

Will Total Knee Replacement Ever Provide Normal Knee Function?

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ABSTRACT

Knee osteoarthritis or gonarthrosis is considered the most common joint disease, affecting more than 70% of subjects aged over 65 years. Its occurrence is increasing with age and is more problematic with the current rise in the incidence of obesity. In severe and advanced cases, total knee arthroplasty is recommended as a gold standard therapy for pain relief, restoration of normal knee function, and quality of life improvement. There are numerous controversies whether total knee arthroplasty is able to reach and provide end-point outcomes and restore previous function of the knee joint. Studies suggest that the surgeons' experience, type of prosthesis used, associated pathology, underlying pathologies, risk factors, continuous passive movement, and patient expectations about the surgery may influence the outcomes to a great extent. "Normal knee function" is a statement that is hardly defined in the current literature, as authors usually refer to subjective results when analyzing outcomes. Objective results may be more straightforward, but they do not always symbolize the actual state that the patient is reporting or the actual quality of life. Our objective was to analyze and present summaries of the current literature regarding normal knee function restoration after total knee replacement surgery. Our literature review results confirm the hypothesis that subjective and objective results are difficult to interpret and unravel. Complex future trials may bring supplementary and clearer conclusions regarding knee function and kinematics, clinical improvement, patient satisfaction, and quality of life.

Keywords: knee replacement, total knee arthroplasty, outcomes

INTRODUCTION

Osteoarthritis (OA) of the knee or gonarthrosis is the most common joint disease, its occurrence increasing with age. Its prevalence reaches 30% between 45–65 years and about 70% in subjects aged over 65 years. Disease distribution is identical for both genders under the age of 55, but between 55–75 years, women seem to have a higher incidence.¹ Gonarthrosis is the consequence of a functional imbalance between the strength of the articular structures and the stresses, friction, and traumas exerted on them. When demands become amplified and go beyond the physiological threshold or normal stresses are exerted on a low-strength cartilage, the conditions for alterations in cartilage are created.² Together with underlying biomechanical factors that may predispose subjects

to knee OA, obesity, previous knee injuries, and intensive physical activities are considered key risk factors for the development and advancement of the disease and the necessity for total knee replacement.³⁻⁵ Total knee arthroplasty (TKA) is now considered the gold standard therapy in treating end-stage knee osteoarthritis, with a nearly 90% patient satisfaction rate reported in recent studies.⁶⁻¹² Even with the high patient satisfaction rate reports, some studies also suggest that TKA is not achieving its primary goal of pain relief and improvement of joint function.¹³⁻¹⁵ The successfulness and outcome of a TKA mainly depends on the senior surgeon and his interaction with instruments, the operating team, and patient, his skill, learning curve, enthusiasm, and hospital facilities that are available.¹⁶ The surgeon's actions are considered to have the prime effect on outcomes: postoperative instability, malalignment, poor range of motion, sepsis, and other failure outcomes. Besides the surgeon's experience and managerial skills, rehabilitation and physiotherapy after the intervention is also essential in order to achieve the functional and clinical outcomes that are expected.¹⁷ Our review sought to highlight the outcomes reported in the literature after total knee replacement and to answer the question whether TKA restores the previous functionality of the affected joint.

NORMAL CARTILAGE DESCRIPTION AND PATHOGENESIS OF KNEE OSTEOARTHRITIS

The parts covered by cartilage in the knee joint are the femoral condyles, the tibial plateau, and the posterior surface of the patella. Thus, the articular movements are achieved by sliding between these three cartilage surfaces.¹⁸ The normal articular cartilage achieves two essential functions for locomotion: the transmission of mechanical forces to the bone extremities and a smooth, perfectly congruent, self-lubricated surface. Usually, the cartilage is exposed to a continuous internal remodeling process, considered to be the result of the activity of chondrocytes and synovial cells.¹⁹ Cartilage cells show a low rate of division due to reduced DNA synthesis.¹⁹ Due to the hypocellularity of the articular cartilage, its mechanical and biochemical characteristics are dependent on the composition of extracellular matrix.¹⁹ Due to the increased concentration of proteoglycans, normal cartilage is poorly water-permeable. When a compressive force is applied, although the pressure in the cartilage increases immediately, it deforms slowly and reversibly, as the water surrounds the entire joint surface as a smooth film. When the force is removed, the layer of fluid on the surface of the cartilage is absorbed by proteogly-

cans, which have a high density of negative charges. The capacity of proteoglycans to retain water and to increase in volume is limited by the tensioning collagen network. Hydrated proteoglycans are compressed into the meshes of the collagen network, creating considerable tissue pressure even in the absence of compressive forces.¹ The etiology of knee OA is usually described as intra-articular and extra-articular. Intra-articular causes produce a functional overload due to defective mechanical conditions such as traumas, meniscus and ligament lesions, quadriceps muscle atrophy, or König's disease. On the other hand, extra-articular factors include deviations in the frontal (genu valgum or varus) or sagittal planes (genu flexum). The existence of anatomical malformations favoring articular overload (genu varum, genu valgum, lateral instability of the spine) are recognized as "pre-arthritis malformations" because they favor and lead to OA over time.¹ In addition to these causes, a number of factors contributing to overweight, prolonged kneeling professions, and sports (football, rugby, skiing) are also encountered in the etiology of the disease. OA may reach only a part or the entire knee joint, thus distinguishing the following locations according to knee anatomy:²⁰

- internal tibio-femoral OA that concerns the inner compartment of the knee joint;
- external tibio-femoral OA that concerns the outer knee compartment;
- femoral-patellar OA involving the patello-femoral compartment of the knee;
- global OA of the knee joint.

SHORT DESCRIPTION OF THE CONVENTIONAL TKA SURGICAL TECHNIQUE²¹

There are several techniques described in orthopedics regarding TKA, which is performed under aseptic conditions, under spinal or general anesthesia, with the patient in dorsal decubitus and the knee to be operated in a 90° flexion position. A tourniquet can be applied around the thigh to help surgical exposure and limit the blood loss, but this practice should be avoided in patients with a history of deep vein thrombosis.

The knee joint is approached anteriorly by a para-patellar medial incision; the osteophytes and the intra-articular soft tissue are afterwards removed. The bony excisions in the distal femur are perpendicular to the mechanical shaft using an intramedullary alignment system. In the proximal tibia, bone excisions are also perpendicular to the mechanical shaft, but both intramedullary or extramedul-

lary alignment systems can be used. Restoring mechanical alignment is important to allow optimal distribution of the knee load and to prevent eccentric loading. Enough bone should be removed so that the prosthesis will re-create the level of the joint line. This allows the ligaments around the knee to be perfectly balanced and thus prevent possible alterations of the height of patella, which may have a damaging effect on femoral-patellar biomechanics.

Due to the preoperative deformation, some ligaments around the knee are contracted. These will be strained gradually to balance the soft tissues around the knee and allow optimal kinetic articulation. After the intercondylar space is prepared, the mobility of the new articulation (flexion, extension) with the test components is controlled, and the bone surfaces are washed. If the patellar-femoral joint is significantly affected, the patella surface may be restored with a polyethylene component. The initial width of the patella should be restored.

Once the final components have been selected, they are fixed with polymethyl methacrylate cement. If non-cemented prostheses are used, they are set by the press-fit technique, and the bone growth around the prosthesis will ensure the fixation in the long term. The tourniquet should be removed before closing, and the knee joint is usually drained and fixed in full extension. At the end of the intervention, the pulse at the level of the dorsalis pedis artery is tested.

OUTCOMES AFTER TOTAL KNEE ARTHROPLASTY – LITERATURE REVIEW

With the implementation of modern prosthetics, the survival rates following TKA have increased radically to a 90% rate at 15 years after the surgery.²²

I. Patient satisfaction

With increased survival rates, the patients' satisfaction, post-surgery joint performance and functionality have become an obligatory topic. Meeting patient expectations is of the highest significance in achieving patient fulfilment after primary TKA.^{9,12,23} It was demonstrated that patient expectations regarding surgery have a significant effect on the satisfaction rate after surgery, even if functionality was not completely restored.¹³ Robertsson *et al.* studied whether Swedish patients operated by knee arthroplasty are satisfied with the procedure or not.¹⁴ They ran a questionnaire on 27,372 subjects who underwent knee arthroplasty between 1981 and 1995 in the Swedish Knee Arthroplasty Register. Their follow-up range was between 2 and

17 years, and 92% of the individuals were satisfied with the outcomes of the procedure. However, a higher rate of satisfaction was reported in those who underwent TKA compared to unilateral compartment arthroplasty. In a similar observational study, Anderson *et al.* found that 88.8% of subjects were satisfied with the surgery, and 91% felt that they made the right decision when opting for total replacement.²⁴ An important detail was that patients with higher satisfaction rates were also scoring better in the Western Ontario and McMaster University Osteoarthritis Index (WOMAC) evaluation ($p < 0.05$).

II. Subjective outcomes

In 108 patients who underwent TKA with an average of 4.9 years of follow-up, the WOMAC subjective score and patient satisfaction were studied.²⁵ WOMAC was once again correlated with the self-reported satisfaction level. Seventy-three patients (68%) were "very satisfied" with the surgery. In a study from 2009, Bourne *et al.* assessed patient satisfaction on subjects who underwent TKA.²⁶ From 1,703 patients, 1375 (81%) were satisfied with the overall procedure results. WOMAC is the most common tool used to evaluate subjective outcomes after treating osteoarthritis and includes questions regarding three main subscales considered as end-points: pain, stiffness, and physical function.^{27,28} The score usually ranges from 100 to 0 (from worse to best), but some authors reverse the score in their reports from 0 to 100, a 100 score showing the best outcome possible. In Bourne's study, the reversed WOMAC score improved significantly to 81.9 ± 16.6 with an average overall change of 39.5 ± 19.8 at the one-year follow-up.²⁶ In their report, the pain subscale had the highest change compared to the preoperative state (86.2 ± 16.3 , with a change of 42.9 ± 20.6 in 12 months).

III. Surgical technique and prosthesis type influence the desired outcomes

A common discussed topic in the orthopedics community is whether to use posterior stabilized arthroplasty or retain the posterior cruciate ligament (PCL) during surgery. It is a topic of debate, as several authors and systematic reviews provided evidence that sacrificing the PCL might lead to better functional outcomes and a reduced range of motion limitation.^{29,30} Other authors concluded in 2008, using a sample of 100 patients, that the two techniques had shown no superiority to each other regarding pain, quality of life, and knee function two years post-surgery.³¹ Seon *et al.* dem-

onstrated that posterior stabilized TKA is superior in terms of weight-bearing flexion, but with no superiority observed in the clinical outcomes.³² It is additionally considered that the type of prosthesis is influencing the results after TKA. In a meta-analysis comprising 130 studies, Callahan *et al.* analyzed reported outcomes after TKA with the following techniques: PCL-sacrificing TKA, PCL-retaining TKA, and PCL-substituting TKA.³³ The mean range of motion was 99 degrees following a PCL-sacrificing TKA, 107 degrees after PCL-retaining knee arthroplasty, and 103 after PC-substituting TKA. They also concluded that underlying knee pathology and prosthesis type can be considered as predictors for outcomes following TKA. After analyzing data regarding postoperative flexion range of motion following 313 PCL sparing TKAs, Parsley *et al.* affirmed that subjects who had limited flexion preoperatively showed an increase in flexion after surgery.³⁴ In comparison, individuals with above 105 degrees of flexion before surgery showed a decline in flexion after the surgery.

IV. Associated risk factors and underlying disease

Associated disorders, underlying disease type or risk factors may influence the final outcome after knee replacement. Patients who underwent TKA with underlying rheumatoid arthritis, septic arthritis, or avascular necrosis had reduced flexion range of motion postoperatively (100°) compared to subjects with OA, trauma, or gout (120°) as a primary diagnosis.³⁵ Studying the same topic, Harvey *et al.* concluded that patients who had OA as a primary diagnosis lost 2° of flexion after TKA, and patients who had rheumatoid arthritis as underlying disease gained 5° of flexion at a minimum 12 months follow-up.³⁶

V. Continuous passive motion – yes or no?

Usage of continuous passive motion (CPM) is a frequent topic addressed in the rehabilitation process after TKA for obtaining better clinical and subjective results. One of the fundamental meta-analyses that addressed this topic was published in 2004 by Brosseau *et al.*, which concluded that CPM, in addition to physiotherapy, has statistically significant superior effects when analyzing active knee flexion and decreased hospitalization time compared to physiotherapy alone.³⁷ However, CPM usage was not correlated with better passive knee flexion and passive or active knee extension. In a review elaborated for French clinical practice guidelines, CPM was found to provide beneficial effects regarding pain, swelling, and knee kinematics, together with a shorter recovery time post-surgery.³⁸

However, a clear statement regarding long-term outcomes could not be elaborated due to short follow-up times in studies reporting CPM as rehabilitation procedure. Pope *et al.* reported beneficial postoperative outcomes and reduced joint manipulation, but only for a short time.³⁹ At one week after TKA, there was a statistically significant increase in the range of flexion and total range of movement in the group that used CPM. At one year, however, they found no significant differences in mean flexion, range of motion, or functional results between the groups.

CONCLUSIONS

The review of the literature has many contradictions and controversies between the authors' opinions and the obtained results. Higher-evidence trials may bring further clear statements regarding knee function, clinical improvement, patient satisfaction, and quality of life. Will TKA ever be able to provide normal knee function? If we address normality as a patient subjective outcome and satisfaction after the surgery, we can state that TKA provides sufficient beneficial effects to restore normal knee function. If objective outcomes are assessed, the conclusion whether a knee is functioning normally is hard to be established among the literature's disagreements.

CONFLICT OF INTEREST

Nothing to declare.

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