the Exeter femoral stem, permits

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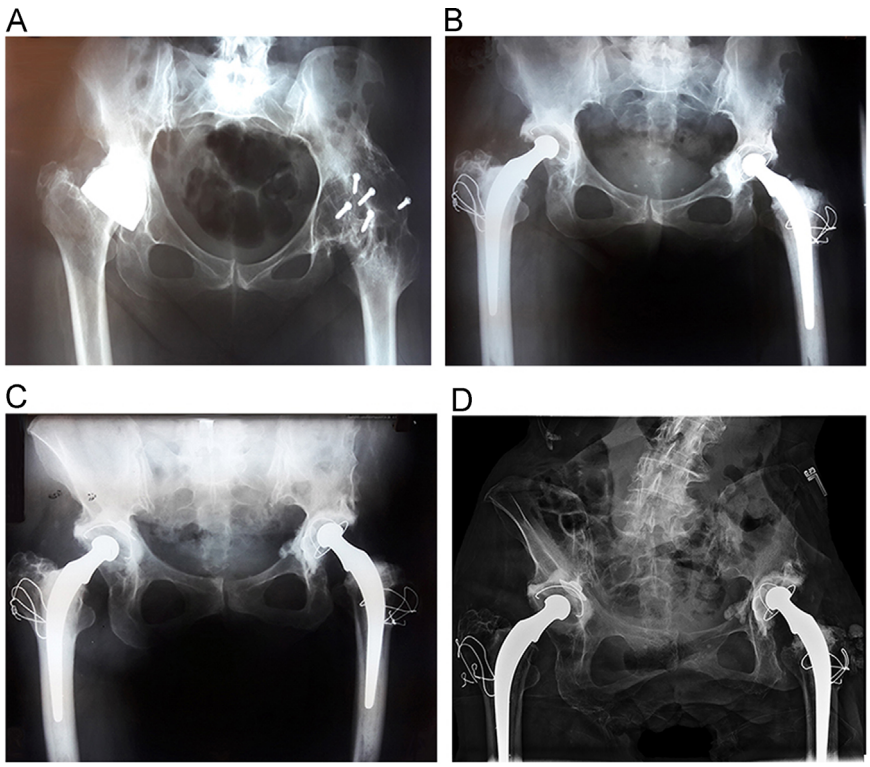

Figure – Sequential radiographs of a patient with previous Thompson osteotomy and arthrodesis (left hip), and vitallium cup (right hip) secondary to developmental dysplasia of the hip bilaterally and pyogenic arthritis in the left hip. (A) 1971. Previous to THA′s. (B) 1973. After sequential THA′s. (C) 1992. 20-years follow up. (D) 2008. 38-years follow up.

stem subsidence within the cement mantle to function as a loaded taper. This is the fundamental principle of this philosophy. The design usually employs a polished, collarless stem with a tapered geometry. The polished surface is fundamental as it prevents bonding at the stem–cement interface, and therefore allows subsidence without generating significant cement debris [13], which would otherwise result in progressive osteolysis with eventual loosening and failure. In this design, the load is transmitted from the prosthetic head to the stem, which forces the taper to subside within the cement mantle [14]. As the stem subsides, axial compression generates radial compressive forces in the surrounding cement mantle, which are then transferred to bone as hoop stress [13,15,16].

Conversely, the *composite beam* philosophy requires a strong and secure bond at the stem–cement interface to be effective [13,15]. The design is usually characterized by a rough stem with a collar. The rough stem facilitates a strong stem–cement bond, with the aim of providing excellent support to form a stable "composite" construct from the metal stem, cement mantle, and bone [14]. In the stable construct, cement and stem strain are identical at the interface at all times and therefore stress in the cement can only be relieved when the interface fails. The latter presents as radiolucency at the bone-cement interface and predicts increased risk of failure [15]. Therefore, the perfect stem-to-cement bond required in the composite beam, cannot allow stress relaxation. The collar serves to prevent subsidence. In this model, load is transmitted via the femoral head to the stem and then through the stem tip, bypassing the proximal femur. This explains why calcar and proximal femur bone reabsorption is often observed over time [14,15]. Thus, these two different systems require different stem–cement interfaces, a perfect stem–cement bond for the composite beam system, but essentially no bond between the stem and cement in the taper slip design [14]. It should be noted that combining these two philosophies, dramatically increases the rate of failure [15,17–19].

3. Advantages of cemented stems

Cemented femoral stems may provide numerous advantages over their cementless counterparts depending on the clinical context. The following sub-sections review the major benefits of using cemented stems.

3.1. *Survivorship*

Cemented femoral stems of select designs have demonstrated outstanding long-term survivorship [20]. Callaghan et al. [21] and Ling et al. [22] reported >90% survivorship for revision due to aseptic loosening, at >30 years follow-up for the Charnley stems and the Exeter polished stems, respectively. Warth et al. [23] also reported outstanding results with the Charnley stems, in patients less than 50 years old at ≥35 years follow-up [23]. Additionally, recent studies suggest that cemented and cementless stems have comparable outcomes and therefore remain a viable option in different patient groups [24–26] (Fig.).