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Bone Loss During Revision of Unicompartmental to Total Knee Arthroplasty An Analysis of Implanted Polyethylene Thickness From the National Joint Registry Data

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ABSTRACT

Using the National Joint Registry (UK) database, we compared the thickness of polyethylene (PE) and the level of constraint used during primary total knee arthroplasty (TKA) versus the revision of unicondylar knee arthroplasty (UKA) to TKA. A total of 251,803 TKA procedures and 374 revision UKA–TKA procedures between 2003 and 2009 were reviewed. The commonest PE size used in TKA was 10 mm, compared to 12.79 mm in the revision group. The use of constrained knee implant was required in 2.15% of primary TKA and 4.19% of UKA to TKA revisions. The revision of UKA to TKA is a more complex procedure compared to primary TKA, with a higher incidence of using constrained implants and thicker PE inserts. These findings may be useful for surgeons in their decision making.

The use of unicompartmental knee arthroplasty (UKA) in isolated medial gonarthrosis has become more widespread over the last decade. It has been performed as an alternative to total knee arthroplasty (TKA) and high tibial osteotomy for unicompartmental osteoarthritis since it was introduced in the 1970s [1]. A well-functioning UKA has been shown to have benefits above the average total knee arthroplasty (TKA) including improved range of motion [2], better gait pattern [3], shorter average recovery period [4] and a decreased rate of deep vein thrombosis [5]. Various studies in the literature show a currently accepted 10-year survival is in the region of 90% for UKA [6–8]. Furthermore, the latest National Joint Registry Annual Report reported an 8-year revision rate for cemented TKA at 2.82% while the 8-year revision rate for unicondylar knee arthroplasty was 10.82% (this includes both mobile and fixed bearing) [9].

However, concerns have been raised regarding UKA's increased rate of revision, highlighted by the 2009 Annual report from the New Zealand Joint Registry [10]. Advocates for the use of UKA have drawn attention to its potential for being less invasive than a TKA, allowing for revision of UKA to TKA to be carried out at the time of failure [3,11,12]. This has been reported in the past as being no more complex than a primary TKA [13], and less complicated than a revision of a TKA [3,11].

There are limited published data on outcomes of the revised UKA to TKA, however a large series from the Swedish Knee Arthroplasty study reported re-revision rates of 7% in patients undergoing a conversion of a UKA to TKA, at 5 years. This was almost double their rate of revision in primary TKA (4%) at 5 years [14].

The most common indication for conversion of a primary UKA to TKA was loosening and evidence of lysis which accounted for half of all revisions that were performed in the New Zealand Joint Registry [10]. While the study by Dudley et al. [15] showed that progression of arthritis within the non-operated compartments of the knee, was the most common indication for conversion according to the Minnesota database. Further established indications for revision are continued pain, infection, patella-femoral pain and others including periprosthetic fractures [10,15].

We hypothesize that revision of UKA to TKA is more complex than primary TKA. We have sought to investigate this by analyzing data from the UK National Joint Registry (NJR), using the thickness of polyethylene implanted and the level of constraint used during primary UKA, primary TKA, as well as revision of UKA to TKA and revision of TKA to TKA.

The Conflict of Interest statement associated with this article can be found at http://dx.doi.org/10.1016/j.arth.2013.02.003.

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Materials and Methods

Data Collection

We contacted the National Joint Registry of England and Wales and requested information regarding all knee arthroplasty-related procedures contained within their database between the years 2003 and 2009 (7 years). From 2008 onward data regarding the explanted prostheses were available. Data included in this study were of patients who underwent a total knee arthroplasty; medial unicompartmental knee arthroplasty; and revision knee arthroplasty.

Patients with isolated patello-femoral joint arthroplasties or lateral unicondylar knee arthroplasties were not included in this study. Procedures with incomplete data were also excluded.

Between 2003 and 2009, a total of 273,146 primary knee arthroplasties were documented in the NJR. Of these, 251,803 procedures (92.19%) had complete data sets and were included in our study. In 4577 (1.8%) of cases, the surgeon had coded the procedure as a complex primary knee arthroplasty. This may reflect the quality of the available bone stock, the complexity of achieving ligament balance or both.

Over the 7-year time period, 13,953 single-stage revisions of total knee arthroplasty were recorded in the registry database. Complete data sets were available to analyze 12,356 (88.55%) cases. Two-stage revision procedures were excluded.

Revision procedures were undertaken on 512 medial unicondylar knee arthroplasties from 2008 to 2009. In 429 procedures (83.79%), complete data sets were available. Three hundred seventy-four (73.05%) medial unicompartmental knee arthroplasties were revised to TKA. In the remaining cases, exchange of the polyethylene insert or revision to a unicompartmental arthroplasty was undertaken.

Data on the type of implant used, level of constraint and thickness of polyethylene insert employed were extracted from the database. However, data addressing the use of stems, wedges and augments were not investigated in this study.

The polyethylene insert thickness was compared between four groups of procedures: primary total knee arthroplasties, complex primary knee arthroplasties, revision of total knee arthroplasties and revision of unicondylar knee arthroplasties.

Increased ligament laxity and severe bone loss might lead to the use of constrained prostheses. A constrained implant is defined as a prosthesis designed to compensate for joint instability secondary to ligament insufficiency. Their use in primary and revision knee arthroplasties was compared.

Statistical Analysis

All data were collected and recorded using Microsoft Excel (Windows 2007). Mean and standard deviations were used to compare the different groups with regard to the thickness of polyethylene insert. The frequency of use of constrained implants was expressed as percentages.

Results

The polyethylene insert thickness was compared between four groups of procedures: primary total knee arthroplasties, complex primary knee arthroplasties, revision of total knee arthroplasties and revision of unicondylar knee arthroplasties. Table 1 summarizes the mean and standard deviation of the polyethylene insert sizes used in the four groups of procedures. Graphs 1 to 3 show the polyethylene insert thickness versus the total numbers used for procedure groups. The size (mean) of the polyethylene insert used increased in an ascending order as follows: primary knee arthroplasty < complex primary knee arthroplasty < revision of a unicondylar knee arthroplasty to a total knee arthroplasty < single-stage revision of total knee arthroplasty. Graph 1 shows that the majority of polyethylene inserts used were between 8 and 15 mm, with 10-mm insert being the most common. In cases of revision knee arthroplasty, the size of the polyethylene insert used shows greater spread (Graph 2). The mean thickness of the polyethylene of revision medial unicondylar arthroplasty to total knee arthroplasty was 12.79 mm.

Table 1
Mean Polyethylene Thickness in Millimeters and the Standard Deviation, for Each Procedure.

Procedure	Mean Polyethylene Thickness (mm)
Primary TKA ($n = 247{,}226$)	10.43 (SD 3.23)
Complex primary TKA ($n = 4577$)	11.31 (SD 3.15)
Revision TKA–TKA ($n = 12{,}356$)	14.86 (SD 4.71)
Revision medial UKA–TKA ($n = 374$)	12.79 (SD 3.03)

The use of a constrained knee implant was required in 2.15% (6329/294,489 cases) of all primary TKA procedures and 4.19% (21/429) of the revisions of UKA to TKA procedures.

Discussion

There is a body of evidence within the literature supporting the advantages of unicompartmental knee arthroplasty over total knee arthroplasty for the treatment of medial gonarthrosis; these include improved range of motion [2], better gait pattern [3], shorter recovery period [4], cost-effectiveness [16], increased patient satisfaction [3], superior preservation of bone stock [17] and lower morbidity, including a decreased incidence of deep vein thrombosis [5].

Reported survivorship of unicompartmental knee arthroplasty vary in the literature from a 9-year survivorship of 89.8% in the New Zealand Registry [18] to 10-year survivorship of 96%–99.8% in an inventor series of 1000 UKA cases [7]. Advocates of UKA put forth the rationale that it is a less invasive procedure, and that it allows for a conversion to a primary total knee arthroplasty with similar function and survivorship [13]. However, a number of studies have revealed similar outcomes in revised UKA to TKA cases to those of revised TKA to TKA [11,19], including similarly low survivorship [3,13,15].

The data from the National Joint Registry of England and Wales have shown that the mean polyethylene thickness for the revision of a medial UKA to TKA is greater than that in primary and complex primary TKA, but less than that employed in revision TKA to TKA procedures. The level of constraint required was also found to be greater in the revision UKA–TKA group than the primary TKAs.

The use of polyethylene thickness as a surrogate for tibial bone loss in our study is controversial. A number of assumptions are required in order for this to be accurate. These include preservation of the joint line, adequate ligamentous stability and avoidance of augment use. Unfortunately, it is not possible to comment on the first two factors from the registry data. This could lead to inaccuracy, as raising the joint line might lead to overestimating the amount of bone loss. Furthermore, bone loss could be overestimated if resultant ligamentous laxity was compensated for by increasing polyethylene thickness without the use of an increased constraint TKA. Moreover, underestimation of the amount of bone loss could be caused if the joint line was lowered, or if contracted ligaments were inadequately released. Overall, however, it is hoped that the large sample size provided by the registry data might allow these factors to cancel each other out, allowing for meaningful interpretation of the mean thickness data for each procedure group.

Limitations in the use of NJR data exist, including the lack of clinical outcome data and the reliance on the individual data entrants for the quality and accuracy of the data, reflected by the number of incomplete entries found. Also this study does not compare like with like. Data regarding the explanted prostheses were available from 2008 onward. The revision of total knee