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Review Article

Minimally invasive versus conventional approaches in total knee replacement/arthroplasty: A review of the literature

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ABSTRACT

Background: Life expectancy lengthening and aging of population resulted in dramatically increase of patients with osteoarthritis. Total knee arthroplasty is widely used as the gold standard in order to relieve pain, correct deformity and restore function. A contemporary and controversial topic, is that of minimally invasive surgery for TKA. The minimally invasive approaches are based on the concept that they don't violate the extensor mechanism, resulting in earlier functional recovery, shorter hospital stay and enhanced patients' overall satisfaction. The most commonly used MIS approaches in TKA are the subvastus, midvastus and the quadriceps sparing. There is a debate regarding the efficacy and safety of these methods.

Objective: In this article we will review the current literature (randomized controlled trials and systematic reviews/meta-analyses) on MIS compared to traditional approach and analyse their clinical safety, efficacy and long-term results.

Design: Comparison of well-designed studies have tried to demonstrate the advantages/disadvantages, the clinical results and the complications of the MIS approaches compared to the MPP approach.

Results: MIS approaches seem to provide advantages in the immediate post-operative period accompanied by increased reports of complications. Consequently, further investigation based on large well-designed studies with long-term results are warranted to further clarify MIS effectiveness/safety.

1. Introduction

Life expectancy lengthening and aging of population resulted in dramatically increase of patients with osteoarthritis (OA); total knee arthroplasty (TKA) is the optimal surgical method for patients who suffer from severe OA.[1] TKA is widely used as the gold standard in order to relieve pain, correct deformity and restore function; the number of primary TKA is expected to have a significant increase the following years.[2,3]

The evolution of modern TKA has taken place in the last 30 years with improved functional outcomes and prolong implant life-span being the main goals. Nevertheless, the first description of knee joint function improvement dates back to the 19th century. In 1863, Verneuil et al. tried to prevent the bone growth between the articular surfaces by interposing soft tissue between bone ends to prevent ankylosis.[4] Since then, many different methods, implants have been used. Simultaneously, patients' expectations and demands have also increased. Therefore, as surgical experience with TKA increases, new operative techniques, different pain and blood loss management protocols have been tested/established to improve functional recovery and clinical outcomes.[5–7] A contemporary and controversial topic, among others, is that of minimally invasive surgery (MIS) for TKA.

Von Langenbeck firstly described the medial parapatellar (MPP) approach in 1879 in his book entitled "*Zur resection des kniegellenks*".[8] Over the past decades, the "traditional" MPP approach has proven to be a successful standard.[9] However, the associated anterior knee pain combined with the poor functional recovery indicated concerns in regards to patients' satisfaction.[10–12] Thus, many MIS approaches have been described. The MIS approaches are based on the concept that they don't violate the extensor mechanism and as a result they reduce postoperative pain and facilitate the body's healing, resulting in earlier functional recovery, shorter hospital stay and enhanced patients' overall satisfaction.[13–15]

The most commonly used MIS approaches in TKA are the subvastus

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(SV), midvastus (MV) and quadriceps sparing (QDS).[16–18] SV and QDS can be described as more "anatomic" techniques as they fully preserve the extensor mechanism and minimizes vascular damages to the knee compared to the traditional MPP approach. The limited view/access in the surgical field and the increased operative difficulty level limits their popularity.[19–21] On the contrary, MV which minimizes vascular and muscular damages as well, offers a better exposure of the knee. Therefore, MV proved to be the most popular MIS approach in TKA.[22] There is, however, a debate (with no obvious winner till now) regarding the efficacy and safety of these methods. Post-operative complications including longer tourniquet time, poor implant positioning and early implant failure have been reported in many studies.[23–25]

Currently, many well-designed studies have tried to demonstrate the advantages/disadvantages, the clinical results and the complications of the MIS approaches compared to the MPP approach.[26–29] In this article we will review the current literature (based on randomized controlled trials (RCTs), systematic reviews and meta-analyses) on MIS compared to traditional approach and analyse their clinical safety, efficacy and long-term results.

2. Search strategy

Although our article is not a systematic review/meta-analysis we considered that it's really crucial to mention our search strategy. Two of the authors (TT and GD) independently run a systematic literature search using the following electronic databases: PubMed MEDLINE/ OVID MEDLINE (1950 – August 2017) and EMBASE (1974 – August 2017). The terms used in our search were #1. "total knee arthroplasty" OR "total knee replacement" AND #2. "subvastus" OR "mini-subvastus" OR "midvastus" OR "mini-midvastus" OR "quadriceps sparing" OR "quadriceps-sparing" OR "minimal invasive" OR "minimally invasive". Additionally, the references lists of all included studies were also searched. Studies that dealt with computer navigation-assisted TKA and articles that couldn't be fully viewed and/or were not written in English were excluded.

To improve the level of evidence we only included published RCTs, systematic reviews/meta-analysis. The only exception was a well-designed retrospective study, as its results were really noteworthy. In regards to the primary and secondary outcomes we didn't apply any restrictions as we didn't conducted a systematic review/meta-analyses. Therefore we investigated any outcome that was extracted by each of the included studies. Nevertheless, most of the studies assessed similar primary and secondary outcomes including knee society score (KSS), range of motion (ROM), time to straight leg raise (SLR), visual analogue scale (VAS) pain, length of stay (LOS) and complications rates among others.

3. Surgical approaches

3.1. Cutaneous/skin incision

All approaches in TKA follow, in the majority, the same standard cutaneous incision. The epidermis' blood supply in nourished from the dermis and consequently is the organ most at risk of necrosis. Therefore, it's really crucial to respect its anatomy. Two main rules should be taken into consideration: i) cutaneous incision as far as the tendon fascia should be vertical in order to avoid devascularization of the skin flap ii) since the anterior knee skin vascularization arises, in the majority, from the medial genicular arteries, we should bear in mind that the lateral flap is the one most in danger.[30] The anterior midline is the most widely used incision but medial or lateral parapatellar incision have also been reported (Fig. 1).[31] All the incisions are running from a point located 2–3 cm proximal to the top of the patella to the anterior tibial tuberosity/tubercle (TT).[32] Johnson et al. outlined that the medial parapatellar skin incision found to be subjected to significantly less tension during flexion. As a result, it can be expected to heal faster and be less likely disrupted during early mobilisation.[31] On the contrary, Laffosse et al. report that the anterolateral incision is associated with fewer sensory disturbances compared with the midline skin incision.[33] To summarize, any of these skin incisions offer excellent exposure of the knee's extensor mechanism in order to continue with arthrotomy.

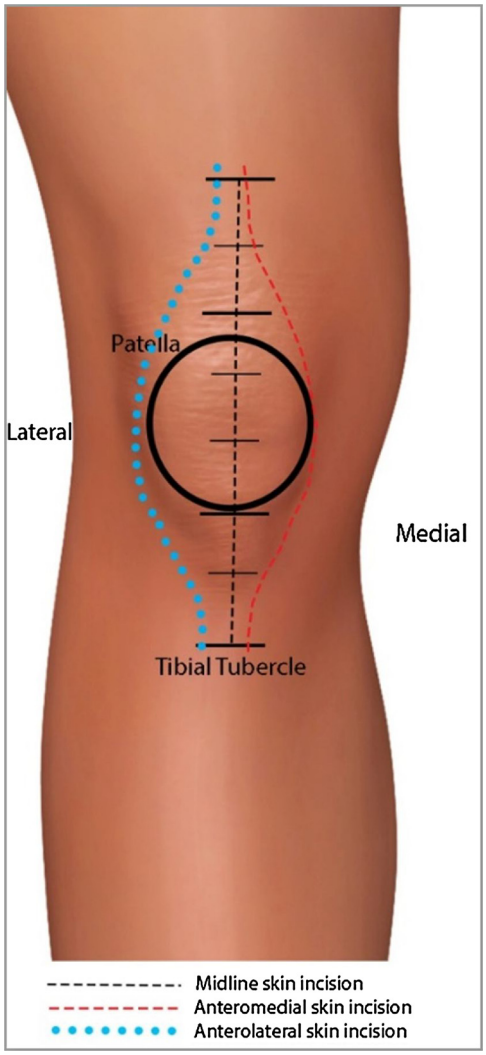

Fig. 1. Knee Skin Incisions.

3.2. The "traditional" MPP arthrotomy

The most-widely used arthrotomy is the MPP incision. The patient's knee should be flexed in order to have better visualization of knee anatomy. Next, the surgeon begins cutting the quadriceps tendon in longitudinal plane up to a point 1 cm from the vastus medialis oblique (VMO), leaving a 3–4 mm cuff of tendon on the vastus medialis for later closure. The incision is continued around the medial side of the patella by cutting the medial patellofemoral ligament and medial capsule until it reaches the medial border of the patellar tendon and anterior TT (Fig. 2). After the deep medial collateral ligament's release, with the patient's knee extended, the fat pad is recognised and been removed. The patella is been everted/subluxated laterally and the knee is been positioned in flexion.[34] Extra care should be taken to minimize tension on the extensor mechanism. In order to achieve better exposure a bent Hohmann retractor can be placed on the lateral side of the tibial plateau. At this point flexion of the knee at 90° provides excellent exposure of the entire joint so the appropriate procedure (TKA, unicondylar knee replacement etc.) can be performed.