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Advantages of a Cementless Unicompartmental Knee Arthroplasty Approach ☆

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Medial unicompartmental knee arthroplasty (UKA) is a procedure designed for resurfacing the medial compartment in isolated medial compartment degenerative joint disease. Many long-term studies have reported the success of UKA. Despite recent interest and isolated reports of success, significant issues still exist today with early failure in UKA. Medial UKA is a promising alternative to total knee arthroplasty for isolated medial compartment degenerative joint disease. Potential advantages of this treatment option compared with total knee arthroplasty include improved patient satisfaction, more consistent return to sporting activities, quicker recovery, decreased complication risk, and greater range of motion. With the introduction of robotic arm tools to help improve accuracy and reliability of implant position, we may be able to decrease failure rates in UKAs. In addition, cementless technologies are promising approaches to improve the durability of UKA fixation. Robotic arm techniques coupled with cementless fixation strategies may dramatically reduce the incidence of aseptic loosening in UKA.

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Introduction

Medial unicompartmental knee arthroplasty (UKA) is a procedure designed for resurfacing the medial compartment in isolated medial compartment degenerative joint disease. Popularity and usage of this procedure faded in the United States in the 1980s following reports of high early conversion rates to total knee arthroplasty (TKA).[1,2] However, with the introduction of minimally invasive techniques and promising midterm results, a renewed interest in UKA developed in the 1990s. As UKA was performed in Europe, a heightened awareness of the potential advantages of UKA over TKA became apparent to surgeons. In the late 1990s, good 10-year results of UKA were reported from single centers in both the United States and Britain.[3,4] Long-term data are now demonstrating that fixed-bearing unicompartmental knees are lasting well into the second decade.[4,5] Although it has been recommended that unicompartmental prostheses should be suitable for 20%-30% of knee replacement procedures, only 8% of all knee arthroplasties performed in the US in 2007 were unicompartmental.[3,6] Despite recent interest, isolated reports of success, and a potentially unrealized patient population, significant issues still exist today with early failure of both the femoral and the tibial components in UKA.[7-14] It has been well documented that the most common failure mechanism of UKA is owing to aseptic loosening.[8,15]

The etiology of aseptic loosening (particularly early loosening) is related primarily to implant positioning and implant fixation. Implant positioning affects final limb and component alignment. Overcorrection or undercorrection of the final limb alignment can cause increased polyethylene wear, disease progression to the contralateral compartment, and implant loosening from overload of the medial prosthesis.[16-20]

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In addition to limb alignment, there are several other factors a surgeon must consider when determining the position of the implant components such as alignment and tibial slope that may improve the longevity and survivorship of the implant.[21] The tibial component should sit perpendicular to the tibia's long axis in the coronal plane to ensure that the components are mated, or remain in contact throughout the gait cycle. Sawatari et al[21] found evidence of increased stresses to cancellous bone when the tibial component was placed varus to the coronal plane. When considering the tibial slope of the component in the sagittal plane, many studies have shown that achieving proper posterior tibial slope is crucial to overall knee stability.[22,23] Although it is recommended to match the native tibial slope of the knee, there are several findings that indicate the limits of tibial slope.[24] Hernigou and Deschamps[25] found that a tibial slope $<7^{\circ}$ reduces the risk for increased anterior cruciate ligament (ACL) damage or potential ACL rupture. This study also found that increased tibial slope correlates to increased tibial translation during weight bearing.

To refine the surgeon's technical control of implant positioning, robotic-arm–assisted technologies have been developed. These tools have been shown to help control long-leg realignment and improve accuracy in implant positioning.[26,27] Studies have shown that robotic arm tools promise to help make implant positioning more reproducible and accurate. However, at present, the robotic arm technique does not affect the major secondary factor associated with aseptic loosening—implant fixation.

At present, there are 2 primary modes of implant fixation. This article intends to compare and highlight the similarities, differences, and failures of cemented and cementless UKA design philosophies. This article also proposes an improved cementless keel design, which aims to solve some of the fixation issues observed in the various marketed designs (Fig. 1). Combining robotic arm control of implant positioning with improved fixation strategies such as novel cementless solutions may reduce the incidence of aseptic loosening and dramatically improve implant survivorship in UKA.

Cemented UKA

Bone cement was introduced more than 30 years ago and is currently successfully used by all orthopedic manufacturers for the fixation of implants.[28] The current cemented UKA market (primarily in Europe) consists of Biomet Oxford Cemented Knee design, followed in no particular order by the Zimmer Uni Knee, Stryker Triathlon PKR, DePuy Sigma PKR, and MAKO MCK Knee.

There are various failure modes associated with cemented designs. Aseptic loosening of tibial, femoral, or both components is the leading cause of failure [8,15,29-36]. Implant loosening is usually verified by X-ray imaging during patient follow-ups. Mariani et al[7] found that even though the femoral component can appear to be fixed in radiographic low flexion angles, at higher flexion the femur can be very mobile and free to "spit-out" (Fig. 2). Pandit et al[37] confirmed tibial component loosening by observing radiolucency 1 mm below the cut line. Radiolucency is either partial or uniform under the implant. This is believed to be because of the stress shielding caused by improper cement application.[37,38]

Cementless UKA

The use of cement with UKA may be technically challenging, and many different failure modes have been observed with cemented fixation.[7-9,12] Elimination of cementing reduces the operation time by an average of 9 min.[37] The cementless market is an up-and-coming segment of UKAs. The market is mainly concentrated in Europe, led by the UK and France. Notable designs regularly used are the Oxford Cementless (Biomet), Alpina (Biomet), LCS (DePuy), and UNIX (Stryker).

The Alpina knee is primarily used in France by a limited number of surgeons and has documented results similar to those on the cemented knees in 5-year and 11-year evaluations.[39,40] Both outcome studies point to a revision initiated by an ACL rupture in the limited number of cases studied. Secondary causes for revision were reported to be technique-related failures of poly surface owing to fracture or wear.

The UNIX knee was reviewed at 5- and 13-year follow-ups in studies by 2 centers.[41,42] Of 125 implants in the first center, 1 ACL rupture and 1 failure owing to a fall were reported. The second center examined 85 implants and identified 4 patients with aseptic loosening of the tibial implant.

The LCS Knee has a relatively lower survival rate when compared with the preceding 2 designs, mainly owing to the more complex procedure required to implant. A 2-center study with 11-year mean follow-up shows that 32 of the 177 procedures were revised owing to technique and poly wear–related failure.[43] The insert alone was replaced in 15 cases.[43]

The cementless Oxford UKA has the largest body of literature and clinical experience. The cementless Oxford UKA is modified slightly from the cemented version by the

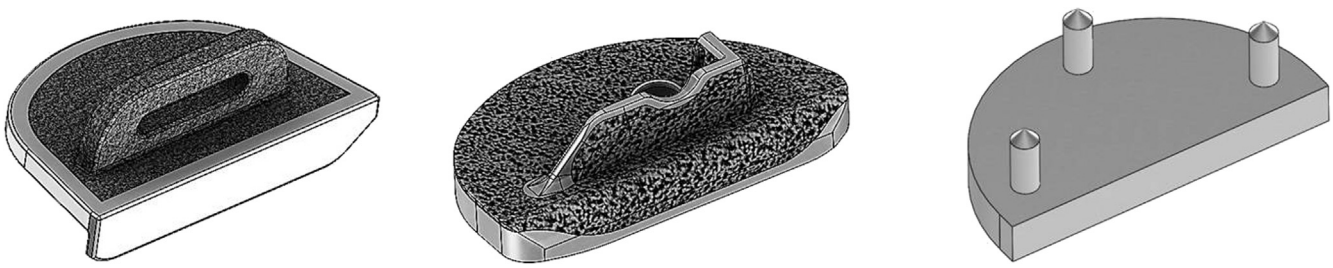

Figure 1 Straight keel and Control (L design).