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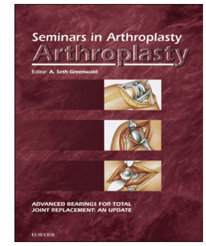


# Pegged or keeled glenoid component use: Which is it?

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ABSTRACT

With variation in glenoid design focused mainly on the backside interface of the component with the glenoid bone, keeled and pegged glenoid components have become the basis for most implants. Keeled implants offer a single, deep anchor for the component, while pegged implants offer stability with less bone removal. There is a trend in multiple studies for decreased radiolucent lines, decreased loosening, and decreased revision rates with pegged components. In-line pegs confer several advantages over out-of-line pegs. Advancements in cementing techniques and glenoid preparation have improved longevity for all types of glenoid implants.



## 1. Introduction

The glenoid component in total shoulder arthroplasty has been the most common cause of failure after total shoulder arthroplasty [1]. Activities of daily living can exert significant force of up to 1.5 times the body weight across the shoulder [2]. These repetitive forces may eventually lead to glenoid loosening, which can result in inferior functional outcomes or can necessitate revision. Thus, much research has been devoted to identify and minimize factors that can lead to glenoid loosening, including issues related to prosthetic design.

A variety of different implant designs exist for the glenoid component in total shoulder arthroplasty. The most common designs consist of a polyethylene glenoid, which is affixed to the bone with low-viscosity PMMA cement for interdigitation with the subchondral glenoid bone and the cancellous glenoid bone [3]. The main interface options for the glenoid implant include a triangular keeled glenoid component or a component with multiple cylindrical pegs, which may be all in straight line or out-of-line and eccentric. Designs intended to allow bone ingrowth, such as anchor pegs or metal-containing components, are beyond the scope of this review.

Radiographic glenoid loosening is typically defined as the progression of radiolucent lines on serial x-rays or a shift in implant position. CT scans are also helpful for delineation of areas of lucency behind the glenoid component. Significant radiolucent lines consist of 1.5-mm thick areas of lucency in one of the five zones surrounding the glenoid component at the implant–cement interface. Progression of the radiolucent lines is significant when two or more lines are continuous. Radiographic loosening usually precedes functional loosening, but not all patients with radiolucent lines on x-ray will have clinical symptoms requiring revision [4]. Radiographic loosening is generally used as the end point for implant survival studies on total shoulder arthroplasty.

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## 2. Keeled glenoid component

The original Neer total shoulder design had a keeled glenoid component, and early studies showed promising survival. A study of 113 patients by Torchia and Cofield [5] showed excellent survival, but nevertheless, there was a 44% rate of radiographic loosening. At that time, glenoid preparation was done manually with a burr.

Keel designs have improved since the initial phases. Cementing techniques including pressurization of a thin, consistent cement mantle and bone preparation have improved the cement–bone interface [6]. Biomechanical studies of pull-out strength using modern cementing techniques have shown an advantage for keeled components, although this may not reproduce the clinical failure pattern [7]. The typical loosening pattern in vivo is a rocking mechanism, producing eccentric loading, followed by medial subsidence, superior or posterior tilt, and loosening via a windshield wiper effect [8,9].

Burring by hand has been replaced with advanced techniques and specialized tools. For example, one technique is to first make the peg holes and then connect them. The quantity of cement used has become more minimal, as a thin 1-mm cement mantle has been found to be ideal with regard to the balancing forces of cement fatigue and interface failure via excessive stiffening of the implant [10]. Cancellous bone removal is now avoided or minimized with both keels and pegs. Taken in combination, the preservation of cancellous bone and the minimal use of cement, keels are not causing the same big areas of bone loss, as they once did. One way to assess this is with the reduction of lucent lines around the glenoid component [11,12].

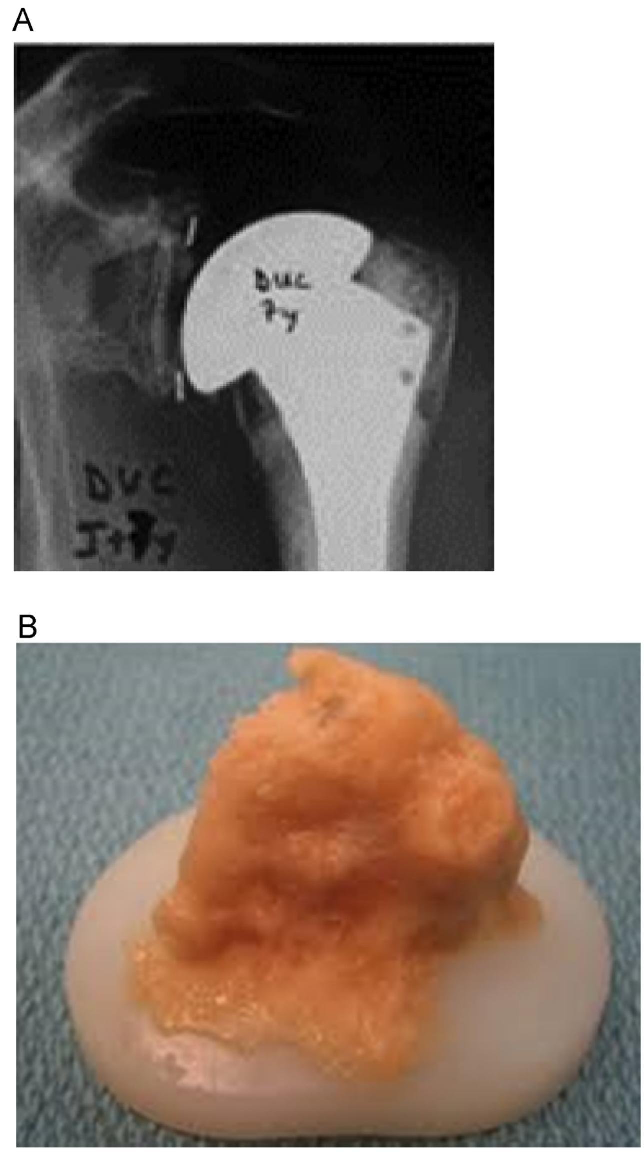

**Figure 1 – (A and B) A radiograph of cavitary glenoid defect after keeled glenoid component implantation, and a clinical photo of appearance of a removed loose, keeled glenoid.**

## 3. Pegged glenoid component

The main disadvantages of keeled components have centered on the large areas of cement implantation and the large areas of bone excavation, leading to a large cavitary defect (Fig. 1). This led to the initial interest in pegged glenoid components. Drilling small holes for the pegs maintains bridging bone in between and usually does not risk supporting subchondral bone from the glenoid vault.

The pegged components have some advantages, even in the eventuality of aseptic loosening of the glenoid. Bone preservation with pegs is superior. In a study by Lazarus et al. [13], they found better radiolucency scores for pegged components, rather than keeled components. In their review of 328 patients with TSAs where 289 patients had pegged glenoid components and 39 had keeled glenoid components, the radiolucent score was significantly higher for keeled components. (Fig. 2) In biomechanical studies where eccentric loading is applied, pegs have outperformed keels [14].

There are variations in peg design, with the pegs created all in a straight line or with the addition of staggered pegs in a horizontal direction known as "out-of-line" pegs. The advantage of in-line pegs is that in-line pegs can be longer, so they are in the deepest part of the glenoid vault and do not go off in a more shallow area of the glenoid. A posterior peg is especially difficult to utilize, as it requires enhanced exposure, moving the humerus back farther, and drilling a posterior peg hole adds complexity to the procedure. Pull-out studies have suggested an advantage for out-of-line pegged components, but pullout from cement is not a typical failure mode seen clinically.

Anatomic studies have shown that attempted correction of more than 15° of glenoid retroversion when using an implant with eccentric pegs usually led to a penetration of the posterior peg as reaming proceeded down beyond 15° of correction [15]. By contrast, another study of in-line pegs found that up to 20° of retroversion could be corrected with asymmetric reaming before glenoid perforation [16]. In-line pegs have the advantage that they can come down to the middle of the glenoid and can be longer, whereas out-of-line pegs may perforate the edge of the glenoid. Therefore, the out-of-line pegs have to either be shorter or have a higher risk of glenoid vault perforation [17].