

Treatment of traumatic knee stiffness with Ilizarov stretcher

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Research

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Abstract

Objective To explore the clinical application of Ilizarov stretcher in the treatment of traumatic knee joint stiffness, and to compare the efficacy of soft tissue release around knee joint with CPM machine exercise.

Methods In this study, 36 patients with ankylosis after operation for periarticular fracture from March 2012 to March 2017 were treated with Ilizarov stretcher after soft tissue lysis. The therapeutic effect was excellent.

Results According to Judet method, the knee joint function was evaluated in the experimental group: excellent in 22 cases, good in 12 cases, fair in 2 cases, the excellent and good rate was 94.4%; in the control group, excellent in 3 cases, good in 18 cases, fair in 12 cases, the excellent and good rate was 63.6%

Conclusions Ilizarov stretcher is an effective method for the treatment of traumatic knee joint stiffness, which has the advantages of short treatment time and good function of knee joint after operation.

Background

Knee joint stiffness is a common complication in orthopaedics clinic. It is usually caused by femoral shaft fracture, femoral condyle, patella and tibial plateau, as well as infections around knee joints, which causes great inconvenience to patients' work and life. At present, there are many clinical methods to treat knee stiffness, including drugs, manipulation, surgery, traction, functional rehabilitation training, etc^[1-13], but each has its advantages and disadvantages. Clinical treatment is tricky^[1-4]. By using Ilizarov stretcher, by gradually extending the conjunctive and contracture perigenicular soft tissue, alternating fixation in flexion position and extension position has the effect of dynamic and static fixation, which can maintain the effective fixation of limbs. Compared with soft tissue release of knee joint + CPM machine, Ilizarov drafting machine has the advantages of short treatment time and good knee joint movement function after operation, and is an effective method to treat knee stiffness.

Materials And Methods

This study is a series of single center cases in a trauma center of a hospital. The study is conducted according to the guideline for case series⁴. The study protocol was approved by the local ethics board, and informed consent was obtained from all the patients in the study.

Samples

All subjects in this study were hospitalized in Department of Traumatic Orthopaedics, Luohe Central Hospital from March 2012 to March 2017 for joint stiffness after operation for periarticular fracture. In

this study, 36 patients with knee joint stiffness were treated with knee joint soft tissue release combined with Ilizarov stretcher, and 33 patients with knee joint soft tissue release combined with CPM exercise.

Treatment group: 36 patients (25 males and 11 females), aged from 20 to 70, with an average age of (45.5 ± 14.15) . There were 15 cases of femoral condyle fracture, 5 cases of middle and lower femoral shaft fracture, 7 cases of patella fracture, and 9 cases of tibial plateau fracture. Preoperative maximum knee flexion was $8 \sim 19^\circ (13.8 \pm 3.37)^\circ$.

Control group: 33 patients (24 males and 9 females) aged from 23 to 65 years, with an average of $(45.2 + 12.67)$ years. Among them, 13 cases were femoral condylar fracture, 5 cases were middle and lower femoral shaft fracture, 8 cases were patellar fracture and 7 cases were tibial plateau fracture. The maximal knee flexion before operation was 10-20 degrees in the control group, and the mean (\pm standard deviation) was $(14.5 (+3.05))$ degrees.

Procedures

Treatment group : (1) the soft tissue around the knee joint was released by the anterolateral longitudinal incision of the lower leg segment, the length of which was determined according to the extent of local scar and adhesion. After the iliotibial band was exposed, it was cut obliquely. Expose the lateral femoral muscle and rectus femoris muscle, then cut off the upper end of the patella of the lateral femoral muscle. According to the intra-articular and extraarticular adhesion of the patient, the range of release was determined, including the release of the anterior femoral and intermedial femoral muscle adhesion, the partial removal of the intermedial femoral tendon, the cutting of the fibrous chordae of the patellofemoral joint adhesion, the suprapatellar capsule and the infrapatellar fat. Loosening of fatty pad fibrosis. At the same time, the knee flexion angle was measured. Under the condition of knee flexion, the scar tissue and tendon with high tension were cut off at different planes, and the knee flexion degree was more than 100 degrees. After the knee flexion degree was satisfied, the internal fixator was removed. Then drainage tube was drained and incision was sutured. (2) Installation of Ilizarov stretcher: insert Ilizarov stretcher into knee joint in flexion position, first locate the rotation center of knee joint with a Kirschner pin 4.0 mm in diameter, then insert the joint hinge of external fixator into the positioning pin to determine the relative position of external fixator, then insert a 4.0 mm Kirschner pin near the steel ring at the distal end of femur, and use steel. The pin fixing clip fixes the pin and the steel ring of external fixator; the proximal femur is close to the steel ring and is connected with the steel ring by a threaded pin with a diameter of 4-4.5mm; and the distal tibia is close to the steel ring by a 4.5mm Kirschner pin and the steel ring. The external fixator should be fixed at the relative position of the operative limb, and then the femur and tibia should be strengthened with Kirschner pins and threaded pins, respectively.

Control group: (1) Soft tissue release around knee joint, the same method as the treatment group. (2) After wound healing, CPM machine functional exercise was performed gradually, 2-3 times a day.

Statistical Analysis

All statistical analyses were performed with the use of SPSS software, version 12 (SPSS Inc., Chicago, IL). The results were expressed as average \pm SD. Dunnett method was used to compare different time in groups. The counting data is indicated by percentage and chi-square test is adopted. Check level was set at both sides $\alpha=0.05$.

Evaluation criteria

Evaluation of knee joint function with Judet method

Results

(1) The maximum flexion of the knee joint in the experimental group was 78–115 °, the mean \pm standard deviation was (102.9 ± 11.03) ° and that in the control group was 65–105 °, the mean \pm standard deviation was (85.5 ± 12.85) ° respectively. The data of the two groups were analyzed by SPSS software, $P < 0.05$ ($t = 6.053$, $P = 0.000$), the difference was statistically significant.

(2) In the experimental group, it took 21–35 days to reach 60 degree of postoperative autonomic flexion activity, the mean \pm standard deviation was (28.5 ± 4.28) days; in the control group, it took 30–92 days, the mean \pm standard deviation was (61.4 ± 19.86) days; using SPSS software to analyze the data of the two groups, $P < 0.05$ ($t = 9.693$, $P = 0.000$), the difference was statistically significant.

Typical Cases

A 45-year-old man with comminuted fracture of right femoral condyle caused by traffic accident underwent open reduction and plate internal fixation (Fig. 1). After operation, the affected limb was braked. One year later, the right knee joint was straight and stiff (Fig. 2). Then Ilizarov stretcher was installed to treat knee joint stiffness. Preoperative examination was performed: extensive scar in front of thigh, atrophy of quadriceps femoris, maximum flexion of right knee joint at 12 degrees, and normal motion of hip joint and ankle joint. The operation was performed in two steps. First, quadriceps femoris muscle relaxation was performed (Fig. 3). The anterior knee skin tension was relieved. The maximum flexion was about 100 degrees. The internal fixator was removed and Ilizarov stretcher was installed (Fig. 4–5). Following up 1 month after removing Ilizarov stretcher, the maximum flexion of the right knee joint was 110 degrees (Fig. 6). The knee joint flexion and extension were normal 3 months after operation (Fig. 7–8).

Discussion

The knee joint is an important joint of the human body, which has the function of transferring load and providing movement power matching including the lower leg ^[5-7]. After fractures around the knee joint, a long period of immobilization is often needed to facilitate the healing of the fracture, but it will affect the knee joint function and even cause knee stiffness ^[8-9].

Ilizarov knee tractor has a unique effect in the treatment of knee stiffness after trauma. Since Ilizarov discovered the tension-stress rule of tissue regeneration, scholars have made unremitting in-depth studies to prove that sustained stretch stress stimulation within physiological limits can enable the body to produce vascular growth factor to promote angiogenesis in new tissues, thereby activating and maintaining the regenerative potential of tissue and cells^[10]. With the extensive development of limb lengthening using tension-stress principle in orthopaedic clinic, knee extensor for knee joint stiffness has gradually been paid attention to and applied.

At present, there are many methods to treat knee joint stiffness clinically, including drugs, manipulation, surgery, traction, functional rehabilitation training, etc^[11-13], but each has its advantages and disadvantages: (1) Drug therapy is an effective method to prevent and reduce knee joint stiffness, among which traditional Chinese medicine has its own characteristics and advantages in the treatment of traumatic knee joint stiffness, but the therapeutic effect is slow and can be used as an adjuvant therapy. (2) The advantages of knee joint adhesiolysis and quadriceps femoris plasty are full exposure and complete release. The disadvantages are more traumatic bleeding, incision dehiscence and anterior patellar skin necrosis infection, inability to perform early functional exercises and loss of secondary angle of motion. (3) Functional rehabilitation training is an important method to restore knee joint function after operation, but single functional training can not achieve satisfactory range of motion. (4) Commonly used adjuvant therapies for knee joint stiffness, such as manipulation, needle-knife, can relieve adhesion and pain, but the therapeutic effect is limited. Violent manipulation may cause unnecessary intra-articular tissue tear, cartilage injury, patellar tendon tear and even femoral fracture complications. (5) Arthroscopic knee arthrolysis has a narrow scope of application. The main treatment for knee joint stiffness is intra-articular adhesion and mild condition. (6) The treatment of knee joint stiffness by small incision release has the advantages of small incision, less trauma and less bleeding, but the shortcomings are inadequate exposure, easy to injure surrounding tissues, inadequate thorough release, and difficult to achieve the desired therapeutic effect.

The treatment of knee joint stiffness is a very complex problem. We should recognize its importance. Because it is not always feasible to use external fixator alone to correct knee joint stiffness, we should have a deep understanding of the function of thigh muscle, anatomical shape and the degree of scar around knee joint. In the past, the knee passive flexion reached 90 degrees after soft tissue release. Even if the extension and flexion exercises began immediately after the operation in the straight position about one week, the knee became stiff and fast. CPM machine assisted exercise has little effect. In short, there is no "one-off" effective treatment for knee stiffness^[14]. Ilizarov stretcher is used to treat knee joint stiffness. By using the tension-stress rule, the continuous stretching stress of external fixator acts on the contracted muscles, articular capsules, blood vessels and nerves around the knee joint. The stretching force will cause the stretching extension and remodeling of the above tissues, and improve the scar contracture of the soft tissue around the joint. On the basis of contraction and adhesion, increasing the range of motion of knee joint, excessive disturbance to peripheral blood vessels and nerves is avoided^[15]. The distractor can adjust the knee joint clearance and flexion angle by adjusting the nuts on the

connecting rod of the external distractor. The straightening and flexion forces can be dispersed to the external fixator to avoid the injury caused by the compression of articular cartilage surface caused by the strong traction.

Preoperative preparation of Ilizarov stretcher for knee joint stiffness. First of all, we need to understand the medical history, physical examination, auxiliary examination (X-ray, CT film) to measure the residual activity of the knee joint and the duration of knee stiffness. At the same time, we need to test whether quadriceps femoris muscle strength is completely lost, whether there is bone connection, whether there is chronic inflammation in bone or joint, whether the fracture achieves bone healing, whether the internal fixator is removed, and the patients' expectation of knee joint function, and prepare the appropriate size of Ilizarov knee joint stretcher (the healthy side is the model).

Ilizarov knee distractor in the treatment of knee stiffness during and after the operation notes:

- Ilizarov knee distractor is mainly completed by adjusting the screw rod above the knee joint. At the same time, if necessary, the knee joint can be lengthened longitudinally to prevent the knee joint from injuring cartilage due to excessive pressure as the fulcrum¹⁶; (2) when the knee joint stretcher is installed, the patella does not wear a Kirschner pin to prevent the necrosis of patella and anterior knee skin due to excessive soft tissue tension; the distal femur and tibia can be pierced with a full pin, if 2 mm Kirschner pin is pierced. The needle should be stretched and fixed, and the Kirschner needle above 2.5mm can not be stretched; the middle and proximal femur and the middle tibia should be fixed with 4-4.5mm threaded needle, and the diameter of the needle should be determined according to the thickness of the operative limb¹⁷. (3) The proximal femur needle should be as high as possible to reach the level of subtrochanteric femur, which can effectively prevent the occurrence of fracture after operation. The curved release of the needle at the contact with fascia lata is beneficial to the flexion and extension locus of the knee joint. (4) The knee joint is maintained in flexion position after operation, and the degree of flexion depends on the intraoperative release. Fixed joints can be relaxed and joints can be moved intermittently¹⁸. (5) On the second day after operation, the external fixator pull rod should be adjusted to pull the knee towards flexion, and the pulling speed should be adjusted dynamically according to the degree of pain and the tension of skin and soft tissue in the front of the knee. (6) The outer thigh pinhole should be wrapped with gauze. Pressure bandaging can reduce pain, tissue exudation and prevent needle infection. (7) The knee joint is fixed in flexion position and changed to straight position for 2 hours after 4 hours. When bending the knee, fix the extension and flexion rod of the external fixator; when stretching the knee, release the extension and flexion rod of the external fixator; (8) If the patient can tolerate, the flexion angle of the knee joint can be stretched > 90 degrees; if not, stop stretching. When the knee joint is fixed in flexion position, it is necessary to pay attention to the soft tissue around the knee joint to prevent local skin necrosis; (9) The time of flexion and extension can be prolonged one week later until the flexion position is extended at night in the daytime; (10) After 3-5 weeks of flexion and extension of the knee joint, if the flexion and extension of the knee joint can be maintained. At the level of traction, the knee

extensor is removed. After removing the stretcher, the knee joint was fitted with a knee brace, and the knee joint flexion and extension function was exercised under the protection of the brace.

Ilizarov drafting apparatus for the treatment of knee stiffness may also produce some complications if not properly mastered: (1) needleway infection; (2) puncture for vascular and nerve injury; (3) symptoms of nerve paralysis; (4) osteofascial compartment syndrome of lower limbs; (5) dislocation of knee joint; (6) re-fracture around the knee joint; (7) deep venous thrombosis of lower limbs; (8) broken needle; (9) recurrence of knee ankylosis; (10) loss of range of motion of knee joint, etc. Several complications were also involved in this study, which did not result in serious consequences through timely and proper treatment. Therefore, these complications can be avoided by correctly mastering the installation method and postoperative management of knee extender.

The advantages of Ilizarov stretcher in the treatment of knee joint stiffness are: (1) less trauma, less bleeding, no large surgical incision and extensive soft tissue dissection and release, effectively avoiding the massive bleeding and injury caused by the release of knee joint and surrounding soft tissue; the distal and proximal bone ends of knee joint pass through round bone needle and external fixator Continuous as a whole, keep the integrity of soft tissue around knee joint such as quadriceps femoris^[19]; (2) Safe and effective, through slow traction of external fixator, avoid the complications such as wound infection, necrosis, delayed healing and neurovascular injury caused by traditional release surgery; (3) Effective traction. At the same time, it can maintain the effective fixation of limbs, which is especially suitable for patients with knee joint stiffness associated with periarticular fracture; (4) While patients are treated with knee joint stiffness, they can go down to the ground and perform functional exercises of hip and ankle joints, thus avoiding many complications of long-term bed rest.

Conclusion

By using Ilizarov stretcher, by gradually extending the conjunctive and contracture perigenicular soft tissue, alternating fixation in flexion position and extension position has the effect of dynamic and static fixation, which can maintain the effective fixation of limbs. Compared with soft tissue release of knee joint + CPM machine, Ilizarov drafting machine has the advantages of short treatment time and good knee joint movement function after operation, and is an effective method to treat knee stiffness.

Declarations

1 Ethics approval and consent to participate

The study protocol was approved by the Institutional Review Boards and the Ethics Committees of Luohe Medical College. Before operation, informed consents were signed by all the patients after detailed explanation of the therapeutic procedure to the patients. The study is conducted according to the guideline for case series.

2 Consent for publication

Written informed consent for publication was obtained from all participants.

3 Availability of data and material

All data generated or analysed during this study are included in this published article

4 Competing interests

The authors declare that they have no competing interests

5 Funding:

No

6 Authors' contributions

all authors contributed to data collection and wrote the manuscript. Chao Liang and YueHua Liu drafted the study protocol. Wei Cui and PengFei Shi performed literature review. JunWei Li, Haile Li collected data. Shuai Dong performed the analyses. Chao Liang, Wei Cui and YueHua Liu drafted the paper. All authors critically reviewed the paper. Chao Liang and YueHua Liu had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. YueHua Liu and Chao Liang are the guarantors of the paper. All authors approved the current manuscript to be published, attested that they contributed substantially to the current work, and disclosed that there was no writing assistance.

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Figures



Figure 1

X-ray film 1 year after operation of femoral condylar fracture.



Figure 2

Right knee joint stiffness 1 year after operation. Maximum flexion 12 degrees.

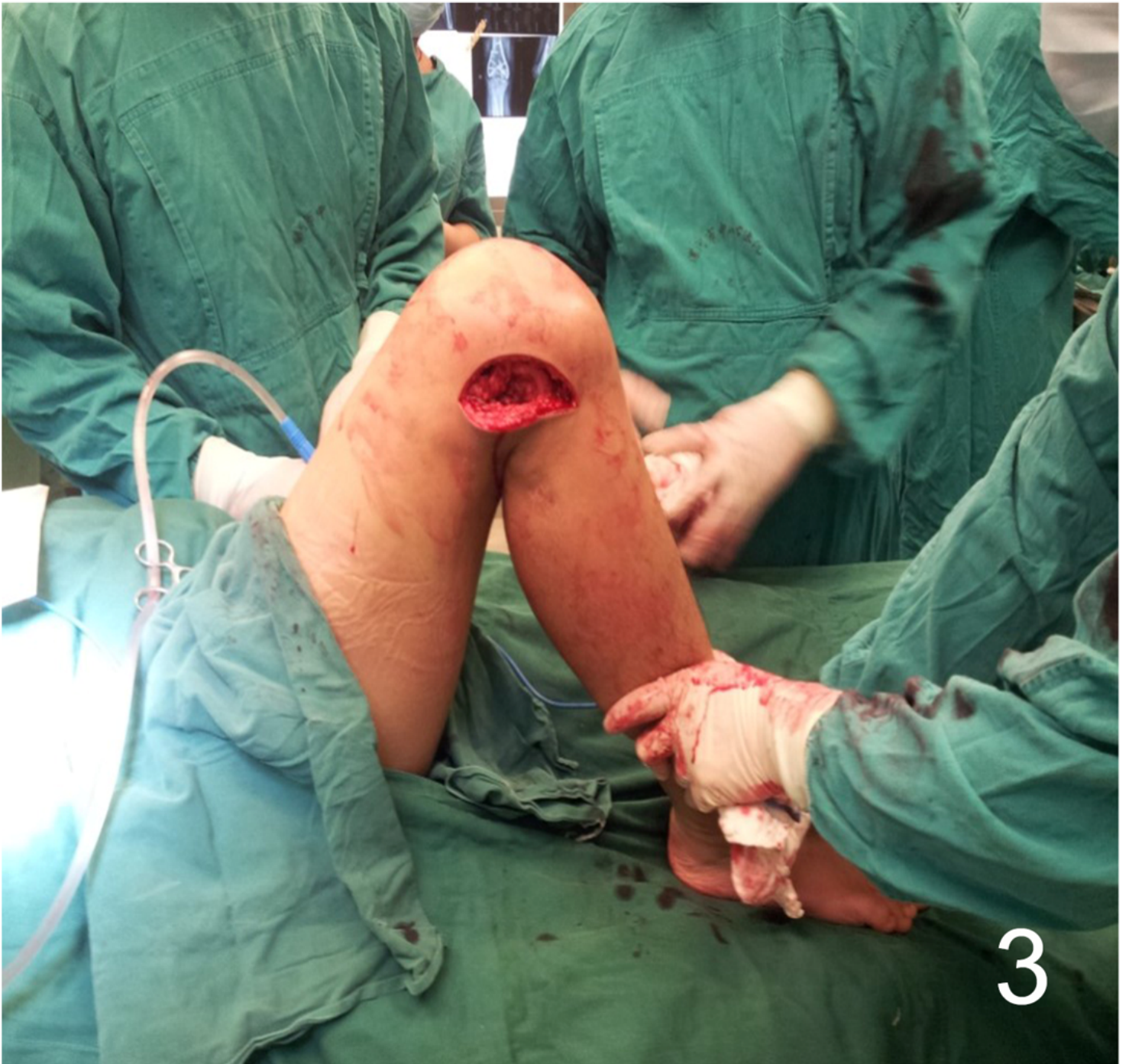


Figure 3

Release quadriceps femoris and remove internal fixator.

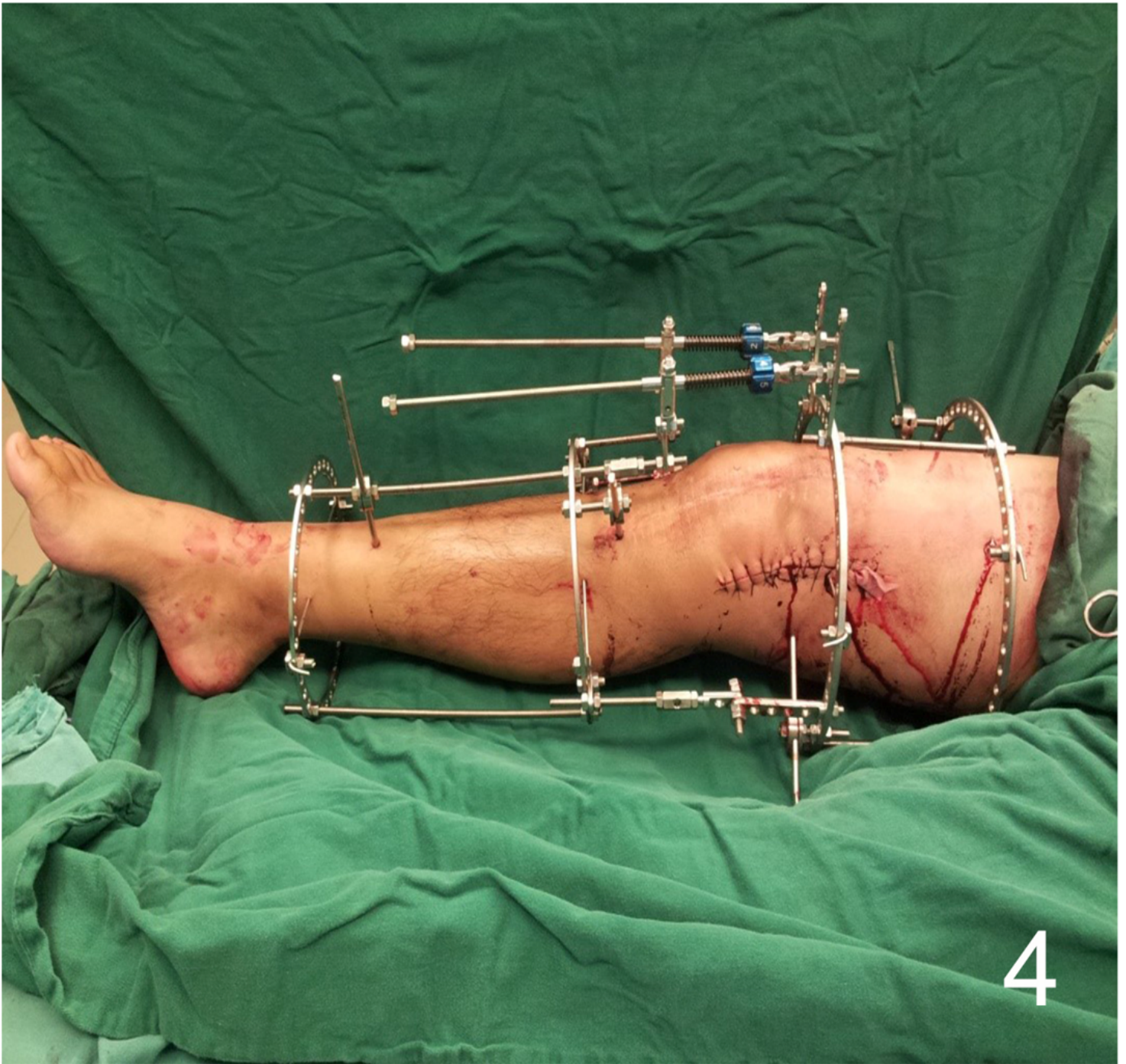


Figure 4

Install Ilizarov stretcher.

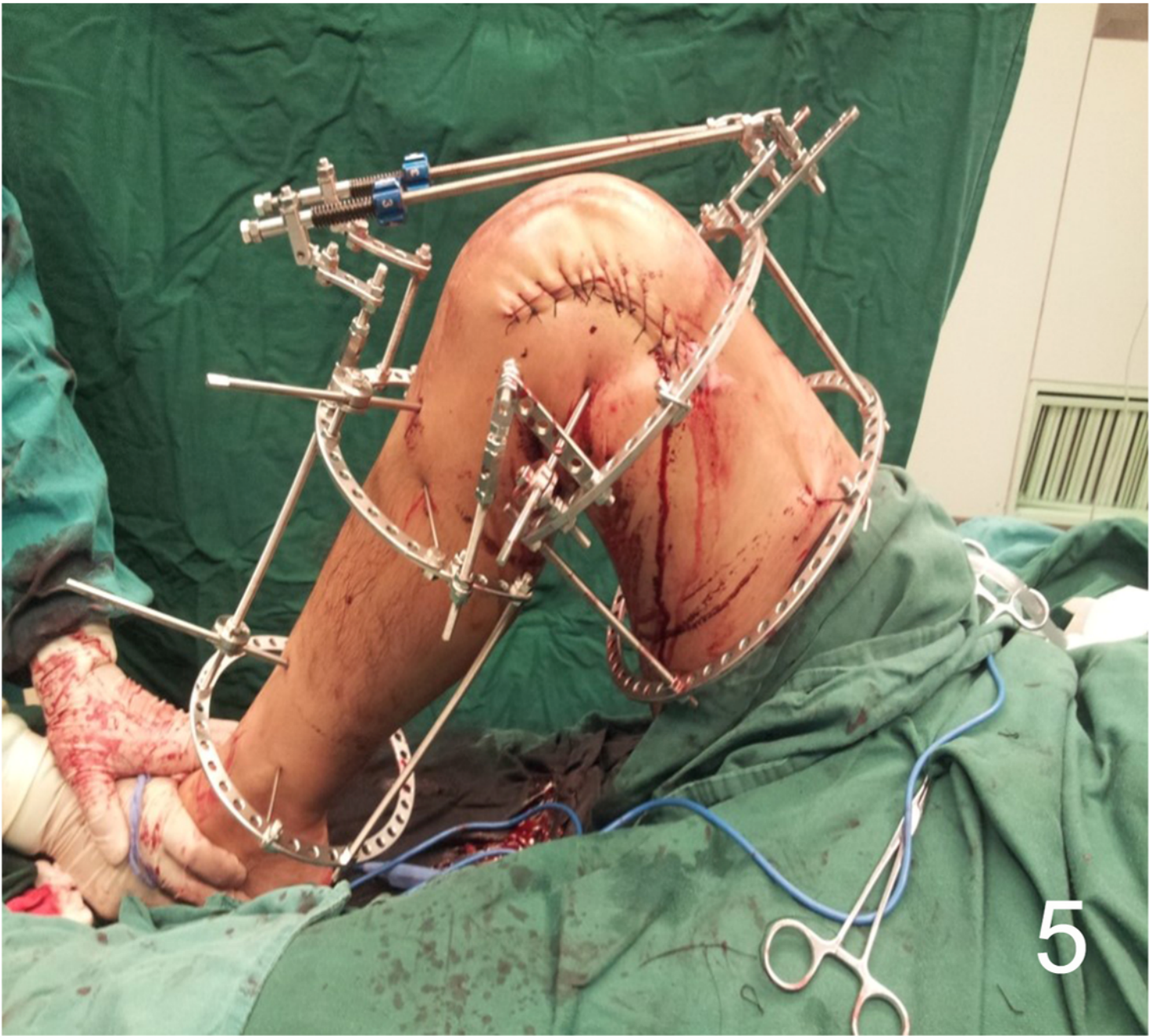


Figure 5

Install Ilizarov stretcher.



Figure 6

Remove Ilizarov stretcher 1 month later, follow-up right knee joint flexion 110 degrees



Figure 7

Right knee joint flexion 3 months after operation. orthergasia



Figure 8

Right knee joint flexion 3 months after operation. orthergasia