Outcomes of a newer-generation cementless total knee arthroplasty design in patients less than 50 years of age

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Background: Younger patients undergoing cemented total knee arthroplasty (TKA) may be at risk for lower implant survivorship and higher revision rates due to the historical increased prevalence of aseptic loosening and instability in this cohort. The recent advances of cementless TKAs may mitigate some of these complications. However, there is a paucity of studies reporting on patients who are under 50 years who have undergone a cementless TKA. Therefore, this study evaluated: (I) implant survivorship; (II) functional outcomes and complications; and (III) radiographic outcomes in patients who were less than 50 years of age and underwent cementless TKA.

Methods: A total of 29 patients (31 knees) younger than 50 years who underwent primary TKA at a single institution (Mount Sinai Beth Israel, New York, New York, USA) from June 2008 to May 2014 were included. Their mean follow-up was 4 years (range, 2 to 6 years). The cohort included 20 women and 9 men who had a mean age of 45 years (range, 34 to 49 years), and a mean body mass index (BMI) of 33 kg/m^2 (range, 22 to 54 kg/m^2). The preoperative knee diagnoses were osteoarthritis (n=24), osteonecrosis (n=5), and rheumatoid arthritis (n=2). A Kaplan-Meier analysis was used to calculate the all cause implant survivorship. Functional outcomes and all complications were recorded for each patient. Additionally, radiographic evaluation using the new Knee Society Radiographic Evaluation and Scoring System was performed.

Results: The overall implant survivorship was 100%; there were no failures or revision surgeries performed as of the latest follow-up visit. At the latest follow-up, the mean Knee Society pain score was 92 points (range, 80 to 95 points) and the mean Knee Society function score was 84 points (range, 70 to 90 points). Additionally, the mean knee extension was 1 degree (range, 0 to 5 degrees) and the mean knee flexion was 125 degrees (range, 95 to 140 degrees). Furthermore, at the latest follow-up, on radiographic evaluation, there was no evidence of component loosening, subsidence, radiolucency, gap formation, or reactive changes, and there were no postoperative complications.

Conclusions: Cementless fixation of TKAs had excellent survivorship and functional and radiographic outcomes at midterm follow-up in patients younger than 50 years. Although longer follow-up is needed, these cementless TKA implants appear to provide promising results in younger patient populations.

Keywords: Cementless; total knee arthroplasty (TKA); young; survivorship; complications

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Introduction

The incidence of total knee arthroplasty (TKA) in younger patient populations has increased over the past several years, and over the next decade, patients younger than 65 years of age are expected to account for 55% of these procedures performed in the United States (1). This growing population is likely a result of the growing incidence of obesity and the expanded indications for this procedure (2-5). Cemented fixation has been the most commonly used method for TKA in younger patients with high 10- to 18-year survivorship (94% and 98%) (6-9). However, others have demonstrated lower implant survivorships, potentially resulting from these patients having higher activity levels and placing greater stress on the implants (6,10-12). Furthermore, there have been concerns regarding cemented implants, particularly in younger patients, in terms of problems at the bone-cement interface such as osteolysis, bone resorption, and aseptic loosening (13,14).

Cementless implants were developed as a method to potentially preserve the native bone stock and improve the implant longevity (15-18). While the early implants were associated with a high failure rate due to aseptic loosening (18-20), advances in materials and designs led to the development of newer implants, which consist of bioactive surface coatings that allow for improved fixation (21). Recent studies have demonstrated excellent outcomes with the newer generation cementless TKA implants (21-24). However, there is a paucity of literature that has reported on the outcomes of newer cementless TKA designs in patients younger than 50 years, a much more active cohort than the traditional TKA patients.

Therefore, the purpose of this study was to evaluate: (I) implant survivorship; (II) functional outcomes and complications; and (III) radiographic outcomes in patients who were less than 50 years of age and underwent cementless TKA.

Methods

Patient selection

After institutional review board approval was obtained, all patients who were less than 50 years of age, who underwent a primary TKA at a single, high-volume institution (Mount Sinai Beth Israel, New York, New York, USA) from June 2008 to May 2014 were identified from a prospectively collected database. We included patients who underwent TKA for any reason and had at least 2 years of follow-up. We excluded all revision cases and patients who had follow-up less than 2 years. A total of 29 patients (31 knees) who had a mean follow-up of 4 years (range, 2 to 6 years) were analyzed (*Table 1*). The cohort included 20 women (69%) and 9 men (31%), who had a mean age of 45 years (range, 34 to 49 years), and a mean body mass index of 33 kg/m^2 (range, 22 to 54 kg/m^2). There were 24 patients who had osteoarthritis (77%), 5 patients who had osteonecrosis (16 %), and 2 patients who had rheumatoid arthritis (7%).

TKA implants

From June 2008 to June 2013, the cementless TKA design that patients received was a beaded, periapatite-coated (PA) femoral component and a cobalt-chrome tibial baseplate (Triathlon Total Knee System; Stryker Orthopaedics, Mahwah, New Jersey, USA) (n=22 knees). Multiple layers of cobalt-chromium beads were incorporated in the implant, forming a 1.5 mm thick coating, with an average pore size of 425 µm and a porosity of 35%. To provide a 3-dimensional coating, periapatite, which is a highly crystalline solution form of hydroxyapatite, was used. The femoral component was an open posterior-stabilized box with medial and lateral pegs.

A highly porous titanium coated baseplate (Triathlon Tritanium tibial baseplate; Stryker Orthopaedics, Mahwah, New Jersey, USA) became available in June 2013 and was used thereafter (n=9 knees). A 3-dimensional modeling and analytical technology (SOMA; Stryker Orthopaedics, Mahwah, New Jersey, USA) was used to design the baseplate, to provide better anthropometric sizing by using an extensive computed tomography scan-based database to improve fit and optimize fixation of the tibial baseplate pegs. Since it identified the optimal areas for bone fixation, instead of screws, a delta keel and 4 peg system was employed.

In October 2014, the beaded PA-coated patellar component was replaced by a highly porous titanium-backed patellar component that had 3 pegs (Triathlon Tritanium patella; Stryker Orthopaedics, Mahwah, New Jersey, USA).

Surgical procedure and rehabilitation

All of the procedures were performed using a midline skin incision, and a minimally invasive mid-vastus approach to the knee joint. Gap-balancing techniques were used to equalize the flexion and extension gaps. If bone defects or

Table 1 Patient characteristics

Characteristic	Value
Number of patients	29
Number of total knee arthroplasties	31
Age, years (mean, range)	45 (34 to 49)
Gender	
Men	9 (31%)
Women	20 (69%)
BMI, kg/m^2	33 (22 to 54)

BMI, body mass index.

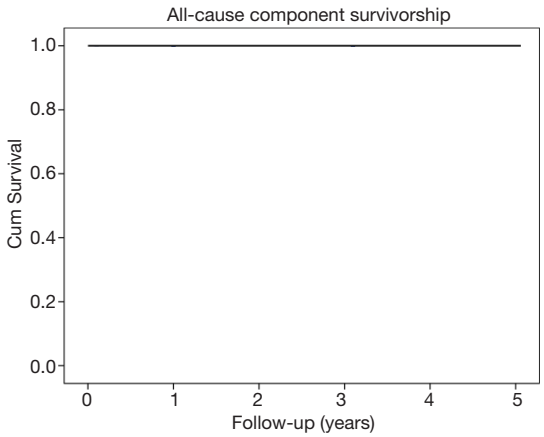

Figure 1 Kaplan-Meier survivorship.

cysts were identified, they were filled with autologous bone, and a 2 mm drill bit was used to drill sclerotic areas of bone. After implantation, range of motion, stability, and patella tracking were evaluated. Routine closure was performed.

A standard, accelerated postoperative physical therapy program with full weight-bearing and range-of-motion exercises was started prior to hospital discharge.

Follow-up

Postoperatively, patients were assessed at 6-weeks, 3-month, 1-year, and then annually. At each follow-up visit, the Knee Society pain and function scores (25) were collected, and the new Knee Society Radiographic Evaluation and Scoring System (26) was used to evaluate the postoperative radiographs. All of the radiographs were performed by 1 of 2 experienced technicians, yielding uniform results without the use of fluoroscopic positioning. Preoperative femoro-tibial angle on standing antero-posterior radiographs showed 19 varus knees (mean of 7.5 degrees; range, 5 to 30 degrees), 8 valgus knees (mean of 12.5 degrees; range, 5 to 30 degrees), and 4 neutral aligned knees (less than 5 degrees of deformity). Post-operative complications were assessed using Standardized List and Definitions of The Knee Society (bleeding, wound complications, thromboembolic disease, neural deficit, vascular injury, medial collateral ligament injury, instability, malalignment, stiffness, deep periprosthetic joint infection, periprosthetic fracture, extensor mechanism disruption, patellofemoral dislocation, tibiofemoral dislocation, bearing surface wear, osteolysis, implant loosening, implant fracture or tibial insert dissociation, reoperation, revision, readmission, death) (27). Any radiographic signs of component loosening, radiolucency, gap formation between the implant and the bone, subsidence, or reactive changes were documented.

Statistical analysis

Descriptive statistics were used to analyze the mean and ranges for the continuous variables. Additionally, a Kaplan-Meier survival analysis, with 95% confidence intervals, was performed to determine the implant survivorship, with the endpoint being revision for any reason. All statistical analyses were performed using SPSS version 23 (IBM Corporation, Armonk, New York, USA).

Results

Survivorship

This cohort of patients had aseptic survivorship of 100% (*Figure 1*). There were no aseptic failures noted, and there were no revisions surgeries performed as of the latest follow-up visit. There were no deep peri-prosthetic infections in this cohort of patients, thus the overall survivorship was also 100%.

Functional outcomes and complications

At the latest follow-up, the mean Knee Society pain score was 92 points (range, 80 to 95 points) and the mean Knee Society function score was 84 points (range, 70 to 90 points). Additionally, at the latest follow-up, the mean knee extension was 1 degree (range, 0 to 5 degrees) and the mean knee flexion was 125 degrees (range, 95 to 140 degrees). As of the latest clinical follow-up, none of the patients had

suffered from any postoperative complications.

Radiographic outcomes

At the latest follow-up, the radiographic evaluation revealed that there was no evidence of component loosening, progressive radiolucency, or reactive changes for any of the prosthetic components. All components appeared stable and no subsidence was noted when compared to previous radiographs.

Discussion

TKA with cementless fixation was developed to decrease cement-related complications, to potentially preserve the native bone stock, and to prolong implant survivorship (13-18). Even though the original designs were associated with early failures, innovations in technology led to newer implants and biomaterials that accelerate implant osseointegration, which could eventually lead to improved long-term survivorship of cementless implants. Moreover, with the growing number of younger, more active patients requiring TKAs, cementless fixation may be the best modality that is most suitable for those who have an active lifestyle; thereby, decreasing the risk for revision surgery. The results of the present study found that at mean 4-year follow-up, patients less than 50 years of age who underwent cementless TKA had a 100% survivorship implant survivorship and excellent functional outcomes scores and range-of-motion.

There were several limitations of the present study. We only assessed a cohort of patients who received cementless TKAs, and did not compare the outcomes to cemented TKAs. Additionally, this study had a small sample size and was performed at a single institution; however, if future, multi-center studies are performed that follow a similar protocol, this information could be generalized to the whole population. Furthermore, this study reported on the early outcomes, and since this is a young population of patients, a much longer follow-up is required in order to determine the true longevity of these implants. Despite these limitations, the results of the present study demonstrated excellent early results, which may lead to successful long-term outcomes of cementless TKAs in younger patients.

Several studies have demonstrated excellent outcomes in younger patients after undergoing cementless TKA using newer-generation implants. Tai and Cross (28) prospectively followed 92 patients (118 knees) who were 55 years or younger and underwent cementless TKA with hydroxyapatite-coated implants, and had a mean follow-up of 8 years (range, 5 to 12 years). They reported that the overall survival rate at 12 years was 97.5%, with 2 patients who developed aseptic loosening and underwent revision surgery. Similarly, in a prospective, randomized, double blinded study, Lizaur-Utrilla *et al.* (29) performed 45 cementless and 48 cemented TKAs in patients who were less than 55 years, and had a mean follow-up of 7 years (range, 5 to 12 years). They reported that the 9-year survivorship for aseptic failure was 94% in the cementless group and 90% in the cemented group; 1 patient in the cementless and 4 patients in the cemented groups underwent revision for aseptic loosening. Also, at the latest follow-up, the cementless group had significantly better knee (94 *vs.* 89 points, P=0.022) and pain scores (47 *vs.* 44 points, P=0.024) compared to the cemented group. Kamath *et al.* (30) reported on 100 patients (100 knees) who were less than 55 years and received cementless TKAs, and 312 patients (312 knees) who had a mean age of 63 years who received cemented TKAs, and had at least a 5-year follow-up. They determined that there were no differences between the cementless and cemented TKAs in terms of Knee Society knee scores (95 *vs.* 91 points, P>0.05) or functional scores (88 *vs.* 86 points, P>0.05). While there were 2 cases of aseptic loosening in the cemented group, there were 3 failures in the cementless group, none of which were related to implant fixation.

Although the newer studies showed favorable results in these implants, studies on the older designs have reported less than satisfactory outcomes with cementless TKAs. These include reports by Moran *et al.* (31) as well as Meneghini and de Beaubien (32), who reported a failure rate of 19% and 8% using older generation implants.

In conclusion, this study demonstrated that younger patients who are less than 50 years had excellent midterm implant survivorship and functional outcomes. Longer follow-up of this patient cohort will continue, and will allow us to make conclusions on the long-term outcomes. As the population of younger patients undergoing TKA continues to grow, cementless implants may be the appropriate design to ensure long-term durability and survivorship.

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Footnote

Conflicts of Interest: Dr. Mont is a paid consultant for Stryker and receives research support and IP royalties from Stryker. Dr. Harwin is a paid consultant and paid presenter or speaker for Stryker. He receives IP royalties and holds stock or stock options from Stryker. The other authors have no conflicts of interest to declare.

Ethical Statement: Institutional review board approval was obtained.

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