Arthroplasty in young adults: options, techniques, trends, and results

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Abstract Total knee arthroplasty (TKA) has been established as a very successful and commonly performed procedure for primary and secondary osteoarthritis, and also for inflammatory arthropathies of the knee in all age groups and both genders. It has predominantly been used as a procedure in the age group of patients 65 years and above. Consequently, the literature is replete with data relevant to various issues associated with TKA in the above 65 years age group population. Although there is reasonable clarity and consensus on the broad parameters of the use of TKA in the above 65 years age group (older), this cannot be said for the same issue as relevant to the below 65 years age group (young adults). Over the last 2 decades there has been an increasing tendency toward the use of TKA in young adults, with some countries reporting a 5-fold increase in the last 10 years [1]. The present article is designed to review the most recent literature specific to this subject and assess it vis-à-vis various issues as listed in the subsequent text, with the aim of highlighting evolving thoughts and trends, which could be useful for decision making by clinicians practicing in the community.

Keywords Total knee arthroplasty · Total knee replacement · Techniques · Young adult · Young patient · 55 years · 60 years · 65 years

Introduction

The use of total knee arthroplasty (TKA) as a procedure in young adults is increasing across the world. In a review of the Swedish Knee Arthroplasty Register (SKAR) [1], it was found

that the use of TKA in patients younger than 55 years had increased 5-fold. Kurtz et al [2] have projected that young adults will become the majority treated with TKA during the next 2 decades in the USA with up to 1 million TKAs possibly being performed for patients younger than 55 years by 2030. The Australian Joint Replacement Registry data [3] also shows that the number of knee reconstructions in young adults increased by 40 % from 2002 until 2007. In the authors' own experience, in India, a very high proportion of patients who undergo TKA are in the young adult age bracket. The Indian Society of Hip and Knee Surgeons (ISHKS) maintains a Registry of TKAs performed by members who contribute to the data. Although it probably does not reflect the entire country's data, it has on record data pertaining to more than 70,000 TKAs performed over the last 3 years. The average age of the patients listed in the entire database is 64 years [Secretariat, ISHKS].

This trend toward an increasing use of TKA in young adults could be a result of 1 or more reasons such as an expectation of increased survival period of modern day implants being implanted using present day surgical techniques, change in the epidemiology of degenerative and/or inflammatory diseases of the knee, increased demand from the patient population to have an immediate and higher level of surgical end result with a higher quality of life, and such other factors. However, there have been recent reports based on data from community, academic, and national registries, which indicate that TKA revision rates are higher in the young adult group compared with the older group [4–6, 7•]. There is also a recent report suggesting a high level of residual symptoms in young patients after TKA [8].

This review of the most recent literature on this subject has been performed to address the following issues:

- (1) Up to what age is a patient to be considered a young adult?
- (2) What are the survival results of TKA in the young adult patient group?
- (3) What are the clinical and functional results of TKA in young adults?

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- (4) Does the literature indicate any guideline for selection of implant based on design or material issues or surgical technique related issues?

Materials and methods

The authors searched PubMed, Ovid, and Medline. The database search terms comprise the keywords as mentioned previously. Special emphasis has been put on articles appearing up to December 31, 2013 and going back to January 1, 2010. Although the focus was on studies which involved TKA as a procedure in young adults, the search results included some articles which had the procedure unicondylar knee arthroplasty (UKA) as part of the study material. Although the brief given to the authors has been to review the literature on TKA in young adults, a limited observation has been made by them vis-à-vis the comparative results of UKA in young adults as this procedure inevitably forms a part of the discussion for treatment of knee joint arthropathy in young adults. Regenerative and arthroscopic procedures have been completely avoided in this review of literature.

A total of 8 articles were found in the above specified period. Studies published prior to January 1, 2010 have also been included to make the review and subsequent observations more comprehensive and dependable.

Results

The author proposes to offer the results of this review as answers to the questions enlisted in the introductory paragraph.

Up to what age is a patient to be considered a young adult?

There is no consensus on what should be the cut-off age to classify a patient as a young adult undergoing TKA. The authors of reports in literature have used varying age limits to define their study population as young adults. A majority selected the age limit of 55 years [1, 9•, 10–12], although the age limit of 60 years [13, 14] has also been selected, as has been the age of 65 years in 1 study [15]. None of the studies offer any rationale for choosing their respective age limits. In the author's opinion, the age limit of 55 years would appear to be a more suitable cut-off point for the purpose of classifying a patient group as young adults undergoing TKA.

What are the survival results of TKA in the young adult patient group?

There are 2 articles, which provide very significant information on this extremely important aspect of this subject. The

first is by W. Dahl et al [1], in which they have extracted data from the Swedish Knee Arthroplasty Register covering the period during 1998–2007. The number of TKAs performed on less than 55 years aged patients was 2832, whereas the figures for those equal and above 55 years was 62,829.

They found that the risk of revision increased in the young adults with the Cumulative Revision Rate (CRR) being 9 % higher compared with the older group at 10 years. Interestingly, they observed that although the use of UKA in young patients had tripled during 1998–2005, it decreased over the next 2 years. Even more significant is their observation that in the young age group the 10-year CRR was 24 %, which was higher than the figure for TKA and was 3 times higher than the CRR for UKA in the older age group. They have interpreted their findings to offer their opinion that UKA as a procedure might be at a risk of diminishing further because the net numbers of this surgery in any given hospital is very low and it has been shown by Robertsson et al [16] that hospitals that performed less than 23 UKAs per year had a 1.6 times higher revision rate than units that operated 23 or more.

The second important article is by Keeney et al [9•], in which they have done a comprehensive search of articles published between January 1950 and November 2009. They used the criteria developed by the STROBE statement (Strengthening the Reporting of Observational Studies in Epidemiology) [17] to include the analysis of the study of TKAs in patients younger than 55 years. This allowed them to analyze 908 TKAs performed for 671 patients, with individual study mean follow-ups from 5 to 18 years, and individual patient follow-ups from 2 to 25.7 years. They found component survivorship between 90.6 % and 99 % during the initial 6–10 years and between 85 % and 96.5 % for studies that calculated at or beyond 15 years. The most commonly reported complications were revisions for patellar component failure, infection, or instability. Component revisions were uncommon. They observed that estimates for component survivorship by calculating Kaplan–Meier survivorship curves were often reported, but actual long-term follow-up with patients did not occur in the majority of cases. Typically, the authors calculated an annual implant failure rate up to the latest follow-up, and then made a linear determination of implant survivorship based on revisions that had been performed. It remains a moot question whether implant survivorship would have followed a linear or exponential curve if the findings were based on actual follow-up to the end of the TKA life, or as is the common practice of projecting survivorship as a calculated figure.

Lizaur-Utrilla et al [10] in a prospective randomized trial have reported on 93 patients aged 55 or younger with noninflammatory arthritis and randomized to compare outcomes between cemented tibial fixation (48 patients) and cementless fixation with screw augmentation (45 patients). The femoral component was cementless in both groups. They found no

difference in revision and survival rates between the 2 groups, which was above 90 % at 9 years.

The Ranawat group [13] reported on a long term follow-up of all-polyethylene tibial components in 60 years and younger patients at a mean follow-up of 12.4 years (range, 10–18 years). They reported on 32 patients (44 knees). The Kaplan-Meier survivorship at 10 years for revision due to mechanical reasons and for all failures was 97.7 % and 95.5 %, respectively.

Bisschop et al [14] reported in a retrospective cohort study in patients 60 years or younger. Minimum follow-up was 10 years. Thirty-nine TKAs in 31 patients were included. After an average 13 year follow-up the survival rate was 89.7 % and no difference was found between inflammatory and noninflammatory arthritis groups.

Mont et al [11] reported on a group of patients 40 years of age and younger. Their cohorts consisted of 33 patients (38 knees) and were followed up for a mean of 49 months (range, 16–101 months). The survival rate was noted as 97 %. It is a short follow-up study with low numbers, but includes patients of a very young age.

Odland et al [12] reported on 67 cemented TKAs (59 patients) 55 years of age and younger with OA using modular Total Knee prostheses. In their Kaplan-Meier survivorship analysis they reported that with the endpoint of re-operation for any reason the survivorship was 78.5 % $\pm$ 16 % at 10 years, 69 % $\pm$ 16 % at 15 years, and the same at 18 years. When the endpoint was taken as revision of the tibial and/or femoral component for aseptic loosening and/or osteolysis, the figures were 93 % $\pm$ 6 % at 10 years, and 81 % $\pm$ 15 % at 15 years, and the same at 18 years. They found that the 16.4 % revision rate for wear related failures was not correlated with age, BMI, gender, preservation, or substitution of the posterior cruciate ligament or even alignment differences. The only variable that did correlate with failures was the use of polyethylene, which was sterilized in air as opposed to in an inert environment. In their series they were able to use the feature of modularity to perform a limited liner exchange procedure in 36 % of the revisions. They suggest that in this age group it might make sense to use modular tibial components, although they also mention that the senior author of the group has also reported a larger work, in which they found that less than 1 % of TKA revisions are amenable to only liner exchange.

Kim et al [15] have reported a study done to correlate implant design with survival of the implant in patients aged 65 years or younger. They compared 894 knees (488 patients) with fixed bearing knee prostheses to 816 knees (445 patients) with mobile bearing knee prostheses with a minimum duration of follow-up of 10 years for both groups with a mean of 12.6 years for the fixed bearing and 12.9 years for the mobile bearing group. They found that there was no significant difference between the 2 groups in relation to the osteolysis

(1.6 % in the fixed bearing group, 2.2 % in the mobile bearing group) or the revision rate (3.7 % in the fixed bearing group and 2.7 % in the mobile bearing group).

Keeney et al [9••] in their article include in their review the data offered by the following authors, besides others, which the author of the present article recommends for further reading: Duffy et al [18], Diduch et al [19], and Dalury et al [20].

What are the clinical and functional results of TKA in young adults?

An overview statement to answer this question would be that the improvement in mean Knee Society (KS) clinical and functional scores are similar to that reported in studies which include all age group patients.

Keeney et al [9••] state that 8 of the 13 studies in their review reported between 94 % and 98 % good or excellent results defined as a postoperative KS clinical score greater than 80.

Odland et al [12] used the KS scores, the Western Ontario McMaster Universities Osteoarthritis Index (WOMAC) [21], SF-36 general health questionnaire, and activity level assessing scores-the UCLA [22], and Tegner [23] scales. Their study focused on only osteoarthritic patients in whom modular tibial components had been used. They retrospectively reviewed 59 patients (67 cemented TKAs) with an average age of 48.5 years. The minimum follow-up period was 10 years and the mean was 12.4 years. They could review 44 of the 47 living patients for clinical follow-up and 41 patients for radiological follow-up. The follow-up KS scores averaged 91.2 for the clinical and 79.5 for the functional. The average WOMAC scores were 11.8 for pain, 31.1 for stiffness, and 24.9 for function. The average UCLA score was 5.6 and the average Tegner score was 3.4.

Bisschop et al [14] found that at the follow-up of an average 13 years, the functional scores in their group of 31 patients with an average age of 52.6 years at index surgery was still good. Meftah et al [13] found that at a mean follow-up of 12.4 years in a group of 32 patients (44 knees), good to excellent results were achieved in 96 % patients. The average WOMAC score was 31 and the KS clinical score was 97. The average UCLA score was 7.2.

Parvizi et al [8] recently published a multicenter study, in which they assessed residual symptoms and functional deficits in 661 young patients with a mean age of 54 years at 1–4 years after primary TKA. Their results showed that 89 % of patients were satisfied with their ability to perform normal daily living activities, although the satisfaction with pain relief was at 91 percent. However, when asked whether their knees felt normal, 33 % reported some degree of pain, 41 % reported stiffness, 33 % reported grinding noises, and 33 % reported a feeling of swelling and tightness. In other words, one-third of young patients reported some residual symptoms. The authors recommend informing this group of patients about

the high likelihood of residual symptoms and take specific steps to set patient expectations to an appropriate level.

Conclusions

The authors would like to conclude by addressing the fourth question enlisted in the introduction of this article.

Does the literature indicate any guideline for selection of implant based on design or material issues or surgical technique related issues?

It becomes clear on reviewing the collected body of literature that individual centers have relatively low numbers of young patients undergoing TKA in their practices. These numbers become even smaller when the patient groups are separated into inflammatory arthritis and noninflammatory, primary/posttraumatic osteoarthritis. This inherently restricts the ability to come up with high level of evidence based guidelines or conclusions on this subject. Having said that, the following observations are useful information for the reader interested in this subject:

- (1) Although the clinical and functional scores in the young arthritic seem to be similar as in the general TKA population, there is a likelihood of a higher level of residual symptoms in this age group. The surgeon would be well advised to counsel these patients appropriately before offering them this surgery.
- (2) The long-term survivorship of TKA as a procedure is good in this age group at above 85 % at 15 years, although some studies do indicate this to be slightly lower compared with the older age group.
- (3) There are no specific guidelines based on high level of evidence regarding the choice of implant design to be used in this age group (1 study has suggested the preference for modularity).
- (4) The quality of polyethylene and the manufacturing process of the plastic insert can have an impact on long-term survivorship. This also holds true for the general TKA population.
- (5) There are no reports in the literature suggesting or recommending any specific surgical technique to be used in this young age group.

Compliance with Ethics Guidelines

Conflict of Interest Bharat S. Mody and Kshitij Mody declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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