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Review

No difference in implant survivorship and clinical outcomes between full-cementless and full-cemented fixation in primary total knee arthroplasty: A systematic review and meta-analysis

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ABSTRACT

Background: The debate over the use of cemented or cementless fixation in total knee arthroplasty (TKA) has never stopped since cementless fixation was introduced. We undertook a systematic review and meta-analysis to evaluate the optimal mode of fixation (full-cementless vs. full-cemented) in TKA.

Methods: PubMed, Embase, and the Cochrane Library databases up to July 2017 were searched to identify randomised controlled trials (RCTs) and quasi-RCTs comparing full-cementless TKA and full-cemented TKA. The primary outcome was implant survivorship. Secondary outcomes included radiological outcomes (maximum total point-motion [MTPM], radiolucent line, rotation degree) and clinical outcomes (Western Ontario and McMaster Universities Osteoarthritis Index [WOMAC] score, Knee Society Score [KSS] score, postoperative range of movement, blood loss and complications).

Results: Seven studies were included in the systematic review and meta-analysis. The mean follow-up was 7.1 years (range from 2 to 16.6 years). There was no difference in implant survivorship (RR, 0.98; 95% CI, 0.95–1.01; $p = 0.25$; $I^2 = 0\%$), MTPM (weighted mean difference [WMD], 0.13 mm; 95% CI, −0.69–0.95; $p = 0.75$; $I^2 = 89.3\%$) and radiolucent line (RR, 1.36; 95% CI, 0.57–3.23; $p = 0.48$; $I^2 = 54\%$) between the cementless and cemented methods. There was a mean 0.22° more rotation in the full-cementless fixation group (95% CI, 0.13–0.32; $p < 0.01$; $I^2 = 28.5\%$). There were no significant differences relating to clinical outcomes (WOMAC score, KSS score, postoperative range of movement, blood loss and complications) between the two fixation groups.

Conclusions: Although more overall component rotation is found in full-cementless fixation, the implant survivorship and clinical efficacy are likely similar between full-cementless and full-cemented fixation. However, future RCTs with similar cementless prosthetic coating and longer-term follow-up are still needed to confirm our findings.

1. Introduction

Today, the demand for total knee arthroplasty (TKA) is continuously increasing, and the mean age of patients undergoing TKA is decreasing. By the year 2030, the number of patients younger than 65 years old who need to undergo TKA will reach 55% of total joint arthroplasty patients of all ages [1]. More postoperative knee range of motion and longer prosthetic life are expected by the gradually younger population [1]. Cemented fixation is widely used in all patients and is the reference standard for TKA [2]. Cemented fixation has many potential advantages: immediate fixation, inaccurate-cut compensation [3] and local antibiotic delivery [4]. However, young and active patients have been shown to place higher stresses on implants, which may result in long-term loosening due to osteolysis [5,6].

Due to concerns regarding late loosening caused by tension, shear or wear debris, the interest in cementless fixation in TKA has increased [7]. The theoretical advantages of cementless TKA include the potential to preserve bone stock and avoid cement debris but, most important, the potential to achieve lasting, biological fixation of the implant to the bone [7,8]. Several studies have demonstrated the relationship between bone ingrowth and long-term implant stability and durability of fixation [6,9].

However, debates over the method of cemented or cementless fixation in TKA have never stopped since cementless fixation was

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introduced. The cementless fixation has not been accepted widely because several early implant designs failed, and many of them did not show superiority over cemented fixation [10]. Limited by poor evidence level and insufficient outcomes, previous meta-analyses failed to draw a consistent conclusion of clear superiority of one modality over the other [2,11–14]. The aim of this systematic review and meta-analysis was to assess the durability and clinical and radiological reliability of full-cementless components versus those of conventional full-cemented components in primary TKA. We hypothesised that the survivorship, radiological outcomes and clinical results are equivalent between the two groups.

2. Materials and methods

The present meta-analysis was conducted following the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) statement [15]. This study was registered in the Research Registry. All analyses in this systematic review and meta-analysis were based on previous published studies that met ethical guidelines.

2.1. Literature search and study selection

A comprehensive literature search was performed in July 2017 by two of the authors (K.Z. and J.L.L.) independently. The primary sources were the electronic databases of PubMed, Embase, and the Cochrane Library. Search terms included "arthroplasty, replacement, knee", "cement", "cemented", "cementless", "uncemented", and "fixation". The language was restricted to English. The computer search was supplemented with manual searches of the reference lists of all retrieved studies, review articles and conference abstracts. This process was performed iteratively until no additional articles could be identified. The following inclusive selection criteria were applied: (a) population: patients undergoing primary TKA; (b) intervention and comparison: full-cementless (cementless femoral component and cementless tibial component) and full-cemented (cemented femoral component and cemented tibial component) TKA; (c) outcome: primary, implant survival rate; secondary, radiological outcomes (maximum total point-motion [MTPM], radiolucent line and rotation degree) and clinical outcomes (Western Ontario and McMaster Universities Osteoarthritis Index [WOMAC] score, Knee Society Score [KSS] score, postoperative range of movement, blood loss and complications); (d) design: prospective randomised controlled trial (RCT) and quasi-RCT. The quasi-RCT is defined as the method of allocation is known but is not considered strictly random. Studies that did not meet the inclusion criteria and those that were repeatedly published were excluded.

2.2. Data extraction and quality assessment

We adopted the Cochrane risk of bias tool to assess the risk of bias for each study [16]. Two reviewers (K.Z. and J.L.L) independently extracted the following data: first author, year of publication, sample size, patient characteristics, length of follow-up, survival rate, radiological outcomes (MTPM, radiolucent line, rotation degree [transverse, longitudinal, sagittal]), clinical outcomes (WOMAC score, KSS score, knee range of motion [ROM], blood loss) and complications (deep venous thrombosis, patellofemoral complications and deep infection). The MTPM and prosthesis rotation of components were measured by radiostereometric analysis using the UMRSA software (RSA Biomedical, Umeå, Sweden) according to guideline [17] and were defined clearly in the articles as follows: (a) the MTPM is the total three-dimensional vector displacement of the marker to the greatest motion; (b) the rotations are angles that are measured around the transverse (flexion/extension), longitudinal (internal/external rotation) and sagittal (varus/valgus) axes. Articles that reported at least one outcome were included. When useful data were presented in graphic plots, we quantified them by using open source Plot Digitizer software (Version 2.6.8, Joseph Huwaldt and Scott Steinhorst) [18]. The median (range) was transformed to mean ± standard deviation. Disagreements were resolved by discussion with a senior author or by contacting the corresponding author.

2.3. Statistical analysis

Pooled analysis was performed to compare the outcome measurements between the two groups using STATA software (version 11.0; Stata Corp., College Station, TX, USA). Differences were expressed as relative risks (RRs) with 95% confidence intervals (CIs) for dichotomous outcomes, and weighted mean differences (WMDs) with 95% CIs for continuous outcomes. Heterogeneities across studies were tested by using the I^2 statistic. A random-effects model was used when I^2 value were greater than 50%; otherwise, a fixed-effects model was used. Subgroup analyses were performed to compare survival rate, radiolucent line and rotation degree. A funnel plot was used to identify publication bias. A p value < 0.05 was judged statistically significant.

3. Results

3.1. Study identification and characteristics

A total of 149 studies were identified by the initial database search. Fifteen of them were excluded because of duplicate studies, and then 92 of them were excluded based on the titles and abstracts. The remaining 42 full-text articles were reviewed for more detailed evaluation. Twenty-three studies were excluded because of review and retrospective study. Eleven studies, which were designed with hybrid fixation (n = 10), and unicompartment knee arthroplasty (n = 1) were also excluded. A study by McCaskie et al. [19] was excluded at last because their data were included in the study of Baker et al. [20]. Finally, 7 studies, including 812 knees (409 cementless and 403 cemented) at last follow-up fulfilled the predefined inclusion criteria and were included in the final analysis [3,20–25] (Fig. 1). Characteristics of included studies are shown in Table 1. The mean follow-up was 7.1 years (range from 2 to 16.6 years).

3.2. Prosthesis designs and surgical variants

The prostheses used are detailed in Table 2. A NexGen (Zimmer, Warsaw, USA) prosthesis was used in 4 studies [3,21–23], a P.F.C. Sigma (Depuy, Warsaw, USA) prosthesis was used in 2 studies [20,24] and only 1 study chose a Interax (Howmedica, Rutherford, USA) prosthesis [25]. All these prostheses were designed as posterior cruciate ligament (PCL)-retaining with a fixed tibial platform. Four studies resurfaced the patella [3,21–23]. Six studies did not use screws for additional reinforcement [3,20–24] and one did not report results clearly [25]. There was variation in the contact surface of the different components. With respect to the cementless tibial components, four kinds had coating (1 porous tantalum coating [22], 2 hydroxyapatite coating [24,25] and 1 porous bead coating [20]); 3 others had no coating but did have a titanium fibre mesh surface [3,21,23]. With respect to the cemented tibial components, only one of them had a pre-coated keeled component [22]; 6 had stemmed components [3,20,21,23–25] (one with a titanium fibre mesh surface [24] and one with a triangular facets surface [25]). With respect to the cementless femoral components, one of them had hydroxyapatite coating [25]; 4 others had no coating but did have a mesh wire surface [3,21–23]. Two studies did not report the type of femoral component surface [20,24]. With respect to the cemented femoral components, one of them was a pre-coated keeled component [22], 4 components had no coating but did have a mesh wire surface [3,21,23,25]. Two studies did not report the type of femoral component surface [20,24].