

Factors affecting range of motion after total knee arthroplasty

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Abstract

Introduction: Range of motion after total knee arthroplasty is an important clinical outcome. Decreasing range of motion can lead to limit activity level as well as patient satisfaction. This study sought to determine the factors affecting range of motion after total knee arthroplasty.

Patients and methods: The retrospective descriptive of 50 patient (54 knees) were operated for total knee arthroplasty from 10/2016 to 10/2019.

Results: The average follow-up time was 24 months (12-36 months). The postoperative average range of motion was 108,6 7,6, 100% patients were more than 90 and there are no cases that loss of extension.

Conclusion: The preoperative knee deformity, compliance with rehabilitation procedures and surgical technique are the most influential factors.

Keywords: Knee range of motion, total knee arthroplasty.

Introduction

The purpose of total knee replacement (the same as arthroplasty) is to maintain function, stabilize the knee joint, and relieve pain. However, the limitation of knee range of motion after surgery can cause inconvenience in daily activities, especially in Asian patients due to the culture of sitting cross-legged or the need to participate in physical activities sports such as golf, bowling in European and American countries. Some recent reports [1] suggested that a minimum 90 knee bending is a necessary condition for most activities. The reduction in mobility affects the overall outcome and patient satisfaction. Therefore, understanding the factors affecting the knee range of motion after total knee replacement is important.

Material and methods

Study subjects: Patients who received total knee arthroplasty at Viet Duc University Hospital from October 2016 to October 2019.

Selection Criteria:

Patients with primary knee osteoarthritis (OA) grade III, IV are indicated for total knee replacement.

Type of joint with cement, without changing the patella, removing the posterior cruciate ligament.

Have complete medical records and re-examination on time.

Exclusion criteria:

Patients with knee arthroplasty due to other causes: OA after injury, tumor, second knee arthroplasty.

Posterior cruciate ligament retained.

Patient refused to participate or does not fully re-examine by appointment.

Descriptive study, convenient sample size.

Measure the site of the artificial knee according to Patel [2]. The matching site is satisfactory when:

The femoral part: Frontal view of radiograph, the femoral part should contain two condyles forms

with the femoral axis at an angle from 5° to 7° lateral curvature. On the lateral view, the anterior and posterior aspects of the femoral part should be parallel to the femoral axis.

The tibial part: On the frontal view of radiograph, the tibial part should be perpendicular to the tibial axis. On the lateral view, the tibial axis should create an angle of about 6°-7° with the tibial part of the joint.

Patella: Using Insall-Salvati index [3] to assess the height of patella. The Insall-Salvati index is the ratio of the length of the patellar tendon to the length of the patella, which is normally between 0.8 and 1.2.

Measure the range of motion of the knee joint following zero degree method (Zero method).

Data processing: using SPSS 22.0 software.

Results

During the period from October 2016 to October 2019, we had 50 patients with 54 total knee joints eligible to be enrolled in the study and obtained the following results:

Knock knee before surgery: 92.6% of knee joints have internal deformity. Herein, internal curvature and flexural shrinkage mainly account for 63%.

Types of joints used in the research group include Nexgen (Zimmer), triathlon and scorpio (Stryker).

100% joints qualify the required position.

Table 1: Joint replacement site (n=54)

Joint	X-ray	
	Straight	Tilted
Femoral part	97,1°	3,9°
Tibial part	87,4°	3,4°

The index between the length of the patellar tendon and the length of the patella (Insall-Salvati index) on average was 0.94 ± 0.12.

Range of knee motion before and after surgery.

Table 2: Range of knee flexion before and after surgery (n=54)

Range of flexion	Before surgery (%)	After surgery (%)
< 90°	0	0
90° - 11°	74,1	70,4
> 110°	25,9	29,6
Average	103,5° ± 6,4°	108,6° ± 7,6°

Medium joint size (thigh size from 1.5 to 2 according to Jonhson & Johnson or C, D as Strykers standards) accounted for the majority with 68.5%.

Exercise after surgery according to the protocol of the Department of Rehabilitation - Viet Duc University Hospital.

In our study group, there were no cases of incidents (vascular damage, fractures...), complications (infections, dislocations...).

Discussions

Studies show that there are 5 groups of factors affecting postoperative knee range of motion, including: factors related to the patient, surgical technique, kinematics of knee joint, intraoperative complications and type of artificial joint that was used [4].

The first group of factors related to the patient is the flexion deformity, the range of motion of the knee joint before surgery and the rehabilitation exercise after surgery. Herein, many authors believe that the flexion deformity is the most influential factor in this group of factors as even in case the limb axis has been restored, surround soft tissue contracture still affects the knee range of motion after surgery. In our series, the preoperative knee range of motion was 103.5°, however, the valgus knee with contracture accounted for 63%, moreover, inadequate compliance with the rehabilitation exercise were also factors that greatly affect the

postoperative knee range of motion. Therefore, the timely intervention of knee replacement before severe deformity is an important factor in achieving the treatment goal.

The second group of factors related to surgical technique includes balance of flexion-extension, misplacement of artificial joint components, excessive elevation of the joint line, etc. According to Table 1, 100% joints qualify the required position. Increased extension gap usually leads to post-operative flexion contracture, while increased flexion leads to limited knee flexion. On the contrary, if the release increases too much gap, it will lead to loose joints. In order to balance the flexion-extension gap, in addition to balancing the internal and external ligaments, the balance of the posterior cruciate ligament is also an important factor. If the posterior cruciate ligament is too tight, it will limit the amount of flexion, whereas if it is over-liberated, especially in the type of joint that retains the posterior cruciate ligament, it will cause the thigh to slide forward and reduce knee flexion.

Misplacement of artificial knee joint components is a factor affecting postoperative joint range of motion. If the thigh is placed back too much, straining the flexion gap, limiting flexion, or placing the thigh in an excessive flexion position, the extensor mechanism will be affected by chronic quadriceps tendon irritation. For the tibia, anterior tilting also causes a decrease in knee flexion range of motion because it stretches the flexion gap and reduces the roll ability of the thigh or if the polyethylene is too thick, it also leads to flexion and limits the knee flexion range of motion [5].

According to Goldstein et al., restoring the distance (offset) from the posterior border of the femoral condyle to the center of rotation will improve the postoperative knee flexion range of motion, in studying the effect of joint size reduction (PFC Sigma type) on the range of motion if the joint size was reduced from size 5 to size 4, the range of motion decreased from 135° to 120° [6]. In the study, the medium joint size accounted for 68.5%. This is

consistent with the anthropometric characteristics of Asian people in general and Vietnamese people in particular.

The Insall-Salvati index is 0.94 (normal 0.8-1.2). The effect of external articular elevation on reducing joint range of motion also causes pain in the anterior knee (thigh-thigh area), patella lower than the joint line, joint instability at the stage of knee flexion, patellar tendon entrapment and increased pressure on the joint. Decreased flexion range of motion is related to entrapment of the tibia and patella or to instability during the knee flexion phase. According to Chiu et al, if the joint line is raised to 10 mm, it can cause a decrease in knee flexion by more than 25% [7].

The third group of factors is the kinematics of the knee joint. The joint types in this study were Nexgen (Zimmer), triathlon and scorio (Stryker), which are new generations of joints that have been shown to meet the biomechanical requirements of the knee joint. Many studies in the normal knee joint have shown a posterior sliding motion of the femoral condyle and rotation in the tibial plateau during knee flexion. According to Johal et al. [8] when the knee is flexed to 120°, the lateral tibial plateau slides back 22 mm while the medial tibial plateau slides less, and the tibial plateau rotates 20°. When the knee is flexed above 120°, both femurs slide back by the same amount (9-10 mm). According to Banks et al [9], a study of 121 total knee joints found an average increase in knee flexion of 1.4° per millimeter posterior slide of the femoral condyle, while no relationship was observed between the degree of medial rotation of the kneecaps. tibial plateau with knee flexion range of motion.

The fourth group of factors is the early complication leading to ankylosing spondylitis such as infection, unstable joint fixation, fracture, ectopic ossification, post-operative psychological trauma. These factors affect the rehabilitation training process after surgery, thus affecting the final outcome in general and the knee range of

motion in particular. In the study, there were no complications as mentioned above, which facilitated early exercise.

The fifth group of factors is the design of the artificial joint. All artificial joints in our study were posterior cruciate ligament replacements. In the study by Dennis et al. [10] on the effect of two types of artificial joints retaining and replacing the posterior cruciate ligament on the postoperative knee range of motion, 20 patients in each group, knee range of motion was measured in different areas with load-bearing and without load-bearing positions. The author found that the knee range of motion decreased when measured in the load-bearing position in both groups of joints and in the group that replaced the posterior cruciate ligament, the knee range of motion was larger than the group that retained the posterior cruciate.

Other joint design factors that affect knee range of motion are the distance from the posterior aspect of the femoral condyle to the center of rotation, and the depth of the intercondylar groove. Another factor is the high-flexion TKA design, however the benefits of these joints are controversial and require further research.

Conclusions

Through the study, we found that there are a number of factors affecting the knee joint range of motion after total knee arthroscopy. Herein, preoperative knee deformity, compliance with rehabilitation procedures and surgical technique are the most influential factors.

Conflict of interest: The authors declare that they have no conflict of interest.

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