

# Indications for Total Knee Arthroplasty and Choice of Prosthesis

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**Abstract:** Total knee arthroplasty (TKA) is performed when the knee joint is severely damaged in osteoarthritis, rheumatoid arthritis and other diseases. In Japan, about 20,000 TKA procedures are performed each year and it is the second most common arthroplasty after total hip arthroplasty (THA). Knee replacement prostheses can be classified into three categories, which are unconstrained, semiconstrained, and constrained. Depending on the underlying disease and the extent of destruction of the knee joint, a prosthesis is selected. At present, semiconstrained prostheses are most commonly used. This type of prosthesis can be divided into groups depending on whether surgery requires excision of the posterior cruciate ligament and whether the prosthesis has posterior stabilizer or not. A prosthesis that can be implanted while sparing the posterior cruciate ligament is most commonly employed. When the knee is severely damaged and unstable, however, a stabilised prosthesis is used. Unconstrained prostheses are used for unicompartmental knee arthroplasty. Constrained prostheses are used for revision arthroplasty and for arthroplasty in knees that are extremely unstable, although the employment of this type is rare. Thus, a prosthesis is chosen depending on the underlying disease and the extent of destruction of the knee along with consideration of the general health and the blood supply to the lower extremity.

**Key words:** Knee prosthesis; Total knee arthroplasty; Osteoarthritis; Rheumatoid arthritis; PCL-sparing arthroplasty

## Introduction

Total knee arthroplasty has been most commonly performed for severe knee joint damage in patients aged 60 and over. The replacement prosthesis of choice varies depending on the underlying disease, the severity of knee

joint damage, and the age of the patient. The indications for total knee arthroplasty are discussed in this article based on the underlying disease and the extent of knee damage together with a description of the various types of prosthesis.

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Table 1 Types of Knee Prostheses

1. Unconstrained	Modular type-Marmor, Lotus, Savastano polycentric type (for unicompartmental knee arthroplasty)
2. Semiconstrained	Many prostheses fall into this category, including the geomedic, anametric, total condylar, kinematic, Kodama-Yamamoto, ceramic devices and others. (Prostheses implanted with preservation of the posterior cruciate ligament, prostheses implanted with excision of the posterior cruciate ligament, and stabilised prostheses.)
3. Constrained	Walldius, Shiers, Guépar, Kinematic rotating hinge

## Types of Knee Prosthesis

Total knee arthroplasty is usually performed in patients aged 60 years or older when the bone and articular cartilage are so severely damaged that there is no other effective therapy. The common diseases causing knee damage treated by arthroplasty are osteoarthritis, chronic rheumatoid arthritis, and osteonecrosis, while contraindications for knee arthroplasty include purulent arthritis and tuberculosis.

Knee prostheses can be classified into three major types, which are unconstrained, semiconstrained, and constrained. Like an endoprosthesis for unicompartmental knee arthroplasty, an unconstrained device is used to replace only a very small portion of the articular surface or a very thin surface layer of tissue, leaving the anatomical structure of the joint intact. A semiconstrained prosthesis is also used for superficial joint replacement. There are two types of semiconstrained devices. One requires excision of the posterior cruciate ligament, whereas the ligament is spared by the other type. In Japan, the posterior cruciate-sparing type of semiconstrained prosthesis is most frequently used. Among the prostheses requiring excision of the posterior cruciate ligament, the stabilised prosthesis, which facilitates the acquisition of antero-posterior stability of the knee, is used most

frequently.

In the United States, however, stabilised prostheses that require excision of the posterior cruciate ligament have been used most commonly, possibly because of the different health care system from that in Japan. The constrained type of prosthesis is only indicated for knees that are very unstable because of large bone defects or for revision total knee arthroplasty. A prosthesis of this type consists of a tibial component and a femoral component, which are connected by a hinge, and it allows reconstruction of a stable knee.

## Fixation of Knee Prostheses

To fix each component of a prosthetic joint to the bone, there are two possible methods. Methyl methacrylate bone cement can be used as one method, whereas screws are used along with metal beads or hydroxyapatite granules in uncemented fixation. The beads or granules are applied to the bone surface under the prosthesis.

If the patient is relatively young and the bone is strong, as occurs in osteoarthritis, uncemented fixation is useful. In patients with rheumatoid arthritis or osteoporosis, however, the bone is often fragile and uncemented fixation frequently results in subsidence or loosening of the implant. Consequently, cemented fixation, which allows early resumption of weight bearing and achieves a better outcome, is useful for such patients.

There is also hybrid fixation, which is a combination of cemented and uncemented fixation. In hybrid fixation, either the femoral or tibial component is fixed with bone cement, while the other component is fixed without cement. Usually, uncemented fixation is used for the femoral component, while the tibial component is cemented.

## Osteoarthritis

The most common disease of the knee is

osteoarthritis. This is initially treated by rehabilitation (exercise), thermotherapy, topical medications (moist packs), and wearing of a supporter, while the course is being followed. Additional conservative management includes using a plate under the sole to raise the lateral border of the foot, and intraarticular injection of agents such as hyaluronic acid to protect the cartilage. Symptoms unresponsive to such conservative treatment are an indication for surgery. Osteotomy and knee arthroplasty are indicated for younger and older patients, respectively.

In more than 95% of Japanese patients with osteoarthritis of the knee, deformity of the bone and articular cartilage predominantly affects the medial compartment. This type of osteoarthritis is usually treated by high tibial osteotomy if the patient is relatively young, while unicompartmental knee arthroplasty (UKA) or total knee arthroplasty is indicated for patients aged 65 to 70 years or older.

Unicompartmental knee arthroplasty (UKA) involves replacement of the affected articular surfaces in the medial compartment (distal femur and proximal tibia) using metal or ceramic components, with retention of both the anterior and posterior cruciate ligaments. UKA of the knee is indicated for osteoarthritis or osteonecrosis in patients between 65 and 70 years old or older. It is contraindicated for rheumatoid arthritis or other inflammatory diseases because the bone and cartilage lesions can be expected to spread and eventually the entire knee will be involved. Because both the anterior and posterior cruciate ligaments are spared, neither ligament can show degeneration and the knee must be completely stable or minimally unstable.

When UKA is considered, the weight of the patient is the most important factor and obesity is a contraindication. It is our general rule that this method is contraindicated for patients exceeding 70 kg in weight. In the United States, however, some surgeons use 90 kg as the cutoff value. A body mass index

(BMI: weight (kg)/height (m)<sup>2</sup>) exceeding 25 or 27 is considered to indicate mild obesity and obesity, respectively. It is desirable for this index to be below 25. The mean BMI exceeded 25 in 50 patients who underwent total knee arthroplasty recently at our department. It cannot be denied that patients tend to be obese when their osteoarthritis is so advanced that it requires surgical treatment.

UKA of the knee has several advantages: 1) It only takes a short time to perform, 2) postoperative rehabilitation can be started earlier and proceeds smoothly, and 3) the surgical invasion is smaller and there is little risk of postoperative infection. If the patient is overweight, the prosthesis will subside over time postoperatively and then will become loose. Consequently, the weight should be controlled quite strictly.

If the bones and cartilage of the entire knee joint have been affected, as occurs in advanced osteoarthritis, total knee arthroplasty is indicated instead. Precisely speaking, if flexion of the knee is reduced because of severe genu valgum or varum and there is a prominent fixed flexion contracture, total knee arthroplasty is the treatment of choice. If genu varum is prominent and the knee is stiff, total knee arthroplasty rather than UKA is also indicated, even if the patient's osteoarthritis shows medial predominance. When the range of motion of the knee is severely restricted by flexion contracture, excision of the posterior cruciate ligament becomes necessary. Consequently, total knee arthroplasty is indicated.

When patients with osteoarthritis have strong bones without osteoporosis and are around 60 years old, instead of fixation using bone cement, quite a few surgeons employ uncemented fixation using screws that are coated or treated with hydroxyapatite. Bone cement has systemic effects, such as causing hypotension. Also, a great deal of heat is generated during polymerization and this can damage tissues around the site of fixation. However, Ranawatt *et al.* studied the results at

more than 20 years after cemented total knee arthroplasty in the United States and found that the outcome was excellent in more than 90% of patients, suggesting that bone cement causes little harm. Moreover, patients benefit from the use of cement because it achieves firm fixation soon after the operation and hence allows the knee to bear weight earlier, allowing the patient to start rehabilitation more rapidly.

It is still controversial whether the articular surface of the patella should be replaced with a polyethylene patellar component in total knee arthroplasty. According to my experience, several years after total knee arthroplasty without patella replacement, a number of patients will require additional patellar replacement because of local pain. Consequently, patellar replacement is performed with the initial total knee arthroplasty at our department. Particularly in patients who have chronic rheumatoid arthritis, it may extend to involve the articular surface of the patella, and the disease has recurred this way in some of our patients. Thus, patellar replacement seems to be necessary when the underlying disease is rheumatoid arthritis.

If the knee shows anteroposterior instability because of severe degeneration of the anterior and posterior cruciate ligaments or because of marked varus or valgus deformity, such instability may persist after joint replacement if the cruciate ligaments are spared and postoperative rehabilitation will be impaired.

Stabilised knee prostheses are equipped with a stabiliser that increases the anteroposterior stability of the knee joint and are useful for unstable knees like those described above. If the width of the stabiliser is increased, it can also prevent instability in the frontal plane. To implant a posterior-stabilised knee (PSK) prosthesis, the posterior cruciate ligament is divided from the femur at its insertion into the periosteum, and osteotomy is done to create room for the stabiliser between the femoral condyles. Because osteotomy is

required for the PSK prosthesis, posterior cruciate ligament-sparing arthroplasty with a prosthesis that does not need osteotomy is more commonly performed in Japan. However, the reasons for selecting prostheses vary between countries, and use of the PSK prosthesis is far more common in the United States.

Excision of the posterior cruciate ligament when inserting the PSK prosthesis allows adequate division of the soft tissues behind the knee, which makes it easy to pull the proximal articular surface of the tibia anteriorly during the operation and assists surgical manipulation. The space that remains even after insertion of the polyethylene tibial plate makes it easy to achieve flexion of 90 degrees or more by postoperative rehabilitation. The roll-back that occurs during flexion of the knee is believed to be physiological when the posterior cruciate ligament is intact. In many cases, however, the posterior cruciate ligament shows degeneration to some extent at the time of arthroplasty. In addition, there is often scar tissue behind the knee and the division of such scar tissue for insertion of a PSK prosthesis is said to allow physiological roll-back. This view is partly based on the finding that wear of the polyethylene tibial component is greater after posterior cruciate-sparing arthroplasty than after PSK arthroplasty.

In the United States, patients are only hospitalised for 3 or 4 days after total knee arthroplasty. Following discharge, they perform rehabilitation exercises at home by themselves, so there is a possibility that they will stop exercising if they feel pain, even if it is slight. According to a recent report from the United States, as many as 40% of the patients who underwent total knee arthroplasty with sparing of the posterior cruciate ligament required manipulation under anaesthesia about 1 month postoperatively to mobilize the knee because exercise at home had failed to achieve flexion exceeding 90 degrees. When the PSK prosthesis was used, in contrast, few

patients required this additional procedure. This indicates that with the PSK prosthesis, postoperative exercise at home can achieve adequate flexibility of the knee, which is considered to be one reason for its popularity in the United States.

### **Chronic Rheumatoid Arthritis**

In rheumatoid arthritis, articular damage caused by inflammation involves the entire knee joint. In many patients, not only the anterior cruciate ligament, but also the posterior cruciate ligament, undergoes degeneration because of inflammation. The anterior cruciate ligament is completely covered by the synovial membrane and so is more susceptible to damage by synovial inflammation. When inflammation is severe, the whole anterior cruciate ligament can disappear in some cases. In the case of the posterior cruciate ligament, only the anterior segment is covered by synovial membrane and the posterior segment is bare so it is thought to be less liable to degenerate than the anterior cruciate ligament. However, if inflammation is severe in patients with rheumatoid arthritis, the posterior cruciate ligament is always affected. Consequently, its excision and removal of the affected synovial membrane and scar tissue behind the knee is useful because it prevents the recurrence of inflammation.

In patients with rheumatoid arthritis, osteoporosis of the bones around an affected joint becomes severe because of inflammation and reduced movement. Because of the presence of osteoporosis, we always use bone cement to fix implants in rheumatoid arthritis patients.

When there is a large bone defect in either the medial or the lateral condyle of the tibia, it will remain if the bone is cut in the conventional manner. Therefore, the defect must be repaired with bone grafts using bone fragments obtained by femoral osteotomy. Recently, such defects have also been repaired

by inserting a metal wedge that is fixed with bone cement.

### **Constrained Knee Prostheses**

When the knee has large bone defects or marked instability that cannot be repaired with a resurfacing prosthesis, or when revision arthroplasty is performed because of loosening or subsidence of the previous implant, constrained prostheses are used. The early hinged prostheses did not permit the knee to rotate at all and hence placed excessive stress on the stem of the implant when the knee joint moved, frequently leading to destruction of bone around the tip of the stem. Consequently, prostheses of this type are no longer used. The current hinged prosthesis is called a rotatory prosthesis and it can rotate around the axis of the stem of the tibial component. This type of prosthesis is associated with fewer complications such as loosening.

### **Complications of Knee Arthroplasty**

The major complications of knee arthroplasty are mechanical problems, such as loosening and subsidence of the prosthesis, and postoperative infection. Infection occurs immediately after implantation in some cases, but it is often delayed and manifests several years after surgery. Although the incidence of infection varies among institutions, it is usually around 1-2%.

Once it has become infected, a prosthesis must be removed. However, removal means that the patient will be unable to perform normal daily activities because of instability of the knee, the reduced length of the affected limb, and the device worn to compensate for knee instability. Therefore, great care must be taken to prevent infection and this cannot be overemphasized.

Immunosuppressants such as methotrexate (MTX) are used in the treatment of rheumatoid arthritis. There is a risk that such drugs

could affect the immunity of patients and reduce their resistance to infection, so withdrawal for a period before and after surgery warrants consideration. Patients with diabetes and patients on hemodialysis have a high risk of developing infection. It is therefore better to choose the arthroplasty associated with the least surgical, if possible.

### Summary

The indications for knee arthroplasty and the types of prosthesis were described above. In patients with osteoarthritis, it is desirable for the amount of bone removed at arthroplasty to be minimized and the posterior cruciate ligament to be spared if it is in good

condition. In patients with rheumatoid arthritis, however, there is usually severe osteoporosis and severe degeneration of both cruciate ligaments causing the knee to be unstable, so a PSK prosthesis is used and is fixed with bone cement.

For revision arthroplasty, a constrained knee prosthesis of the rotatory hinged type seems to be most suitable, because the knee is severely unstable and there is considerable bone loss. Among the complications of knee arthroplasty, infection is the most serious and its prevention deserves great care. Once a prosthesis is infected, the patient will suffer serious disability in daily life. Risk factors for infection should be countered with great diligence whenever possible.