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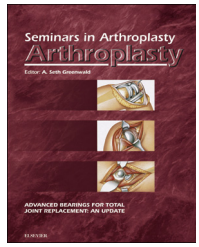

Stemless constrained total knee arthroplasty: An obsolete concept or a contemporary solution?

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ABSTRACT

Achieving a balanced total knee arthroplasty (TKA) can be challenging when addressing fixed deformities with bone deficiencies and a compromised soft issue envelope. Efforts to achieve ligamentous stability without violating the medullary canal led to the introduction of stemless constrained implants. While a stemless constrained implant is bone conserving and efficient, there are biomechanical concerns of higher failure rates due to increased stresses at the bone–implant interface. The purpose of this study is to review the current literature on stemless constrained implants in TKA and address the controversy around their use.

1. Introduction

The surgical goals of a successful TKA include durable implant fixation, neutral mechanical alignment with balanced flexion and extension gaps, central patellofemoral tracking, and joint line restoration [1]. However, achieving these basic principles is not always easy, especially when treating fixed knee deformities, bone loss, and/or compromised soft tissues. In these situations, additional implant constraint is necessary to compensate for inadequate soft tissue tension. A constrained tibial insert has a taller and thicker central post that fits intimately in the box of the femoral component and limits rotational and varus–valgus translations [2].

Constrained condylar knee (CCK) implants are currently used in revision procedures but their use has been extended in selected complex primary TKAs, especially in cases of genu valgum deformity and secondary medial collateral ligament incompetence [2–6]. The CCK implants can be used in lieu of extensive lateral ligament releases or medial ligament imbrication and advancement. Addressing ligamentous incompetence with implant design may reduce the incidence of peroneal nerve palsy and flexion instability [3,7].

However, the increased implant constraint transmits larger bending and torsional stresses across the bone–cement–implant interface and to the underlying femoral and tibial cancellous bone [8,9]. Repetitive stress across this interface raises the concern for early loosening and subsequent aseptic failure. For this reason, intramedullary stems are often used with constrained implants in order to distribute implants loads into the diaphyseal portion of femur and tibia [10–13], potentially mitigating thus the odds for aseptic loosening [8,14,15]. A recent study reported no aseptic component loosening in 127 primary stemmed CCK knees at a minimum of 7 years follow-up [6]. However, stemless constrained condylar knee (CCK) arthroplasty, has also demonstrated positive preliminary results with the added benefit of

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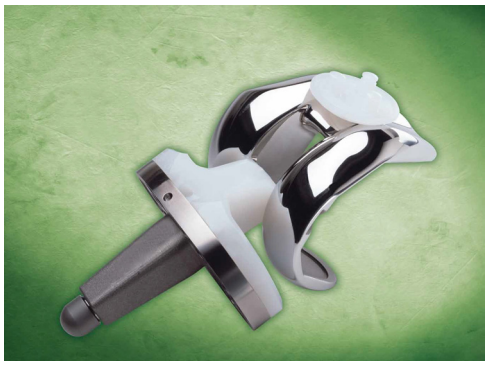

Figure 1 – The NMC implant. (Adopted with permission from Exactech.com.)

avoiding the morbidity associated with diaphyseal stem fixation [2,3,9,16–19].

The objective of this article is to review the current literature of stemless, also known as non-modular CCK, or NMC, implants, to identify the advantages and limitations associated with their use and potentially delineate circumstances in which they are contraindicated.

1.1. *Contemporary stemless CCK implants design*

The NMC implant (Exactech, Gainesville, FL) incorporates a femoral component following the standard posterior-stabilized articular geometry with a central box cut-out that is 2 mm deeper. The NMC provides varus/valgus constraint equivalent to a traditional constrained insert with similar increased resistance to anterior/posterior translation compared to a posterior-stabilized (PS) knee. The NMC does not allow for stem extensions or metal augments to be attached to the femoral component. The tibial component is modular with a 5 cm stem and optional stem extension (Figs. 1 and 2). Highly controlled tolerances between the condylar polyethylene post and the femoral intercondylar box provide for ±1.5° of varus/valgus and ±2° of rotational constraint (Fig. 3). The post is reinforced by a screw to increase its bending resistance [20].

Another stemless CCK implant design is incorporated in the Genesis II™ Total Knee System (Smith and Nephew, Memphis, TN). The insert has an oversized post, which fully engages into the femoral box, providing stability in the frontal plane. The CCK post features less rounded edges, resulting in an almost rectangular shape [21]. Moreover, it is thicker, taller, and wider than its corresponding PS post (Fig. 3). This allows greater constraint of the articulation to within 2°–3° of varus/valgus motion when the knee is in full extension [22].

The Optetrak Logic® PS knee system (Exactech, Gainesville, FL) offers the choice of a posterior stabilized constrained (PSC) tibial insert in addition to the traditional PS insert. These 2 designs are identical except for the increased width of the PSC polyethylene post, which constrains internal/external rotation to 4° and varus/valgus to 3° (Fig. 4). Both insert designs are compatible with the Logic® PS femoral component which does not have a stem extension option. Similar semi-constrained solutions have been developed by other manufacturers. The Persona® Knee System (Zimmer Biomet, Warsaw, IN) offers the constrained posterior stabilized (CPS) articular surface in addition to its PS insert. The CPS insert provides ±1.5° varus/valgus constraint and ±5.5° internal/external rotation constraint.

1.2. *Rationale behind stemless CCK in TKA*

The rationale behind the use of stemless CCK implants is to utilize the enhanced stability of CCK implants without the

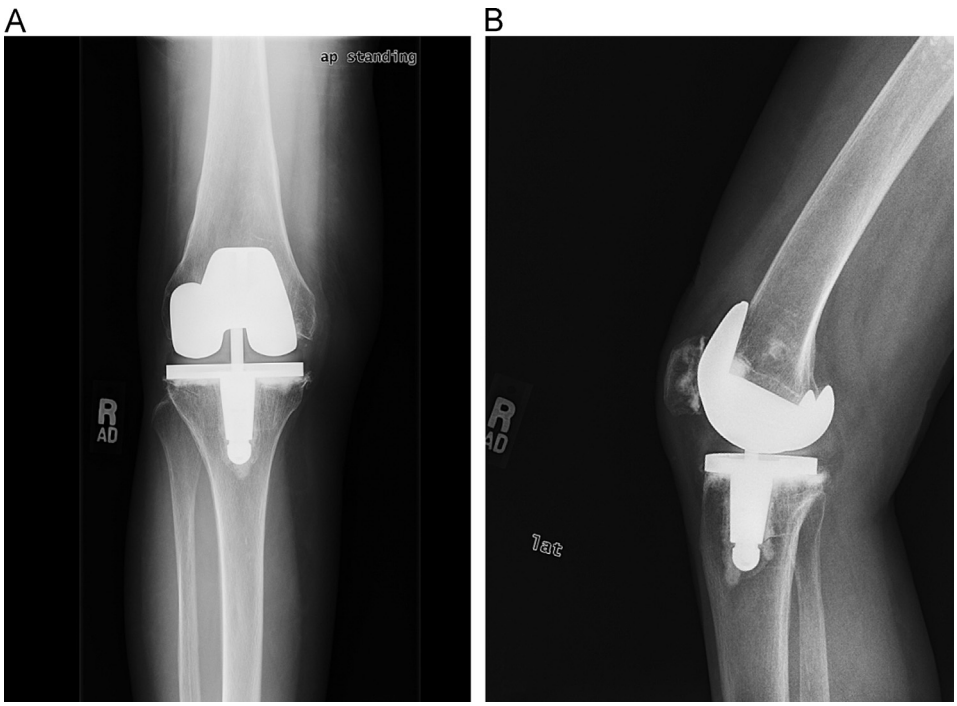

Figure 2 – Anteroposterior (A) and lateral (B) radiographic view of a non-modular constrained (NMC) knee implant.