Technical Note

All-Arthroscopic Treatment of Schatzker Type III Lateral Tibial Plateau Fracture Without Fluoroscopy

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Abstract: Tibial plateau fracture treatment remains challenging for orthopaedic surgeons around the world, especially in case of type III fractures according to the Schatzker classification, which are a pure depression of the lateral tibial plateau. Whereas open surgical procedures are associated with increased soft-tissue trauma because of the extent of the surgical approach and do not always allow for proper visualization of the fracture site, arthroscopic-assisted surgeries have been proven to have benefits over the former in terms of minimizing soft-tissue trauma, improved visual control of the fracture reduction, and the time of recovery. Most arthroscopic techniques, however, require using fluoroscopy. We present an all-arthroscopic procedure for Schatzker type III lateral tibial plateau fractures with using a trans-septal portal for visualization, which does not demand fluoroscopy.

Lateral tibial plateau fractures are very complicated problem that orthopaedic surgeons around the world have to face. Whereas the annual incidence of posterolateral tibial plateau fractures is about 10.3 cases per 100,000 people and concomitant intraarticular lesions, such as cruciate ligament tears or lateral meniscus (LM) tears, occur in 36% and 48%, respectively, a complex management must be applied to avoid post-operative significant disability.[1,2] The main goals for surgical treatment in such cases are to re-establish the knee joint stability, recreate proper knee alignment, restore joint congruity, and allow for early knee range of motion (ROM).[3] These objectives can be achieved with both open surgical procedures and minimally invasive approaches. Classic anterior and posterior approaches cause significant trauma to the soft tissues around the knee and are associated with the necessity of common peroneal nerve dissection and sometimes a fibular head osteotomy.[4] Moreover, they usually provide for a sub-optimal visualization of the posterior column of the tibia, what makes the proper identification, reduction, and stabilization of the fragment difficult, especially in case of Schatzker type III fractures.[5] For this specific articular depression of the lateral tibial plateau, arthroscopy-assisted surgeries were developed.[3,6-8] They allow one to avoid a majority of the limitations and risks of open surgeries, but most of them require fluoroscopy and hardware placement for fracture reduction and fixation. We present all-arthroscopic technique for the treatment of Schatzker type III tibial plateau fracture involving stabilization with biocomposite screws and visualization through a trans-septal portal, which makes the use of fluoroscopy unnecessary.

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Diagnosis

The diagnosis of a Schatzker type III lateral tibial plateau fracture is based upon anteroposterior and lateral radiographs and clarified with computed tomography scans. Magnetic resonance imaging is performed to evaluate additional intraarticular lesions (Fig 1).

Surgical Technique

Indications

Patients had to have a type III tibial plateau fracture according to the Schatzker classification. Type II tibial plateau fracture had additional fixation with a lag screw needed.

Contraindications

Comminuted tibial plateau fracture; Schatzker type I, IV, V, and VI fractures; the extent of the skin injury with indications to use external fixation; compartment syndrome; passive knee flexion < 100°; and an unstable patient condition.

Patient Positioning

The surgery can be performed under regional or general anesthesia. The patient is positioned supine with a high padded nonsterile thigh tourniquet on the operated leg, which is placed in a leg holder. Knee range of motion of at least 0° to 110° should be achieved. The leg is then draped and prepared in a sterile fashion.

Diagnostic Arthroscopy, Mid-Lateral, and Trans-Septal Portal Creation

The diagnostic arthroscopy is performed with 30° arthroscope (Arthrex) through standard anterolateral and anteromedial portals. When the diagnosis of a

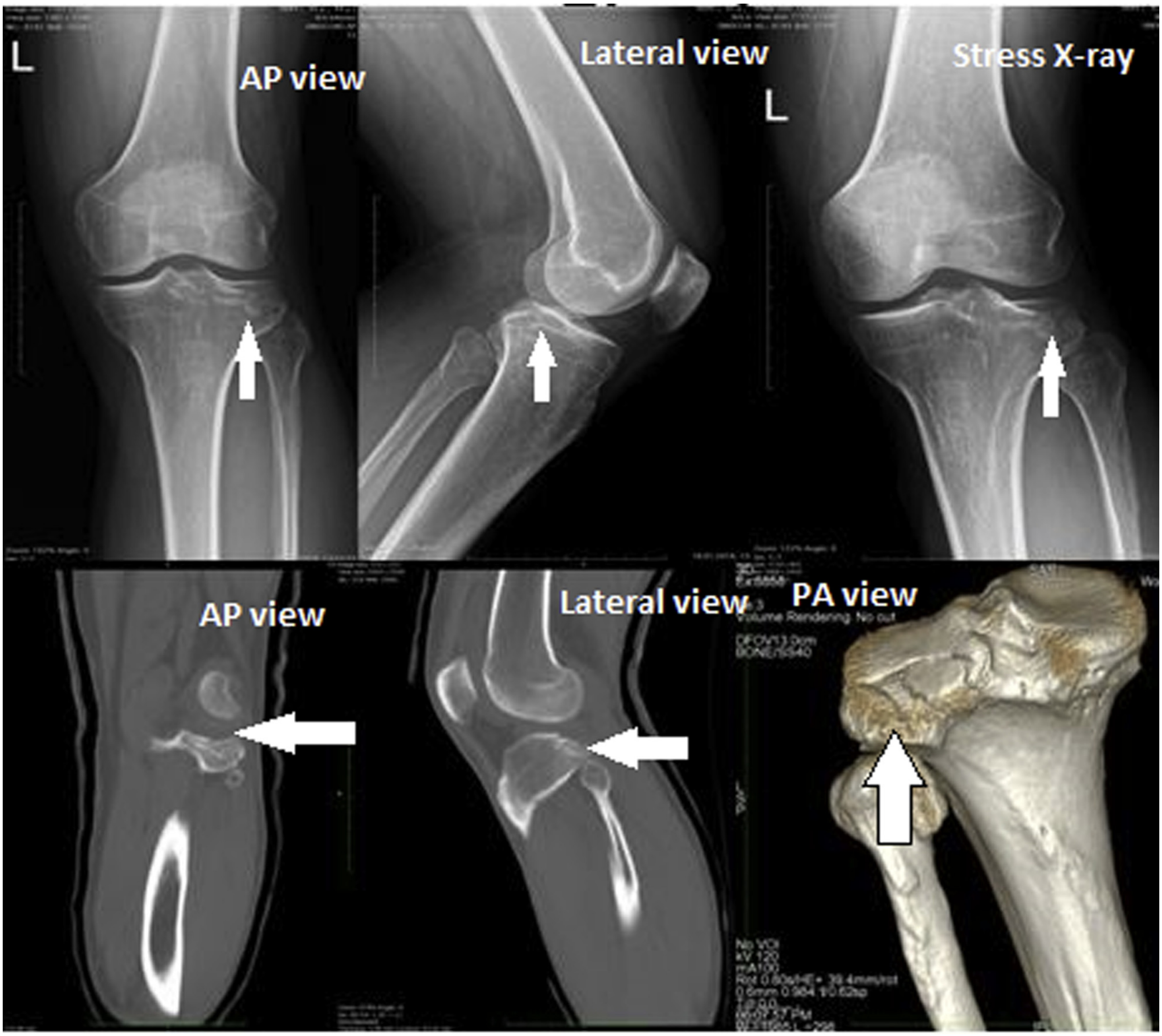

Fig 1. Left knee type III lateral tibial plateau fracture on anteroposterior and lateral radiographs, frontal and sagittal computed tomography scans, and 3-dimensional reconstruction. White arrows present the posterolateral tibial plateau depression. (AP, anteroposterior; L, left; PA, posteroanterior.)

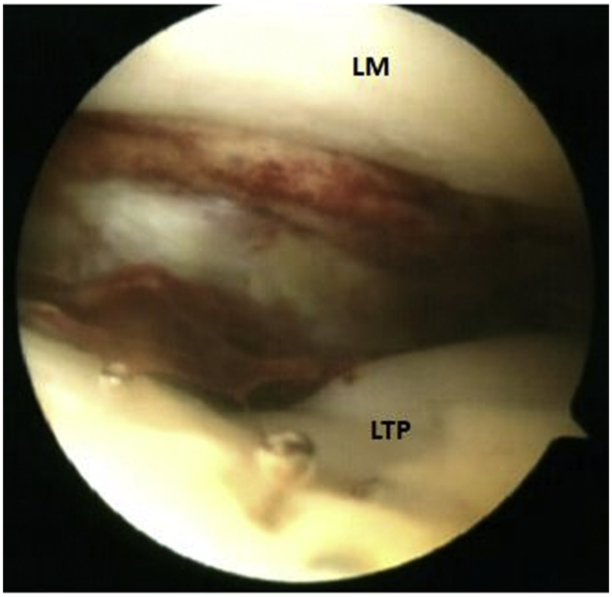

Fig 2. Arthroscopic view from the anterolateral viewing portal in the left knee. The depression of the posterolateral part of the lateral tibial plateau (LTP) just below the lateral meniscus (LM) is visualized. The diagnosis of type III lateral tibial plateau fracture is confirmed. (LM, lateral meniscus; LTP, lateral tibial plateau.)

posterolateral tibial plateau depression fracture is confirmed (Fig 2, Video), concomitant intraarticular lesions must be excluded. If these lesions are found, they should be addressed and treated first. Then, an additional mid-lateral working arthroscopic portal is made to achieve better access to the posterolateral tibial plateau (Fig 3, Video).[9] The portal is located 1.5 cm proximal to the fibular head and 1 cm anterior to the lateral collateral ligament and is made under direct visualization. Then, the arthroscope is introduced to the posteromedial compartment using the trans-notch maneuver and the posteromedial portal is created under visual control in the soft spot between the posterior oblique ligament and the medial edge of the medial head of gastrocnemius with a spinal needle and No. 11 surgical blade (Fig 4A, Video). The instrument cannula (Arthrex) is introduced to maintain the portal and facilitate maneuvering (Fig 4B, Video). Through the cannula, a radiofrequency (RF) probe (Smith & Nephew) is introduced and positioned under visual control in a safe area of the posterior septum, right posterior to the posterior cruciate ligament, with the working side directed anteriorly (Fig 5, Video). Then, the arthroscope is positioned back and inserted into the posterolateral compartment through the area between the lateral margin of the anterior cruciate ligament and the posterior horn of the LM. This maneuver should be easier to perform with the leg in a figure-of-4 position. Now, the RF probe, previously positioned in the safe posterior septum area, is used to create the trans-septal portal (Fig 6, Video). Then, the arthroscope is introduced through the cannula in the posteromedial portal and through the trans-septal portal to the posterolateral compartment (Video). For the next step, the posterolateral portal is created in the soft spot between the lateral collateral ligament and the lateral edge of the lateral head of gastrocnemius. The RF probe is introduced and used to perform a partial lateral capsulotomy, extending from the hiatus popliteus to the lateral margin of the lateral tibial plateau at the level of the posterior third of the LM, which allows for proper visualization of the lateral and posterior tibial cortex (Fig 7, Video). In this way, comfortable access to the posterolateral tibial plateau is achieved with the trans-septal viewing portal and posterolateral and mid-lateral working portals.

Fracture reduction and stabilization

With arthroscopic visualization through the trans-septal portal, a bone chisel (Conmed) is introduced through the mid-lateral portal, posterior to the popliteus tendon, and inserted into the bone 1.5 cm distal to the joint line to mobilize the posterolateral fragment (Fig 8, Video). Then, the bone chisel is introduced through the posterolateral portal and inserted under the posterolateral fragment 1.5 cm distal to the joint line and used to elevate the fragment (Fig 9, Video). The arthroscope is inserted through the anterolateral viewing portal to assist with control of the fracture reduction (Fig 10, Video). When the articular surface correction is satisfying, the arthroscope is introduced again through the trans-septal portal for visualization of

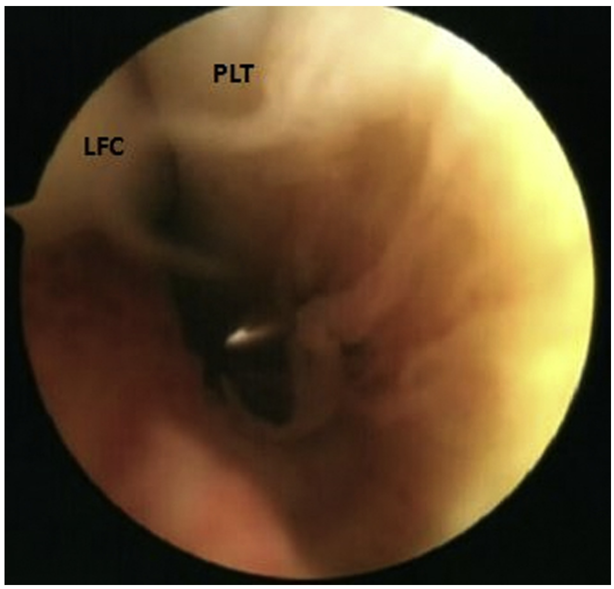

Fig 3. Arthroscopic view from the anterolateral viewing portal in the left knee. The arthroscope is introduced into the lateral recess. An additional mid-lateral working portal is created with a needle and surgical blade to achieve better access to the lateral part of the tibia. (LFC, lateral femoral condyle; PLT, popliteus tendon.)

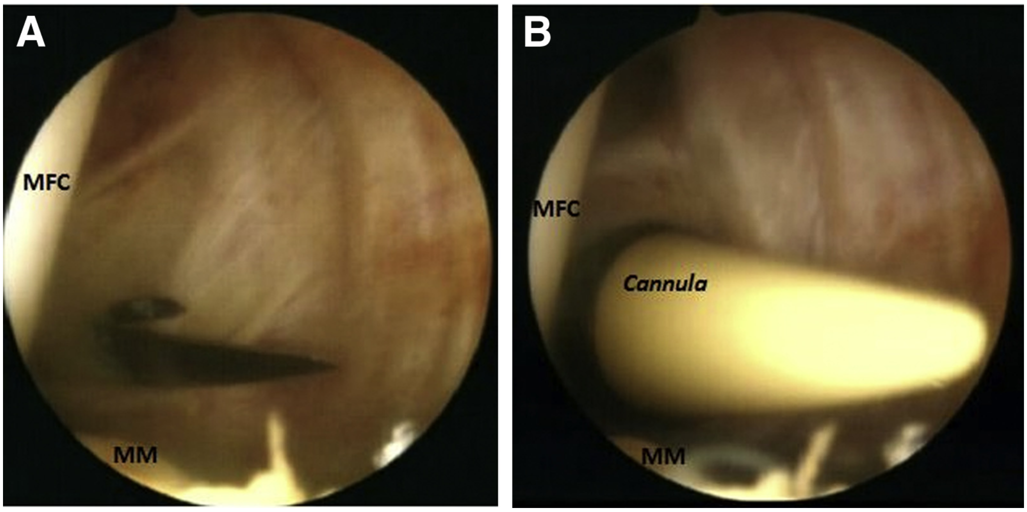

Fig 4. Arthroscopic view from the anterolateral viewing portal on the posteromedial compartment in the left knee. Trans-notch maneuver. An additional posteromedial portal is created with a spinal needle and (A) surgical blade and the (B) instrument cannula is introduced to maintain the portal and facilitate visualization. (MFC, medial femoral condyle; MM, medial meniscus.)

the posterolateral part of the tibia. Through the posterolateral portal, the aiming wire is introduced into the bone gap and the first BioComposite Interference Screw (Arthrex) matched to the size of the bony defect is placed underneath the posterolateral fragment (Fig 11, Video). Next, with arthroscopic visualization through the anterolateral portal, the aiming wire is introduced through the mid-lateral portal into the bone gap, and the second BioComposite Interference Screw (Arthrex), matched to the size of the bony defect, is placed underneath the posterolateral fragment, from the lateral side (Fig 12, Video).

The results of surgery are controlled with the arthroscope and imaging (Fig 13, Video).

Rehabilitation

The rehabilitation protocol involves using a continuous passive motion machine for 30 minutes 6 times

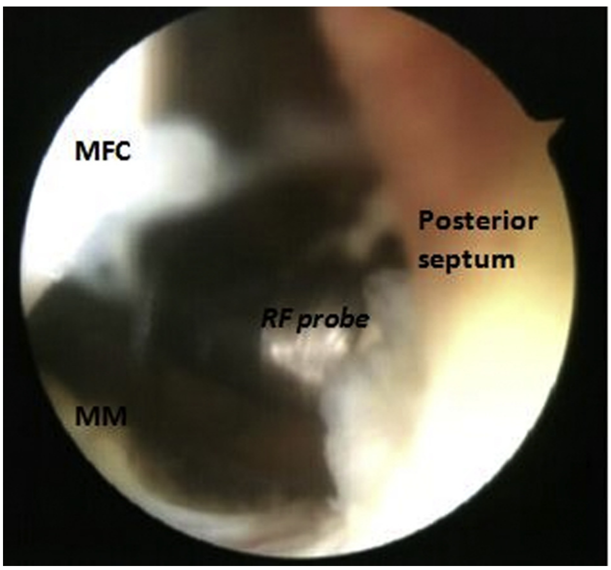

Fig 5. Arthroscopic view from the anterolateral viewing portal on the posteromedial compartment in the left knee. Trans-notch maneuver. The radiofrequency probe introduced through the cannula into the posteromedial portal is placed into the safe area of the posterior septum with the working edge directed anterior to the popliteal neurovascular bundle to avoid its injury during making a trans-septal portal. (MFC, medial femoral condyle; MM, medial meniscus; RF, radiofrequency.)

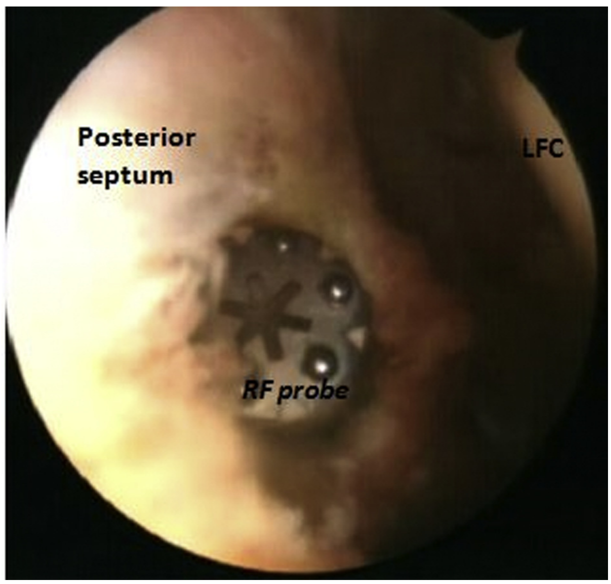

Fig 6. Arthroscopic view from the anterolateral viewing portal into the posterolateral compartment in the left knee. Trans-notch maneuver. The radiofrequency probe previously positioned in a safe area on the medial wall of the posterior septum is used to create a trans-septal portal. (LFC, lateral femoral condyle; RF, radiofrequency.)

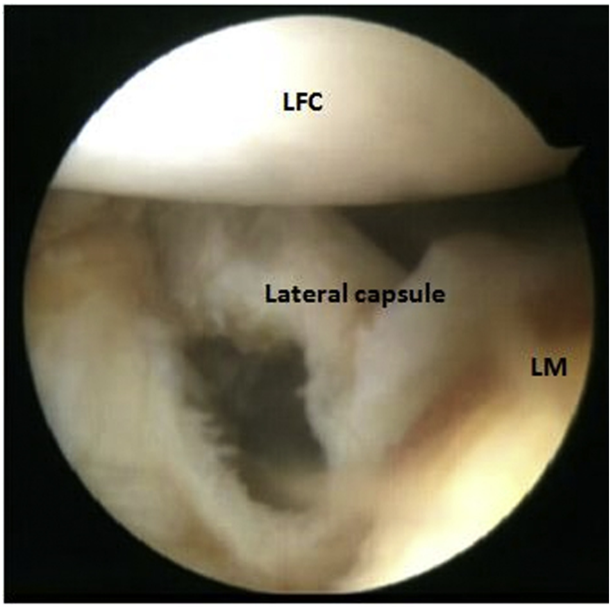

Fig 7. Arthroscopic view from the trans-septal portal into the posterolateral compartment of the left knee. A partial lateral capsulotomy performed from the posterolateral working portal achieves better access to the posterolateral part of the tibia. (LFC, lateral femoral condyle; LM, lateral meniscus; RF, radiofrequency.)

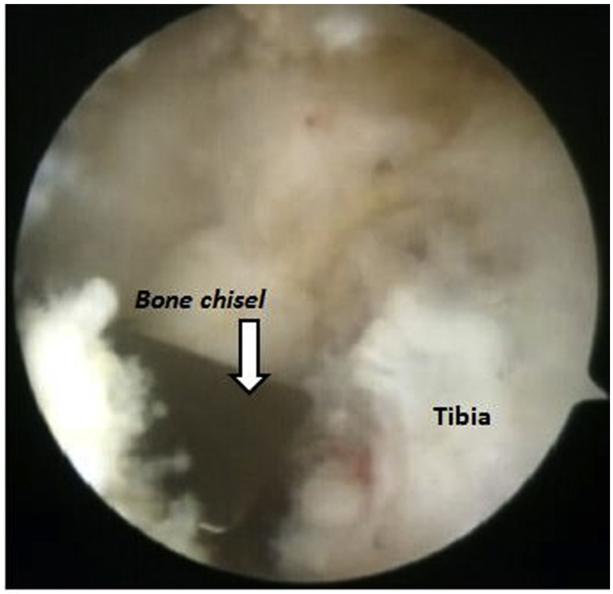

Fig 9. Arthroscopic view from the trans-septal portal into the posterolateral part of the left tibia. The bone chisel introduced through the additional posterolateral working portal is used to elevate the posterolateral fracture fragment of the tibia. The whole fragment is mobilized and can be reduce under visual control.

per day for 9 weeks with progressively increasing the flexion angle to no more than 90° before the sixth week. Walking on crutches for 9 weeks with progressive weight-bearing from the fourth week is recommended. Manual therapy begins after the third postoperative day.

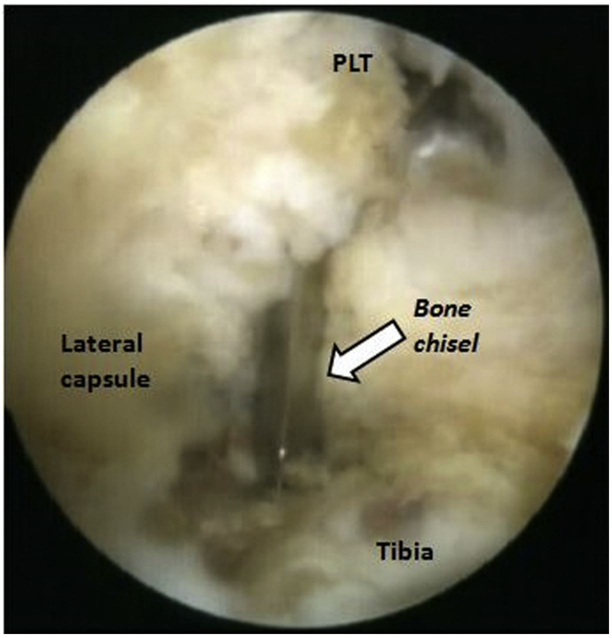

Fig 8. Arthroscopic view from the trans-septal portal on the posterolateral part of the left tibia. The bone chisel introduced through the additional mid-lateral working portal is used to mobilize the posterolateral fracture fragment of the tibia. The mobilization is essential for a proper reduction of the fracture in the next steps. (PLT, popliteus tendon.)

Fig 10. Arthroscopic view from the anterolateral viewing portal in the left knee. Visual control is achieved during fracture reduction and articular surface correction. It is essential not to overcorrect the fracture to avoid excessive loads on the lateral compartment. (LM, lateral meniscus; LTP, lateral tibial plateau.)

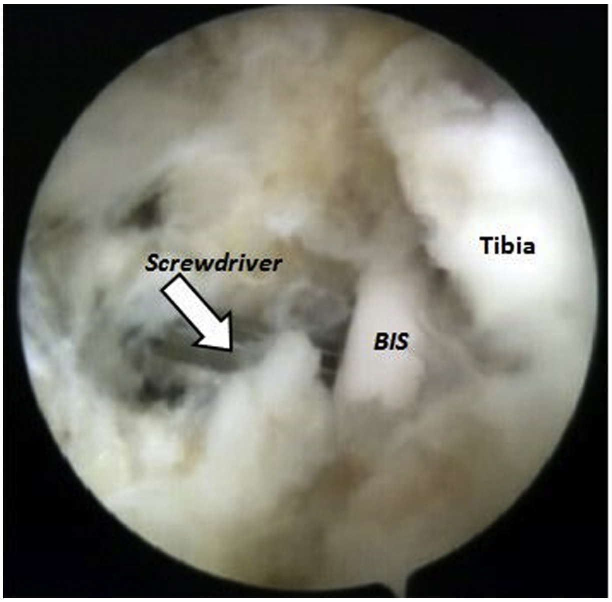

Fig 11. Arthroscopic view from the trans-septal portal on the posterolateral part of the left tibia. The BioComposite Interference Screw introduced through the posterolateral working portal is placed into the bony defect underneath the posterolateral fracture fragment of the lateral tibial plateau. It plays a role of a buttress for bony fragment as well as a material to fulfill the bony gap created during mobilization and fracture reduction. (BIS, BioComposite Interference Screw.)

Discussion

The presented technique, as an arthroscopic procedure, provides benefits characterized for minimally invasive approaches. It allows for excellent visualization of the lateral tibial plateau fracture site and visual control of reduction, limits the soft-tissue trauma around the knee, facilitates introducing early free ROM and reduces the time of recovery. Furthermore, some specific risks for particular open surgical approaches, such as common peroneal nerve injury, anterior tibial artery injury, proximal tibiofibular joint instability, residual posterolateral instability, or meniscotibial detachment can be avoided.[4,5] Another important fact is that arthroscopic procedures for tibial plateau fractures have been proven in mid-term observations to be safe, reproducible, and effective techniques that enable treatment of the fracture and concomitant intraarticular lesions in a 1-stage procedure.[10]

Some specific features differentiate our technique from other arthroscopic procedures. First, most of them require drilling a canal in the proximal tibia and using a K-wire, a bone tamp, or an inflatable balloon for fracture reduction and correction of the articular depression of the posterolateral tibial plateau.[3,6-8] This technique makes the fracture reduction possible only when the special anterior cruciate ligament aiming guide is available and has a risk of iatrogenic articular cartilage lesions and displacement of the fracture fragment into the joint.[11] Direct visualization through the trans-septal portal and creating additional mid-lateral and posterolateral working portals facilitate a comfortable access to the posterolateral fragment and gives us a chance for more precise, in comparison to other techniques, fracture reduction with a bone chisels. Second, in our technique no titanium implants are used for fracture stabilization. In the current presented procedure, 2 BioComposite interference screws of an appropriate size are placed into the bony defect underneath the posterolateral fracture fragment. These screws have a dualistic role as a support to maintain the fracture reduction and as a firm stabilized material to fill the bony defect developed during posterolateral fragment elevation. The former allows the avoidance of any titanium or metal implants placement, whereas the latter makes it possible to evade graft harvesting; for example, fibular shaft or iliac crest graft, for bony defect fulfillment, which always has a potential risk of donor site morbidity.[11] Another advantage of the current presented technique is that precise fracture reduction can be achieved without using fluoroscopy, which eliminates the risk of radiation exposure. It is of benefit not only for the patient, but also for the medical staff working in the operating room.[8]

On the other side, there are also some limitations to the presented technique. It requires advanced surgical skills and some experience in arthroscopic posterior knee surgeries, especially for trans-septal portal formation. In

Fig 12. Arthroscopic view from the anterolateral viewing portal in the lateral recess of the left knee. The second BioComposite Interference Screw (Arthrex) is introduced through the additional mid-lateral working portal in the bony defect underneath the posterolateral fragment of the lateral tibial plateau. The whole mobilized and reduced bony fragment is now stabilized. (BIS, BioComposite Interference Screw; PLT, popliteus tendon.)

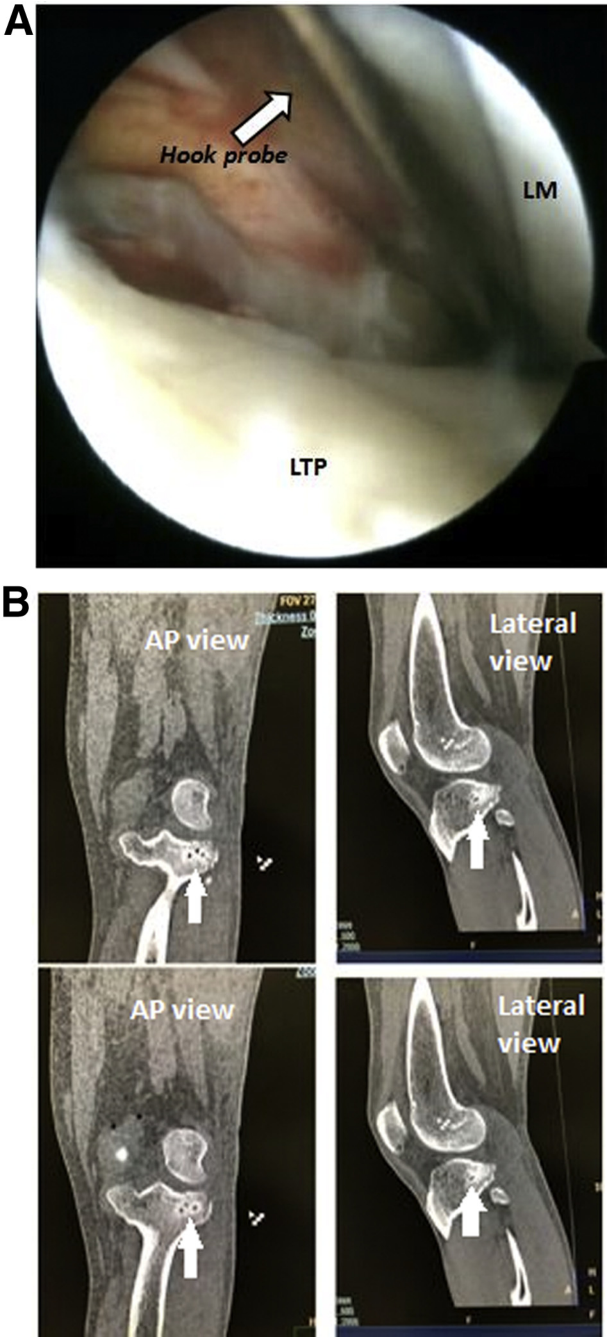

Fig 13. (A) Arthroscopic view from the anterolateral viewing portal in the left knee. The result of all-arthroscopic type III lateral tibia plateau fracture reduction and stabilization. (B) Anteroposterior and lateral computed tomography scans reveal healed fracture with good posterolateral fragment reduction 2 months after all-arthroscopic type III lateral tibial plateau fracture treatment. White arrows show BioComposite Interference Screws, which were used for fracture stabilization. (LM, lateral meniscus; LTP, lateral tibial plateau.)

this stage of surgery, a realistic risk of popliteal neurovascular bundle injury exists. To reduce this risk, the RF probe is placed in a safe area under visual control with the working edge of the probe directed away from the popliteal structures. Moreover, because with the partial lateral capsulotomy, the risk of compartment syndrome increases, the arthroscopic pump pressure should not be too high, about 40 mm Hg in the presented case. There is also a risk of overcorrection of the lateral tibial plateau depression; to avoid this risk, the articular surface should be visualized with the arthroscope introduced through the anterolateral viewing portal during posterolateral fragment elevation.

Advantages and disadvantages of the technique described here are summarized in Table 1.

Table 1. Advantages and Disadvantages of All-Arthroscopic Treatment of Type III Lateral Tibial Plateau Fracture Without Fluoroscopy

Advantages	Disadvantages
Minimal invasiveness: reduced soft-tissue trauma and time of recovery, minimal risk of common peroneal nerve and anterior tibial artery injury, and no need for meniscus detachment	Some experience in posterior knee surgery necessary, especially during trans-septal portal creation
Direct visualization of fracture site	The risk of popliteal neurovascular bundle injury
Visual control of fracture reduction and stabilization	The risk of compartment syndrome
Comfortable access to the posterolateral fragment of the tibia	The risk of overcorrection
No need for special instruments	
BioComposite interference screws as a buttress for posterolateral fragment and firm stabilized material to fulfill bony defect	
No need for autograft harvesting	
No need for fluoroscopy, which provides patient and staff protection against radiation	

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