

# *Research Progress on Treatment of Knee Extension Stiffness*

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**Abstract:** Knee extension stiffness is a common complication after knee surgery and trauma, which will seriously affect the quality of life of patients. This article reviews the clinical manifestations, risk factors, mechanism, differential diagnosis and treatment of knee ankylosis, in order to promote the prevention and treatment of knee ankylosis in China.

## **1. Introduction**

At present, the definition of knee joint stiffness is not unified [1-5]. In clinic, the knee joint whose range of motion is less than 50° is defined as stiff knee (1). According to the relevant literature statistics, the incidence of knee joint stiffness after total knee arthroplasty (TKA) is 1.3%-5.8% [6], the incidence of knee joint stiffness after cruciate ligament reconstruction is 0%-4% [7-8], and the incidence of tibial plateau fracture is 7%-21.1% [9-11]. As the largest joint of the human body, the knee joint must reach a suitable range of motion to meet the needs of people's life and work. The knee joint needs flexion 65° when walking on the horizontal ground, 70° flexion when standing up from the sitting position or climbing the stairs, and 90° flexion of the knee joint when going down the stairs [12,13]. Knee joint stiffness is a knee joint dysfunction caused by a variety of reasons. When the knee joint is stiff in the straight position and flexion is limited, it is called knee joint extension stiffness. The causes of the disease can be attributed to soft tissue contracture, bony mechanical occlusion, and fibrous or bony fusion. Knee ankylosis, as a complication of knee joint injury, treatment and some diseases, will cause great life disturbance, economic burden and even the risk of reoperation to patients. This article will review the mechanism, clinical manifestation, differential diagnosis and treatment of knee ankylosis.

## **2. Clinical Manifestations and Risk Factors of Knee Joint Extension Stiffness**

The main manifestations of knee joint extension stiffness were pain, knee joint extension deformity and flexion dysfunction, the surrounding tissue was tough and inelastic, and the degree of motion of the patella decreased (figure 1). It can happen after surgery, but it can also happen after

trauma. The common risk factors can be divided into: (1) After cruciate ligament reconstruction, it mainly lies in gender (male is higher than female), choice of operation time, extra-articular operation, simultaneous repair of medial and lateral collateral ligament, lack of standard rehabilitation training, etc [7]. (2) After tibial plateau fracture, it was mainly due to knee extension device injury, articular surface collapse, external fixator fixation time > 60 days, soft tissue injury that needed skin grafting or skin flap repair, debridement more than 2 times, no standard rehabilitation training and so on. (3) After TKA, it was mainly due to the range of motion of knee joint before operation, obesity, age, previous operation history of knee joint and its surroundings, lack of standard rehabilitation training and so on [14]. In addition, pain is not only one of the clinical manifestations of knee joint stiffness, but also one of the causes of knee joint stiffness. Many patients are unwilling to take the initiative to move the knee joint because of pain, which leads to pseudo-stiffness, which can be found under anesthesia. Patients with knee ankylosis showed higher mean visual analogue scale (VAS) in preoperative and postoperative pain, especially during physiotherapy.



Figure 1: A patient after operation of supracondylar fracture of left femur. (a) range of motion of knee joint <math>< 45^\circ</math>; (b) anterior and lateral films of left knee joint; (c) weight-bearing films of both lower extremities.

### 3. The Mechanism of Knee Joint Extension Stiffness

Knee joint extension stiffness is mostly caused by extensive soft tissue injury after femoral fracture or in front of femur, scar formation or fibrous degeneration of some or all of the devices of quadriceps femoris, it can be seen in trauma, brace or plaster external fixation, joint adhesion after operation and so on. Pathophysiologically, it is caused by cell proliferation and increased synthesis of matrix proteins (collagen I, III and VI) [15]. Reviewing previous studies, most scholars believe that knee extension stiffness is caused by single or combined effects of the following factors: (1) Fibrosis, adhesion and contracture of quadriceps, adhesion or even complete disappearance of suprapatellar bursa; fracture deformity, callus, adhesion between femur and knee extension device, and contracture of patellar retinaculum, which limit the sliding of knee extension device. (2) Adhesion occurred in patellofemoral, tibiofemoral joint and articular capsule, the distal femur was not smooth, and the meniscus or articular cartilage was injured, which limited the activity of knee joint [14-16]. (3) After TKA, the position of the prosthesis was abnormal and the trajectory of the patella was poor.

### 4. Differential Diagnosis of Knee Joint Extension Stiffness

During clinical diagnosis and treatment, doctors should rule out other diseases that may be disguised as knee ankylosis, such as diseases from the hip joint and spine [17]. The main points of distinguishing hip joint disease from knee joint extension stiffness are as follows: (1) hip joint related diseases not only lead to the decrease of the range of motion of the knee joint, but also

mainly affect the hip joint; (2) pelvic radiographs, hip joint anteroposterior and lateral radiographs and hip joint CT can distinguish the above two. Spinal diseases compared with knee ankylosis, spine-related diseases not only lead to reduced range of motion of the knee joint, the main clinical manifestation is neurological symptoms, combined with patient signs is not difficult to distinguish; in addition, spinal MRI can also be identified.

In addition to the above, knee periprosthetic infection (PJI) is also included in the differential diagnosis of knee straightening stiffness. Although PJI may cause symptoms of knee range of motion, because PJI is an infectious disease, the pathogenesis is very different from knee straightening stiffness, and there will be differences in philosophy in follow-up drugs and surgery. The key points of distinguishing the two are as follows: (1) In addition to insufficient range of motion of the knee joint, the clinical symptoms of PJI will also appear inflammatory manifestations such as redness, swelling, heat and pain around the knee joint, and even sinus tract; (2) Serological indexes, joint fluid indexes, microbial culture and gene sequencing can prove the existence of PJI pathogenic bacteria.

## 5. The Treatment of Knee Joint Extension Stiffness

The treatment of knee joint extension stiffness can be roughly divided into two types: non-operative treatment and surgical treatment.

### 5.1. Non-Operative Treatment

This kind of treatment generally includes exercise therapy (PT), spa, massage, physiotherapy, continuous passive activity (CPM) (figure 2), etc. The specific indications were as follows: the patient could not tolerate the operation, the course of disease within 90 days, no knee extension device involved, no severe osteoporosis and firm internal fixation [18]. The doctor in charge is required to make a regular and systematic non-operative treatment according to the condition, and the specific operation should be carried out by a professional rehabilitation physician, and the range of motion of the joint should be measured regularly and the relevant score scale should be filled in. This kind of treatment can train the muscle strength around the knee joint, restore the range of motion and maintain the stability of the joint, and restore the walking function as soon as possible.



Figure 2: Passive training assisted by CPM machine.

## 5.2. Surgical Treatment

### 5.2.1. Manipulation Release under Anesthesia

Manipulation release under anesthesia is mainly aimed at intra-articular adhesion, but when there is adhesion between articular surfaces, the operation will lead to fracture and articular surface injury. Therefore, if there is a surgical incision, it must wait until the surgical incision is completely healed; if you encounter a knee joint without a prosthesis, manual release should be performed within 30 days after operation; patients with adhesion after total knee arthroplasty should be carried out within 90 days after operation. When releasing, the operator should hold the tubercle of the tibia with both hands and apply the force gently and gradually (figure 3).



Figure 3: Steps of manual release under anesthesia.

### 5.2.2. Arthroscopic Release of Knee Joint

Arthroscopic release of knee joint is mainly suitable for secondary knee joint stiffness caused by intra-articular causes. Arthroscopic release should be performed within 90-180 days after TKA. For knee joint stiffness, most scholars use electric planing knife to release the adhesive tissue around the suprapatellar bursa, the medial and lateral sulcus of the femoral condyle and the polyethylene pad, and remove the excessive synovial tissue at the same time. In addition, Cao Jiangang et al. (19) proposed to use a hook knife to release the dilated part of the medial quadriceps femoris (figure 4) to avoid patellar instability caused by loosening the medial and medial patella.

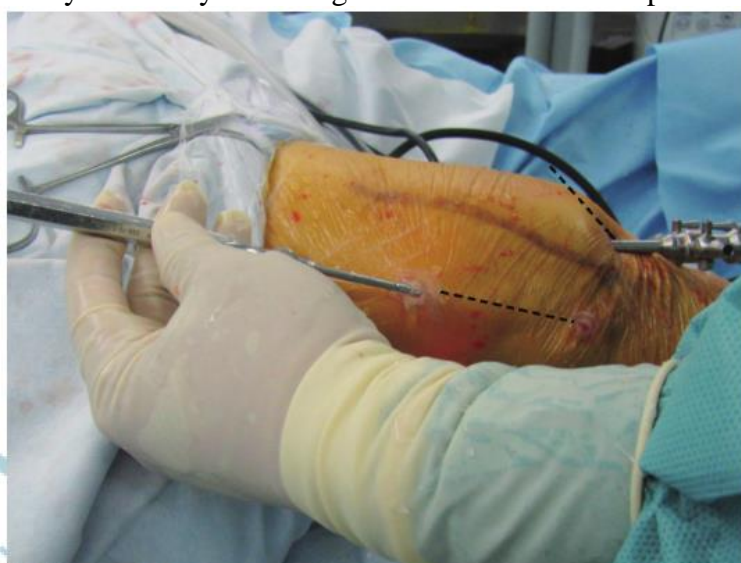


Figure 4: The dotted line in figure shows the release of the lateral retinaculum of the knee and the medial dilation of the quadriceps femoris [19].

### 5.2.3. Traditional and Modified Quadriceps Myoplasty

Traditional and modified quadriceps myoplasty is a classic treatment for knee ankylosis, which is suitable for patients with very severe knee stiffness, mostly after trauma (after internal fixation of femoral shaft fracture or distal femoral fracture). At present, most clinicians use Thompson quadriceps myoplasty, Judet quadriceps myoplasty, V-Y quadriceps myoplasty (figure 5) and various modified quadriceps myoplasty. The injury of this kind of operation is large, and the postoperative re-adhesion affects the curative effect, and there may be complications such as skin necrosis, heterotopic ossification, weakness of quadriceps femoris and lag of knee extension [20, 21]. After operation, different rehabilitation exercises should be given according to individual needs (specific methods are the same as non-operative treatment).

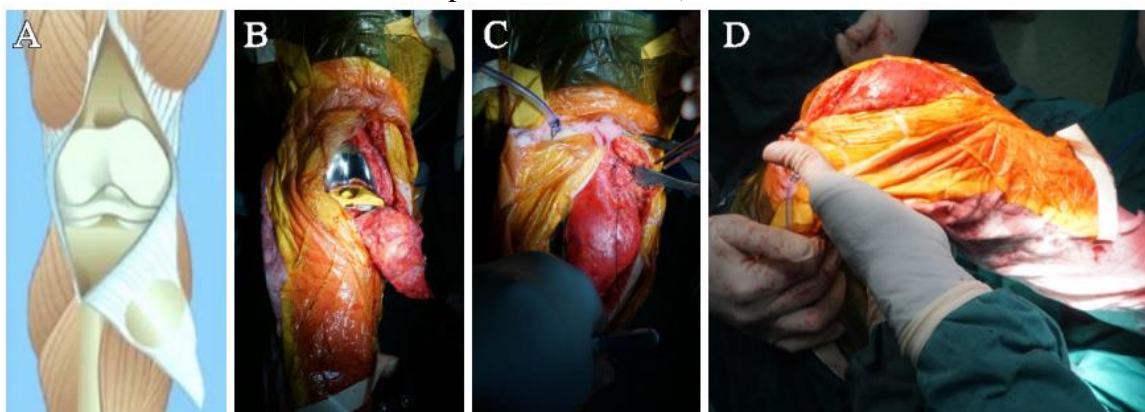


Figure 5: Incision design and intraoperative operation of V-Y myoplasty of quadriceps femoris [22].

### 5.2.4. Total Knee Replacement and Revision Surgery

If the treatment effect of total knee arthroplasty and revision is not good, and when there are imaging indications, patients can choose total knee arthroplasty and revision. The key points of this kind of operation are the full exposure of the joint, the protection of the integrity of the knee extension device, the balance of the flexion and extension gap, accurate osteotomy and effective soft tissue release, the selection of prosthesis and so on. As the ultimate solution, doctors should pay attention to surgical complications: skin necrosis and tear; wound dehiscence; secondary fracture; decreased strength of the quadriceps femoris and retention of knee extension; low patella; rupture of the quadriceps tendon or patellar tendon; knee joint infection; recurrence of knee instability and knee stiffness [18-23].

To sum up, this article reviews the clinical manifestations, epidemiology, pathogenesis, differential diagnosis and treatment of knee ankylosis. With the acceleration of the aging process in China, there are more and more patients with knee joint ankylosis, in order to play a certain role in the prevention and treatment of the disease.

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