Technical Note

Arthroscopic In Situ Fixation of Osteochondral Fragments on the Weightbearing Area of the Knee Joint With a Single Anchor

Wei Huang, M.D., Wenbo Yang, M.D., Chunqing Meng, M.D., Zengwu Shao, M.D., and Hong Wang, M.D.

Abstract: Osteochondral fracture of knee joint occurring in the femur is a serious clinical trauma. The presence of osteochondral fragments in the knee joint often necessitates surgery. Arthroscopic repair is a minimally invasive treatment, and there are many methods, among which suture anchor is often adopted by clinicians because of its obvious advantages such as simplicity. In the past, there were many methods for fixing osteochondral fragments, but using suture anchors to fix free osteochondral fragments has become a common approach. Moreover, the local mechanical environment will also be affected because of the increase in the number of bone channels. In this report, we describe a method for fixing 1 or 2 osteochondral fragments using a single suture anchor based on the mechanical characteristics of the femoral weightbearing region of the knee joint. We use relevant case reports to introduce our technology. Through the application of our improved technique, the arthroscopic repair of osteochondral fractures in the weightbearing area of femur can be more convenient and more economical, and the rehabilitation of patients will not be affected.

Osteochondral fracture of the knee joint is not common, but its clinical manifestations are often serious. Osteochondral fracture of the knee joint usually leads to the production of osteochondral fragments in the joint, and most patients experience disturbance of knee movement. Patients with osteochondral fractures need high-quality radiography and computed tomography scans to confirm the presence of osteochondral fragment. If a stray fragment is identified, surgery is usually required, especially if the defect is located in a weightbearing area.[1] Large fragments should be fixed. For osteochondral fracture of knee joint, many fixation methods have been proposed, such as using a Herbert screw, internal fixation system, absorbable suture fixation, and more.[2,3] These surgical techniques are relatively difficult to achieve to get good results. Recently, suture anchor has been used to fix loose body in osteochondral fracture of knee.[4] In traditional techniques, multiple anchors/anchors are often used to ensure fixed effects. This makes the surgical procedure longer, more difficult, and less economical. In addition, because multiple anchors are implanted, the mechanical structure of the weightbearing area may change. Here we demonstrated the effect of using a single anchor to fix single or multiple osteochondral fragments under arthroscopy to repair osteochondral fractures of the knee. Our improved technique shows simplicity, economy, and good results. This report provides an important reference for the diagnosis and treatment of osteochondral fracture, as well as other osteochondral injury diseases of the knee of knee joint. The entire technology is described in Video 1.

Surgical Technique

Fixation of a Single Osteochondral Fragment

We illustrate our improved technique with an example of acute patellar dislocation with osteochondral injury of

From the Department of Orthopaedics, Union Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China.

All authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

W.H. and W.Y. contributed equally to this work and are joint first authors.

Received May 15, 2023; accepted July 20, 2023.

Address correspondence to Hong Wang, M.D., Department of Orthopaedics, Union Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China. E-mail: xiehewanghong@163.com

2212-6287/23727

https://doi.org/10.1016/j.eats.2023.07.038

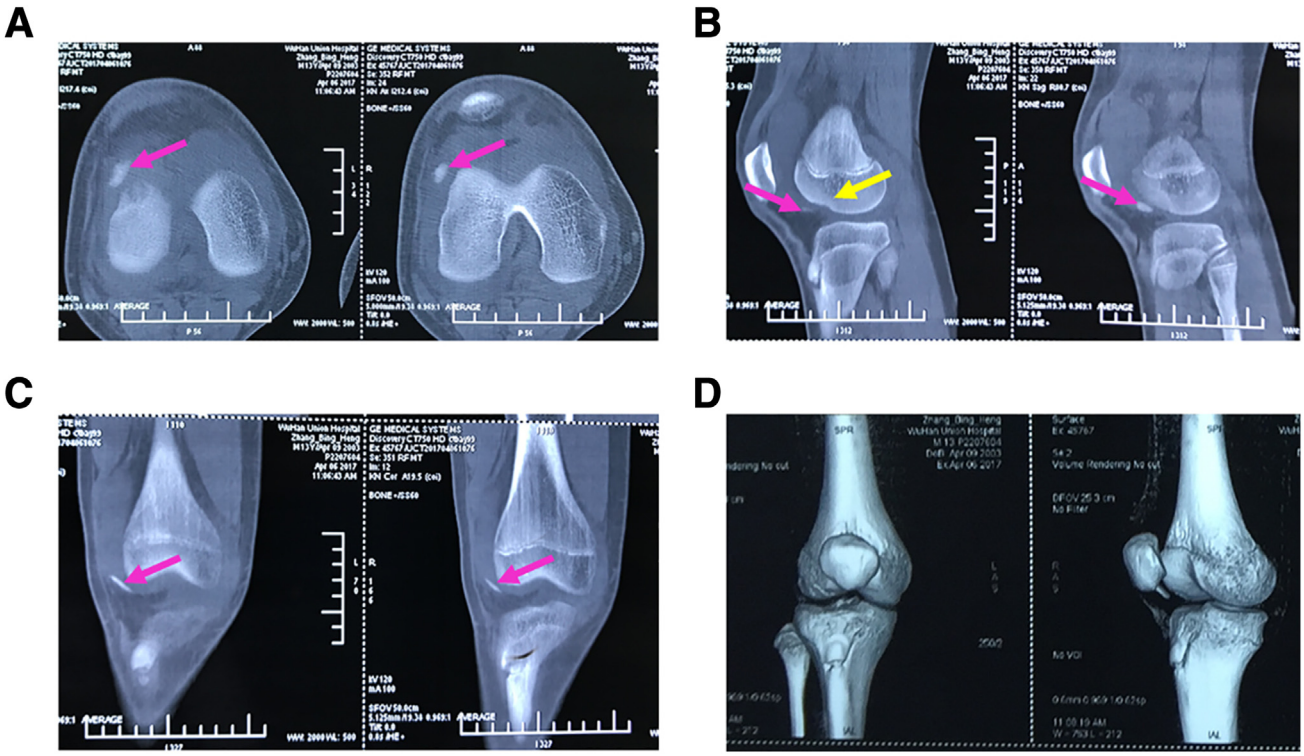

Fig 1. Computed tomography results of the patient before surgery. As shown in this figure, osteochondral injury and free osteochondral fragments of the femoral lateral condyle of the right knee are easily and clearly observed. (A) Cross-section. (B) Sagittal section. (C) Coronal section. (D) Three-dimensional reconstruction. The pink arrow indicates the free osteochondral fragment. The yellow arrow indicates the defect area.

the right knee (Fig 1). The surgical procedure for immobilizing a single bone block is as follows:

1. Patient preparation. The patient is placed in the supine position. After general anesthesia is administered, a tourniquet is applied to the root of the thigh of the affected limb, and routine disinfection is performed.
2. Approach establishment and damage observation. First, the anterolateral approach is established as an observation approach and the anteromedial approach as an observation/operation approach. In this example, we find the loose body (osteochondral fragment) in the joint and the site of osteochondral injury in the weightbearing area of the femoral lateral condyle (Fig 2).
3. Comparison of cartilage block to defect site. The number of free osteochondral fragments is confirmed by careful arthroscopy. At the same time, it should be carefully confirmed whether the bone shape and the defect site fit. After confirming the site and condition of the injury are suitable for repair surgery, the fixation of the osteochondral mass is prepared.

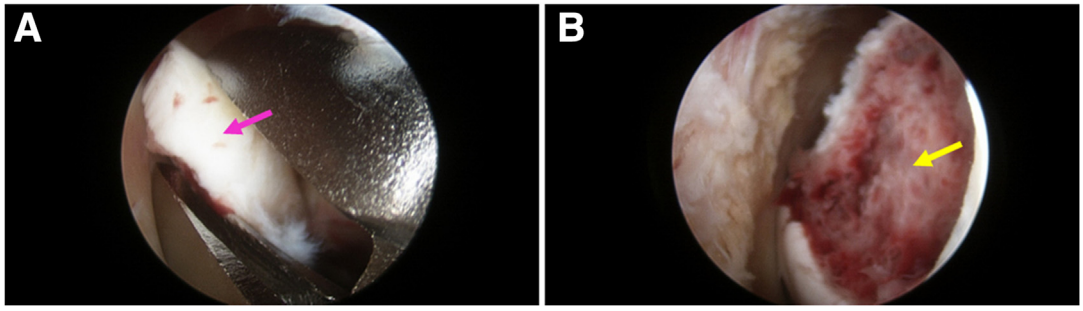

Fig 2. The patient's injury is investigated by arthroscopy. (A) An arthroscopic investigation of the lateral interval of the right knee revealed a free osteochondral fragment.The anterolateral approach in this figure is the observation approach. (B) The anteromedial approach is used as an observation approach to see the osteochondral lesion in the weightbearing area of the lateral condyle of the femur. The pink arrow indicates the free osteochondral fragment. The yellow arrow indicates the defect area.

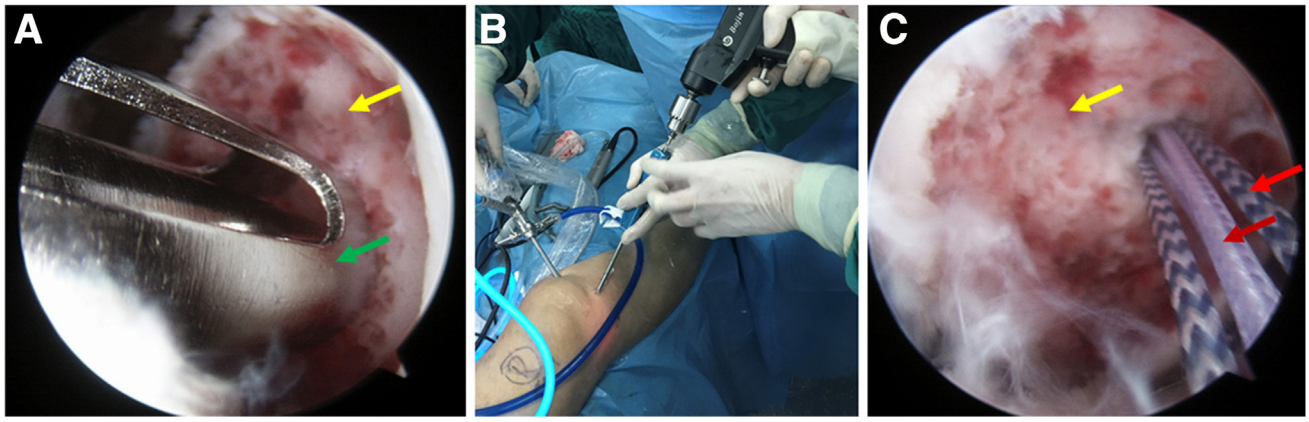

Fig 3. A suture anchor is inserted into the center of the osteochondral lesion through an anterolateral approach under arthroscopy. (A) Suture anchor location has been selected and a locator placed at the center of lesion. (B) An electric drill is used to prepare bone tunnel for anchor placement. (C) Suture anchor placement is completed. The yellow arrow indicates the defect area. The green arrow indicates the locator. The red and dark red arrows indicate the two sets of sutures on the anchor.

4. Fresh treatment of bone bed and anchor implantation. First, the free osteochondral fragment is removed to avoid further damage. Subsequently, the patient is positioned at 15° to 30° with the knee bent, and the injured site is freshened with a shaver. A suture anchor loaded with 2 sutures is implanted into the center of the bone defect (Lupine; Mitek, Paynham, MA) (Fig 3).
5. Treatment and delivery of free osteochondral fragment into the articular cavity. Four evenly distributed holes are then drilled in vitro with a 1.5 to 2 mm Kirschner wire into the osteochondral fragments. Then we pass the 4 free suture ends through each of the 4 holes of the osteochondral fragment. The fracture surface of the osteochondral fragment should face the bone defect area when threading the suture (Fig 4). The osteochondral fragment is sent into the joint under the direct view of the arthroscopy.
6. Resetting and fixing of Free osteochondral fragment (Fig 5).

Postoperative imaging examination shows that the location of the osteochondral fragment and anchor are

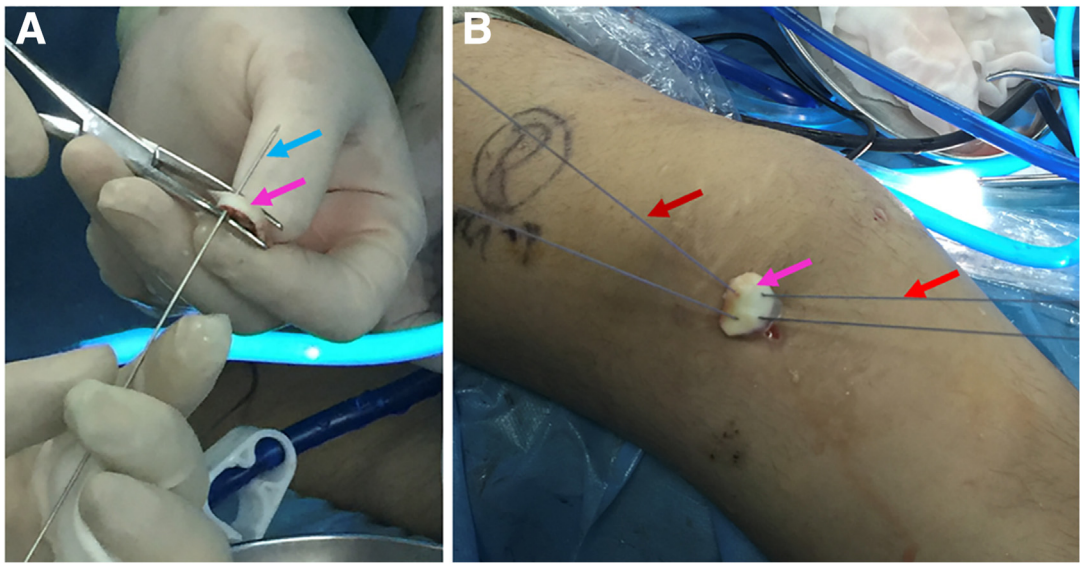

Fig 4. Osteochondral fragment drilling and placement. (A) Drilling of free osteochondral fragment using 1.5 to 2.0 mm Kirschner wire. (B) Pass through the free end of the anchor suture into the drilled hole and send the fragment into the joint cavity. The cartilaginous surface of the fragment should be facing outward. The blue arrow indicates the Kirschner wire. The red and dark red arrows indicate the 2 sets of sutures on the anchor. The pink arrow indicates the free osteochondral fragment.

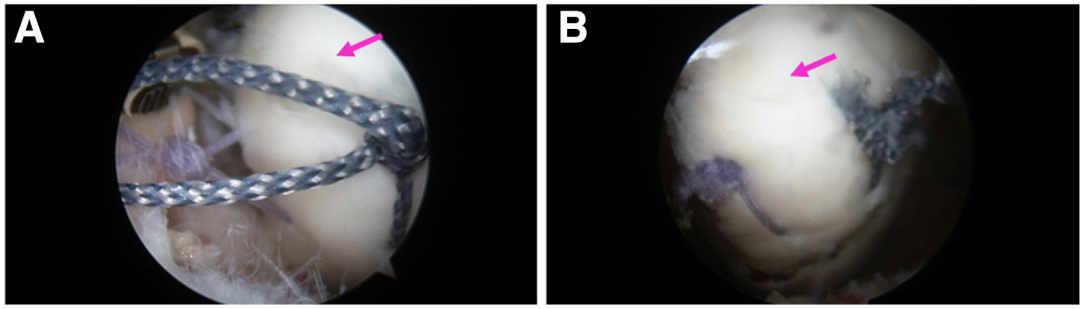

Fig 5. The osteochondral fragment is placed on the lesion site. (A) The edge of osteochondral fragment closely matches the edge of lesion site. The anteromedial approach used as the observation approach. (B) The sutures are knotted, and the osteochondral fragment is secured. The anterolateral approach is used as the observation approach. The pink arrow indicates the free osteochondral fragment.

satisfactory, and the placement of the anchor avoids the injury in the epiphysis (Fig 6). Postoperative recovery and follow-up of the patient show the same effect as the traditional technique.

Fixation of Two Osteochondral Fragments

The fragments generated by osteochondral fractures of the knee joint may be incomplete, such as 2 fragments. The fixation technique of osteochondral fracture pieces by a single anchor containing 4 free ends of sutures is also suitable for the fixation of 2 fracture pieces. Here we illustrate our improved technique in a patient with primary right knee patellar dislocation combined with old osteochondral injury. The specific steps are as follows:

1. Patient preparation is similar as above.
2. Approach establishment and damage observation. Similarly, the anterolateral approach is established as

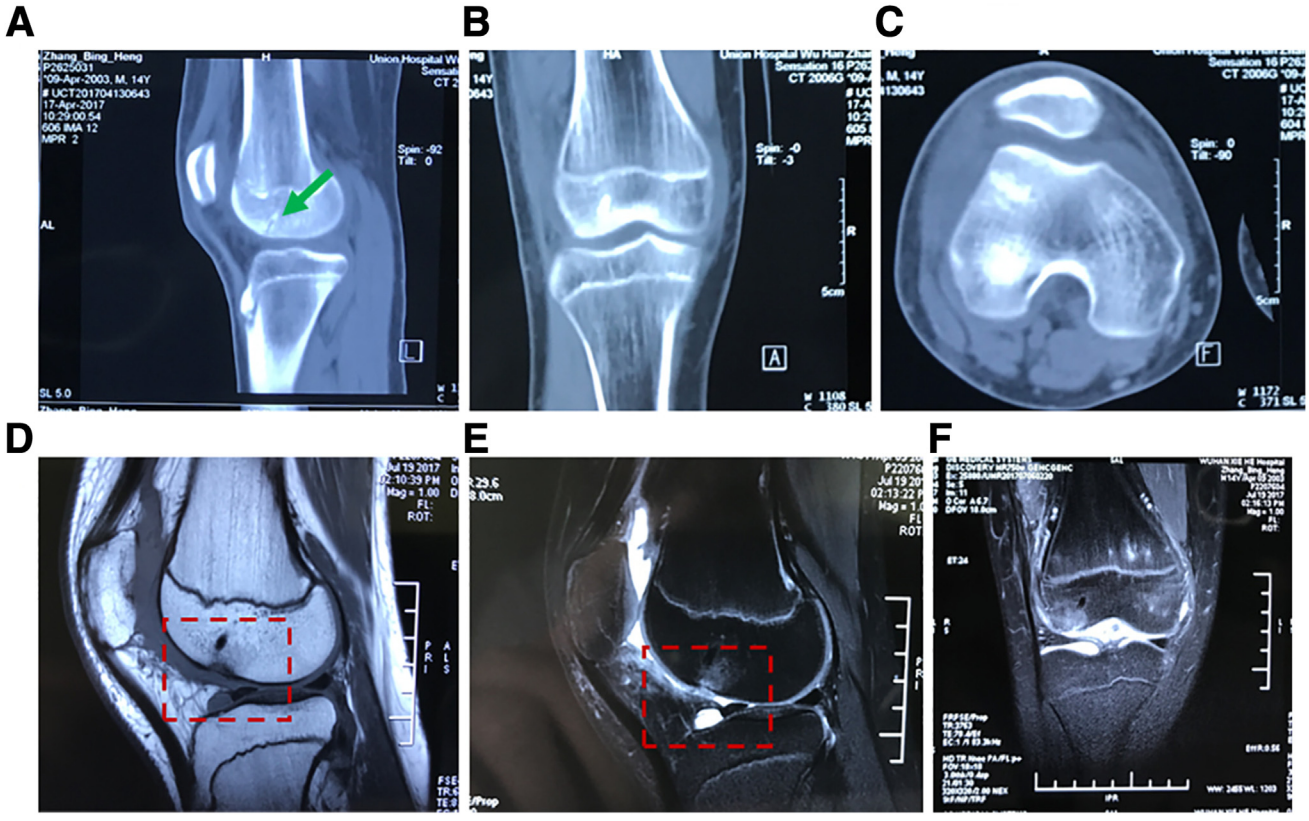

Fig 6. Postoperative computed tomography (CT) and magnetic resonance imaging (MRI) results of the patient's knee. Postoperative CT and MRI indicated that the reduction position of the osteochondral fragment is right, and the anchor is placed in a good position, which would not hurt the epiphysis. (A) Sagittal section of CT. The green arrow indicates the location of the anchor. (B) Coronal section of CT. (C) Cross-section of CT. (D) Sagittal section of T1 MRI. (E) Sagittal section of T2 MRI. (F) Coronal section of T2 MRI. The deep red box indicates the tight fit of the fragment to the bone bed.

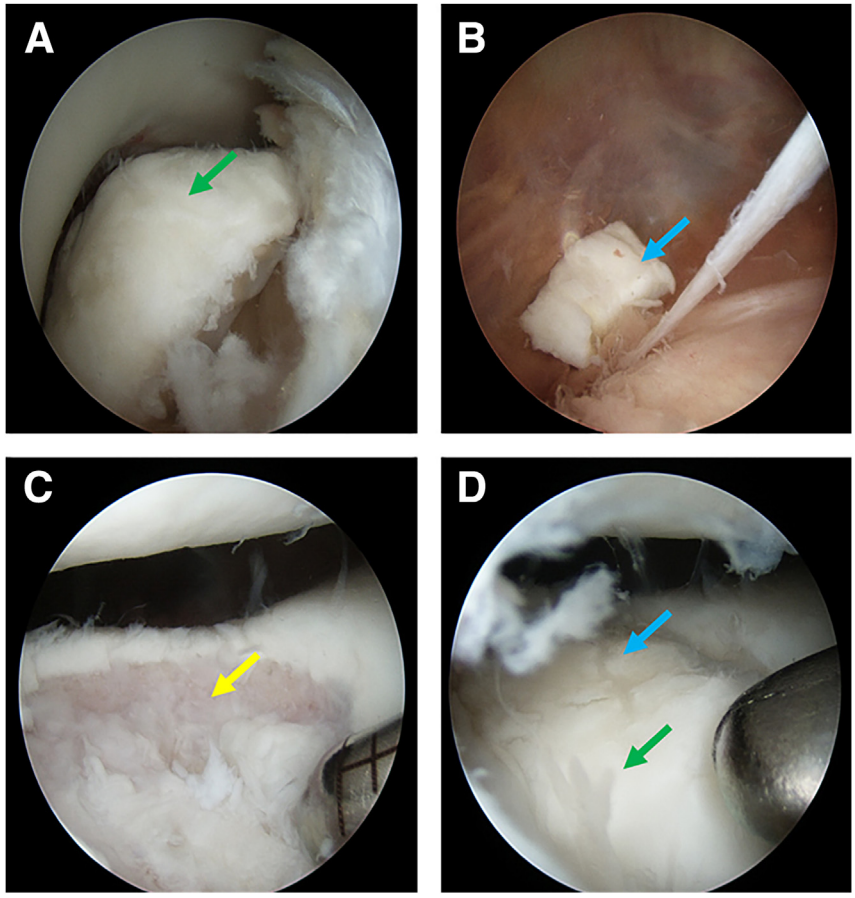

Fig 7. Arthroscopic exploration of the knee joint of example 2. (A) Osteochondral fragments located in the intercondylar fossae. The anterolateral approach is used as the observation approach. The green arrow indicates the free fragment. (B) Cartilage fragments located in the bursa suprapatellaris. The anterolateral approach is used as the observation approach. The blue arrow indicates the free fragment. (C) An old lesion located in the trochlea of the femur. Yellow arrow indicates the bone bed. (D) Temporary reduction of the 2 fragments can fill the entire defect.The green and blue arrows indicate the positions of the two fragments, respectively.

an observation approach and the anteromedial approach as an observation/operation approach. Two free osteochondral fragments from the same site of injury can be observed arthroscopically. In this example, the lesion is located in the trochlear of the femur (Fig 7A-C).

3. Comparison of cartilage block to defect site. By comparing the fracture fragment to the defect site, we found that the two fragments are placed together just enough to fill the defect area (Fig 7D). This is an indication of our improved technique. Therefore, we plan to fix 2 osteochondral fragments by single anchor.

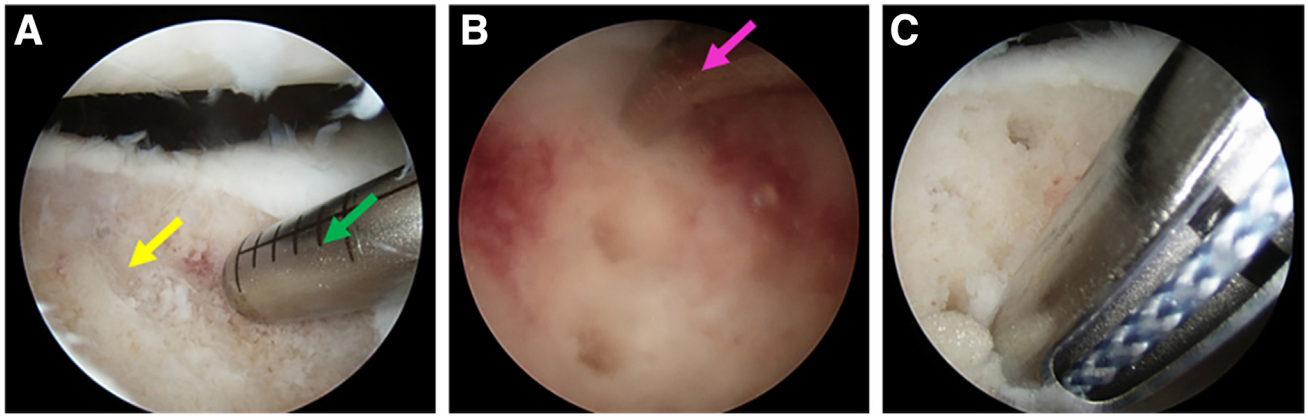

Fig 8. The process of implantation of the suture anchor. (A) The anteromedial approach allows the shaver to enter and freshen the bone bed. Green arrow indicates the shaver. Yellow arrow indicates the bone bed. (B) Bone marrow stimulation in the lesion area. The pink arrow indicates the Microfractor. (C) Implant suture anchor. The observation approaches are all anterolateral approach.

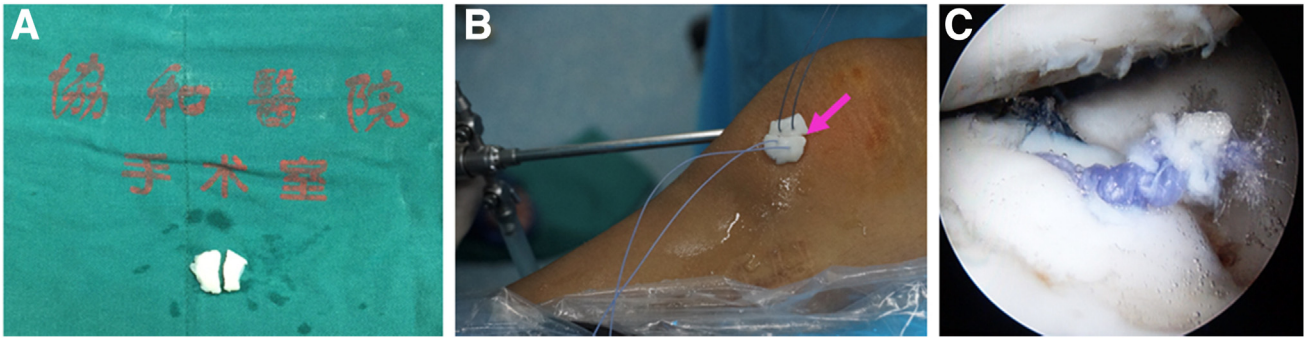

Fig 9. The process of splicing and implantation of two fragments. (A) In vitro fragment splicing. (B) Pass through 4 free ends of suture anchor into the osteochondral fragments. Two suture ends are passed through each osteochondral fragments. The fracture surface of the osteochondral fragment should be inward, and pay attention to the direction. Pink arrow indicates the placement of the two fragments. (C) Careful placement of the osteochondral fragments into the joint space. After the osteochondral fragments are fitted to the lesion area, the sutures are knotted and fixed. The observation approach is the anterolateral approach.

4. Fresh treatment of bone bed and anchor implantation. The defect site is also freshened and bone marrow stimulated. An anchor with 4 free ends of sutures is then implanted (Fig 8). Key technical points such as the patient's position are the same as above.
5. Treatment and delivery of free osteochondral fragment into the articular cavity. The 2 fragments of bone cartilage are taken out, assembled into a complete shape in vitro, and pierced with a Kirschner wire. Each free end of the suture anchor is then threaded through each osteochondral fragment and carefully placed into the joint along their respective anchor sutures for knotting and fixation (Fig 9). It should be noted that the directions of the 2 fragments must be correct.
6. Resetting and fixing of free osteochondral fragment.

Similarly, postoperative recovery and follow-up of patients showed the same effect as traditional techniques.

Table 1. The Pearls and Pitfalls of In Situ Fixation of Osteochondral Fragments on the Weightbearing Area With a Single Anchor

Pearls
We should determine whether the site of osteochondral injury is in the weightbearing area to determine our surgical strategy.
If the fragment is a bit large and likely to get stuck when removing, extend the incision if necessary instead of forcing the fragment out to avoid damaging the fragment.
The place of anchor should be placed on the center of lesion site and vertically. When the angle is difficult to adjust, it can be achieved by knee joint flexion and extension.
Old injuries require more thorough freshening of the fracture surface and stimulation of the bone marrow.
When fixing fragment, it is generally first used to introduce the fragment into the joint and fit the bone bed, and then the knot is finally fixed.
When 2 fragments need to be fixed, it is necessary to splice the shape and determine the location of the sutures before fixing them. Tighten the sutures simultaneously while fixing.
The joint should be flexed and extended to make the osteochondral fragments fit better.
Pitfalls
Exercise caution when removing fragments and drilling to avoid secondary damage.
Clean the soft tissue carefully to avoid incarceration.

Discussion

Osteochondral fracture of the knee usually requires surgical treatment to avoid further damage of the cartilage surface.[5] Unless the fragment is too broken or small, it should be reduced and fixed as much as possible to achieve complete repair. Despite the diverse options for restoration, suture anchor has provided advantages in terms of simplicity and effectiveness. However, suture anchor is often limited in application because of its high-value medical consumables. Therefore it is an important objective for surgical improvement to achieve optimal fixation effect with minimal suture anchors. In traditional surgery for fixing free osteochondral fragments with suture anchors, the

Table 2. The Advantages and Disadvantages of In Situ Fixation of Osteochondral Fragments on the Weightbearing Area With a Single Anchor

Advantages
The technique is minimally invasive and avoids the large incisions of traditional open surgery.
The technique is simple and generally does not require additional approach.
This technique is widely used and can be used in children and adolescents to avoid damage to the epiphysis.
This technique is feasible for fixation of osteochondral or chondral fragments.
This technology has better economy for only 1 suture anchor used.
Disadvantages
Our technique is not suitable for osteochondral injury on the side of the patella.
Large fragments may not be able to be repaired arthroscopically

number of suture anchors is usually more than one.[6] In addition to increasing the economic burden of patients, the application of anchor may further destroy the local mechanical structure, especially for patients with osteoporosis. The above factors will affect the patient's recovery. In this study, we demonstrated the feasibility of using a single anchor to anchor 1 or 2 isolated osteochondral fragments. In our clinical practice, we used an anchor containing 4 free suture ends, which enabled the fixation of 2 free osteochondral fragments. If an anchor with 3 sutures is used in this surgical technique, which has 6 free ends, it is possible to fix at least 3 free osteochondral fragments, which greatly improves the economics of the procedure. It should be noted that the application of the suture anchor in osteochondral fractures of the knee is different from the use of suture anchor in rotator cuff injury repair. In rotator cuff repair, the force received by the suture anchor is an outward pulling force in later rehabilitation, so a certain amount of anchor needs to be fixed firmly. In the surgical technique we introduce, the force received by the suture anchor is an inward squeezing force in rehabilitation along with flexion, extension, and load bearing of the knee joint. Therefore, from the perspective of force analysis, less anchor quantity can be used in osteochondral fracture of knee joint, and the stability can still be maintained. The pearls and pitfalls of our improved technique are shown in Table 1. In general, the repair of free fragments in the weightbearing region has more clinical significance. As it happens, a "pressurizing" effect ensures the stability of the free fragment after the weightbearing zone is repaired. At the same time, the alignment of osteochondral fragments and the splicing of multiple osteochondral fragments are also key to the success of the surgery. The risk of surgical failure is greatly increased if the bone is fractured as a result of surgery. The advantages and disadvantages of our improved technology are shown in Table 2. As summarized in Table 2, economy and simplicity are prominent advantages. However, for osteochondral injuries on the patellar side, our technique may not be appropriate because of the limited operating angle and the inability to generate enough "squeeze" to ensure stability. In conclusion, our improved technique provides a valuable reference for the repair of osteochondral fractures of the knee femur.

References

1. Pérez GM, Barrow B, Krueger V, Cruz AI Jr. Treatment of osteochondral fractures after acute patellofemoral instability: A critical analysis review. *JBJS Rev* 2022;10:e21.
2. Mochizuki Y, Yamamoto N, Noda T, Ozaki T. Application of mesh plate for the treatment of an osteochondral fracture of the medial femoral condyle with medial wall fracture: A case report. *Acta Orthop Traumatol Turc* 2022;56:228-231.
3. Cordunianu MA, Antoniac I, Niculescu M, Paltanea G, Raiciu AD, Dura H, et al. Treatment of knee osteochondral fractures. *Healthcare (Basel)* 2022;10:1061.
4. Wu L, Liu C, Jiang B, He L. Treatment of osteochondral fracture of lateral femoral condyle after patella dislocation with anchor absorbable sutures: A new surgical technique and a case report. *Medicine* 2022;101:e32104.
5. Samitier G, Vinagre G, Cugat R, Seijas R, Barastegui D. One-stage osteochondral fracture repair technique with knotless anchors and interconnected crossing suture sliding loops for the knee. *Arthrosc Tech* 2020;9:e1813-e1818.
6. Goldenberg NB, Nuelle CW. Knotless suture anchor fixation of a traumatic osteochondral lesion of the lateral femoral condyle. *Arthrosc Tech* 2021;10:e2547-e2551.