The Journal of Arthroplasty 31 (2016) 410–418

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

A Comparison of Short-Term Outcomes of Minimally Invasive Computer-Assisted vs Minimally Invasive Conventional Instrumentation for Primary Total Knee Arthroplasty
A Systematic Review and Meta-Analysis

Iihan A. Alcelik, MRCS, MSN, Mark I. Blomfield, BMedSci, MbChB, MRCS, Givanni Diana, MBBS, MRCS, Anthony J. Gibbon, Bsc (Hons), MBBS, FRCS, Nick Carrington, BMedSci, BM, BS, FRCS (Ed), FRCS (Tr & Orth), Stephen Burr, Bsc (Hons) Mathematics

York District General Hospital, York, UK

A B S T R A C T

Background: Median parapatellar approach is the most used for total knee arthroplasty (TKA). With the advent of enhanced recovery and shorter length of hospital stay, there is an increasing pressure on surgeons to perform surgery through smaller incisions. Minimally invasive (MIS) TKA allows earlier functional recovery; it is not clear if this is associated with more complications. It is also unclear if computer-assisted minimally invasive (MIS CA) TKA has any affect on improving patient outcomes. We performed a systematic review and meta-analysis comparing MIS CA vs MIS TKA.
Methods: We performed an extensive literature search including both randomized controlled studies and prospective cohort studies. All data reported on component alignment, surgical time, complications, knee flexion, and postoperative functional knee scores were included for analysis.
Results: Ten studies were suitable for inclusion resulting in 490 patients with MIS CA and 503 MIS patients. There was no significant difference in the outliers on complications, knee flexion, and postoperative functional scores. Coronal plane tibial component showed statistically significant number of outliers in the MIS group demonstrating superior component positioning in the MIS CA group. Operative time was significantly longer in the MIS CA group with a mean increase of 32 minutes.
Conclusions: Computer-assisted minimally invasive TKA is superior than the standard MIS TKA in terms of component positioning; however, it is unclear if this will have any long-term clinical implications. The increased operative time, although clinically relevant, does not appear to be associated with an increase in complications.

Article history:
Received 9 June 2015
Accepted 9 September 2015
Keywords: minimally invasive, navigated, computer assisted, total knee arthroplasty, meta-analysis, alignment

Medial parapatellar approach remains the most commonly used approach in the UK for primary total knee arthroplasty (TKA) (http://www.njrcentre.org.uk). It is a popular approach that gives an excellent view of the all 3 compartments of the knee joint; it is relatively simple to perform, and most surgeons are familiar with this approach. However, critics argue that because of the extensive soft tissue disruption combined with patellar eversion, the rehabilitation after such surgery is often prolonged [1,2]. Because of the adoption of enhanced recovery techniques resulting in shorter length of stay and faster rehabilitation combined with patients' demands on smaller scars, there is an increasing pressure on surgeons to perform more complex surgery via smaller incisions resulting in an increase in the popularity of the minimally invasive procedures [3,4]. Although there is evidence of faster early functional recovery, there are also concerns regarding minimally invasive TKA due to limited visualization of the operative field, namely, excessive retraction of the tissues leading to increased intraoperative complications and component malpositioning [5,6]. To overcome this specific problem with component malpositioning, computer assistance in such surgery was advocated [7].

In our study, we hypothesized that there are significant benefits of using minimally invasive computer-assisted technique (MIS CA) in TKA as opposed to using minimally invasive instrumentation without the computer navigation (MIS), on both radiological and clinical grounds in the short term. This hypothesis was tested using a meta-analysis of randomized controlled trials (RCTs) and cohort studies comparing the above 2 techniques for primary TKA.

Materials and Methods

A systematic review and meta-analysis was conducted according to guidelines described in the Cochrane handbook for systematic reviews of interventions and PRISMA statement [8,9].

No author associated with this paper has disclosed any potential or pertinent conflicts which may be perceived to have impending conflict with this work. For full disclosure statements refer to http://dx.doi.org/10.1016/j.arth.2015.09.013.

Reprint requests: Mark I. Blomfield, BMedSci, MbChB, MRCS, York District General Hospital, Wigginton Road, York, North Yorkshire YO31 8HE, UK.

http://dx.doi.org/10.1016/j.arth.2015.09.013
0883-5403/

Study Selection Criteria

Types of Studies

Only the RCTs and prospective cohort studies are included in this study.

Types of Participants

The participants were adult patients who underwent primary TKA using either a MIS CA or MIS instrumentation regardless of the type prosthesis.

Types of Interventions

The interventions were MIS CA and MIS instrumentations.

Types of Outcome Measures

The outcome measures were number of mechanical axis outliers and tibial and femoral component coronal axis outliers in postoperative radiographs or computed tomographic scans. Outliers were defined as more than 3° deviation from neutral alignment. Furthermore, surgical times, complications, knee flexion within the first 6 months postoperatively, Knee Society scores, and Knee Society functional scores within the first 6 months postoperatively are also used as an outcome measure.

Exclusion Criteria

Retrospective studies, animal studies, and studies where the aforementioned outcomes are not evaluated and where minimally invasive techniques are not used are excluded in this meta-analysis.

Search Methods for Identification of Studies

Finding Existing Systematic Reviews and Meta-Analyses

The following databases were searched in March 2015 to establish whether there have been any previous systematic reviews or meta-analyses comparing MIS CA and MIS instrumentation in TKA: Cochrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effects, and Medline (1950 to March 2015).

Finding Published and Unpublished Primary Studies

The following exploded MeSH terms were used for the literature search: "arthroplasty," "replacement," "prosthesis," "navigated," "navigation," "computer," "CT," and "knee." A MEDLINE search was then refined to find prospective studies and RCTs in adult humans. The search was extended to the EMBASE database for studies published in any language from 1966 to March 2015. The bibliographies of retrieved trials were examined for additional articles. The following Web sites were searched to identify unpublished and ongoing studies: Current Controlled Trials (controlled-trials.com), Centre Watch (www.centerwatch.com), Trials Central (www.trialscentral.org), System for Information on Grey Literature in Europe (www.opengrey.eu), and The UK National Research Register (www.nihr.ac.uk).

Data Collection and Analysis

Selection of the Studies

Two authors (IA and GD) applied the search strategy independently, and all relevant study abstracts were hand searched by them, after which potentially suitable studies were reviewed in full paper format by each of the authors independently. Disagreement was discussed and resolved with the other authors.

Assessment of Methodological Quality of Included Studies

The review authors used a modification of the generic evaluation tool used by the Cochrane Bone, Joint and Muscle Trauma Group [10] (Table 1). This includes 12 points where each point is scored 2, 1, or 0 (maximum score, 24) depending on whether the question was fully, partly, or not answered at all for each study. MB and GD performed the quality assessment scoring independently, and any disagreements were resolved by discussion and mutual agreement. Total quality assessment score was calculated for each study for descriptive purposes, but it was not used to weight the studies in the meta-analysis or as strict criteria for inclusion/exclusion.

Table 1
Quality Assessment Items and Possible Scores.

A. Was the assigned treatment adequately concealed before allocation?
2 = method did not allow disclosure of assignment
1 = small but possible chance of disclosure of assignment or unclear
0 = quasirandomized or open list/tables
B. Were the outcomes of participants who withdrew described and included in the analysis (intention to treat)?
2 = withdrawals well described and accounted for in analysis
1 = withdrawals described and analysis not possible
0 = no mention, inadequate mention, or obvious differences and no adjustment
C. Were the outcome assessors blinded to treatment status?
2 = effective action taken to blind assessors
1 = small or moderate chance of unblinding of assessors
0 = not mentioned or not possible
D. Were the treatment and control group comparable at entry? (Likely confounders may be age, partial or total rupture, activity level, acute or chronic injury)
2 = good comparability of groups, or confounding adjusted for in analysis
1 = confounding small; mentioned but not adjusted for
0 = large potential for confounding, or not discussed
E. Were the participants blind to assignment status after allocation?
2 = effective action taken to blind participants
1 = small or moderate chance of unblinding of participants
0 = not possible, or not mentioned (unless double blind), or possible but not done
F. Were the treatment providers blind to assignment status?
2 = effective action taken to blind treatment providers
1 = small or moderate chance of un blinding of treatment providers
0 = not possible, or not mentioned (unless double-blind), or possible but not done
G. Were care programs, other than the trial options, identical?
2 = care programs clearly identical
1 = clear but trivial differences
0 = not mentioned or clear and important differences in care programs
H. Were the inclusion and exclusion criteria clearly defined?
2 = clearly defined
1 = inadequately defined
0 = not defined
I. Were the interventions clearly defined?
2 = clearly defined interventions are applied with a standardized protocol
1 = clearly defined interventions are applied but the application protocol is not standardized
0 = intervention and/or application protocol are poorly or not defined
J. Were the outcome measures used clearly defined? (by outcome)
2 = clearly defined
1 = inadequately defined
0 = not defined
K. Were diagnostic tests used in outcome assessment clinically useful? (by outcome)
2 = optimal
1 = adequate
0 = not defined, not adequate
L. Was the surveillance active, and of clinically appropriate duration?
2 = active surveillance and appropriate duration
1 = active surveillance, but inadequate duration
0 = surveillance not active or not defined

Data Extraction and Management

A data extraction form was designed and agreed by the authors. Initially, 2 authors (IA and SB) extracted the data independently, which was later on reviewed jointly to produce agreed accurate data.

Statistical Analysis

Meta-analysis, performed by Review Manager [computer program] (Version 5.3. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2012), was used to combine the relevant estimates of