Arthroscopic Wire Fixation of Avulsion Fractures of the Posterior Cruciate Ligament from the Tibia

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Background:
Avulsion fractures of the posterior cruciate ligament (PCL) from the tibia need surgical intervention. Open reduction and internal fixation with cannulated screw has extensive soft tissue damage and difficulties in screw removal. Arthroscopically assisted fixation techniques from literatures were variance and the results were not consistency. This study is to retrospectively evaluate the clinical results of arthroscopically assisted reduction and wire loop fixation of avulsion fractures of the PCL from the tibia.

Material and method:
June 2009 to March 2015, 15 patients with PCL tibia insertion avulsion fracture underwent arthroscopic reduction and modified figure eight wire loop fixation. The mean age was 30.8 years. The mean period between the injury and operation was 9.5 days. Surgical technique: Spinal anesthesia, supine position with knee in 90 degree of flexion. Apart from anterolateral and anteromedial portals, a posteromedial portal was established routinely. After resection of posterior septum, two parallel 2.5 mm tibial tunnel were created by using the posterior cruciate ligament tibial tunnel drill guide. The locations of tunnels were separated and inferior to the fracture fragment; A 1.6mm wire was passed in front of the ligament-bone junction of PCL avulsion fragment, the two ends of wire crossed the surface of the avulsion fragment, then passed into tibia tunnels respectively, tightened the wire in the anterior cortex of tibia. Muscle excise and range of movement training started immediately after surgery, however, the full weight bearing only allowed after 6-weeks. The post-operation stress x-ray, posterior drawer test and IKDC Score were used to evaluate objective and subjective improvements.

Results:
No surgical complications were noticed. 13 patients underwent review, the mean follow-up period was 22.3 months. No objective PCL laxity was noticed from the post-operation stress X-ray. 1 out of 13 patients had occasional residual pain but no need regular pain killers and resolved within 6 months. 12 out of 13 patients regained full range of motion at 8th week. One got limited motion within 3 months but regained full range at 6 months. All had negative posterior drawer test. Mean IKDC score was 67.5. 9 out of 13 patients had wire removal. All patients rated themselves returned to pre-injury functional level.
Discussion: Although several techniques had been used to treat the avulsion fracture of PCL from the tibia, such as screw, sutures, wires, however, for the small and comminuted PCL bony fragments remained difficulties in fixation. Our technique adopts the figure eight wire loop in which the small and comminute PCL avulsion fragments can be pressed down and hold in place by the loop. The wire loop was sitting in front of the PCL ligament and bony fragment junction. The stiffness property of wire can sustain the tension as long as the wire was tightened. The clinical follow up showed no loosening of fixation and no cutting out of wire through the bony fragments.

Conclusion: Arthroscopically assisted wire loop fixation of avulsion fractures of PCL from the tibia can achieve satisfactory clinical results during the long-term follow-up in terms of the range of motion and knee stability.
Which position of femoral tunnel is better in single bundle PCL reconstruction?  
Higher vs lower in 3D-CT

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Background: The purpose of this study was to compare the clinicoradiological results according to femoral tunnel position using three-dimensional computed tomography (3D-CT) in arthroscopic single-bundle PCL reconstruction.

Materials and Methods: Eighteen knees that underwent primary arthroscopic single-bundle PCL reconstruction between October 2010 and September 2014 for an isolated PCL rupture were retrospectively evaluated with a minimum 1–2 year follow-up. The patients were divided into higher (n = 10) and lower (n = 8) femoral tunnel position groups. The quadrant method was used with postoperative 3D-CT to verify femoral tunnel position. Range of motion (ROM), International Knee Documentation Committee (IKDC) score, Lysholm knee score, and the Tegner activity score were compared between the two groups as a clinical evaluation. Preoperative and postoperative stress radiographs using the Telos stress device were used to assess anteroposterior instability.

Results: No differences were found in ROM, IKDC score, Lysholm knee score, or Tegner activity score between the two groups at the last follow-up. No differences were found in the posterior drawer test between the groups, but the side-to-side difference in posterior translation was 3.8 ± 2.2 mm in the higher and 2.0 ± 1.4 mm in the lower group (mean difference, 1.8 mm; p = 0.037).

Discussion and Conclusion: A higher femoral tunnel position resulted in better anteroposterior stability than that of the higher position in single bundle PCL reconstruction. However, it was unclear whether the lower femoral tunnel position was clinically superior to the higher femoral tunnel position.
A Study of Tibial Osseous Tunnel intersection When Reconstruct PCL and POL Simultaneously

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Background: When simultaneous reconstruction of the Posterior Cruciate Ligament (PCL) and Posterior Oblique Ligament (POL) is necessary, tibial tunnel intersection is a serious concern and its avoidance can be a technically challenging endeavor.

Material: A three-dimensional image from a single cadaveric limb was created.

Methods: A transtibial PCL reconstruction was simulated with two tibial tunnel entry points; one with the PCL tunnel centered directly within the native fovea, the second with the tibial tunnel placed in the posterior half of the fovea. Both tunnels were set to be 10mm in diameter and 50° of the joint line in the sagittal plane. Two different geometries of POL tunnels were then simulated within each of these PCL models; one utilizing a continuous “cylindrical” tunnel, and one utilizing a differentially reamed “grenade” shaped tunnel. Utilizing a coronal plane along the posterior tibial condyles as a reference, we then noted the degree of angle(s) at which the POL tunnel would intersect the PCL tunnel. We also noted the POL tunnel relationship with respect to Gerdy’s tubercle and the tibial tubercle.

Results: With the PCL tunnel centered directly in the fovea, PCL tunnel intersection occurred at angles \( \leq 26° \), and tibial tubercle violation occurred at angles \( \geq 28° \) with a “cylindrical” shaped POL tunnel. With a “grenade” shaped tunnel these values were \( \leq 24° \) and \( \geq 29° \) respectively. When the PCL tunnel was placed in the posterior half of the fovea these values were \( \leq 18° \) and \( \geq 29° \) with a “cylindrical” shaped POL tunnel; and \( \leq 17° \) and \( \geq 28° \) with a “grenade” shaped tunnel.

Discussion: Our study indicated that when reconstructing the PCL and POL simultaneously, utilizing a transtibial technique, there is an extremely small margin of error when drilling the POL tunnel. The reconstructive technique that provided the largest margin of error to prevent PCL tunnel intersection and tibial tubercle violation was use of a PCL tunnel centered in the posterior half of the fovea and either geometry of POL tunnel. This combination provided a safe zone of approximately 11°. Given the difficulty of referencing tunnel direction off of the posterior tibial condyles intraoperatively, we recommend that the POL tunnel start just off of the medial edge of Gerdy’s Tubercle and be aimed towards the lateral edge of the tibial tubercle. Our model suggests that utilizing these easily identifiable landmarks would likely keep the trajectory of the POL tunnel within the above-described safe zone.

Conclusions: Drilling the PCL tibial tunnel in the posterior half of the fovea and utilizing a POL tunnel starting off of the medial edge of Gerdy’s tubercle and exiting anteriorly just lateral to the tibial tubercle is the most effective reconstruction technique to minimize tunnel intersection.
The effect study of Arthroscopic reconstruction of posterior cruciate ligament with ligament advanced reinforcement system Y-shape double bundles artificial ligament

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Abstract:
Background: ligament advanced reinforcement system is a graft choice for ligament reconstruction, we used ligament advanced reinforcement system Y-shape double bundles to reconstruction the posterior cruciate ligament, it's necessary to know the clinical effect of this technique.
Method: A retrospective analysis was conducted among 11 patients with posterior cruciate ligament injuries, who were enrolled from Department of Orthopaedics in Guangzhou General Hospital of Guangzhou Military Area Command of Chinese PLA from January to July in 2007. Arthroscopic reconstructions of posterior cruciate ligament were performed by using the ligament advanced reinforcement system (LARS) Y-shape bundles artificial ligament. Y-shape double cords of LARS artificial ligament were fixed at 90°and 30° flexion respectively. All 11 patients received the follow-ups.
Result: There were no complications occurred, such as synovitis, ligament rupture or limited motion. X-ray results proved the extruded screws were positioned well. Posterior drawer test, Lachman’s test and pivot shift test were negative after surgery. According to the international knee documentation committee activity grades, grade D were 8 cases and grade C were 3 cases preoperatively; while grade A were 10 cases and grade B was 1 case postoperatively, with the significant differences ($\chi^2=9.142$, $P < 0.05$). The clinical assessment judging by lysholm knee functional scoring system showed that, average scores before operation was (65.2±5.6) and increased to an average of (90.7±3.6) postoperatively ($t=10.572$, $P < 0.05$).
Conclusion: LARS artificial ligament is good grafts for posterior cruciate ligament reconstruction, can do early functional exercise and have good clinical effect.

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Remnant augmentation technique with LARS or autologous hamstring graft to early reconstruct posterior cruciate ligament

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Objective: To prospectively research the treatment results of posterior cruciate ligament injury using remnant augmentation technique with LARS ligament or autologous hamstring tendon for substitute.

Methods and materials: 62 cases of PCL injury were randomly allocated into LARS group and autologous hamstring tendon group, involving independent PCL injury in 20 cases, PCL with medial meniscus injury in 8 cases, PCL with ACL injury in 18 cases, PCL with medial collateral ligament injury in 7 cases, PCL with posterolateral structure injury in 9 cases. The LARS reconstruction was used in 35 cases, autologous hamstring tendon reconstruction in 27 cases. The remnant and synovium of PCL were preserved in both groups.

Results: Immediate stability was achieved after operation in all cases, with confirmation of anterior and posterior drawer test (-). No complications such as healing problem, intraarticular infection and synovitis occurred. The average follow-up time was 27 months, and the LARS group had significantly sooner return to daily sports than autologous substitute group. The Lysholm score of latest examination were significantly higher than preoperative data in both groups, however no statistical difference between two groups (87\pm 3.5 vs. 48.6\pm 3.6, P < 0.01 for LARS group and 83.4\pm 2.3 vs. 51.2\pm 3.8, p<0.01 for autologous substitute group).

Conclusion: The abundant blood supply confers a good self healing capability of PCL. Early reconstruction should be recommended for acute or subacute PCL rupture, especially when associated with other ligament injury. The reconstructed substitute was parallel with ruptured ligament and restored the knee stability, actually working
as “external fixator” for PCL remnant to facilitate the healing procedure. Furthermore, the remnant augmentation technique does not need debridement of PCL stump from posterior portal. LARS artificial ligament merits at shorter surgery longevity, sooner recovery and less invasive than autologus grafting, thus should be considered as an encouraging substitute for multiple ligament injury.
The discrepancy between clinical signs and subjective symptoms in patients with posterior cruciate ligament injury examined using gait analysis and surface electromyography

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[Purpose]
Patients with posterior cruciate ligament (PCL) injury often lack subjective symptoms, even though posterior instability of the knee joint can be shown on clinical evaluation. We have previously performed gait analysis of patients with isolated PCL damage, and reported decreased posterior tibial movement and increased external tibial rotation during one gait cycle, but we could only estimate the muscular compensation involved in these mechanisms, and so we were not able to elucidate the difference between clinical results and subjective symptoms. Therefore, in this study, we investigated the influence that PCL damage has to the knee joint and lower limb muscle activity during gait.

[Methods]
We evaluated six patients with unilateral isolated PCL damage (PCL group) and compared them to 10 physically unimpaired participants. Study participants walked 10 m at an optimum speed while measurements were recorded using a three-dimensional movement analysis device (VICON MX) and surface electromyography (EMG; ME6000). The kinematic data calculated knee joint flexion angles and tibial rotation angles, before and after tibial movement during one gait cycle, quantified using the Point Cluster method. Surface EMG examined the medial and lateral heads of the gastrocnemius muscle (GM, GL), the medial and lateral hamstring muscles (MH, LH), and the vastus medialis and lateralis muscles (VM, VL), and calculated the activity latency before and after the activity of each muscle during one gait cycle.

[Results]
The PCL group showed a decrease in the knee joint flexion angle and an increase external tibial rotational displacement in comparison to the physically unimpaired group. Additionally, the PCL group showed an increase in the muscle activity of the VM and VL and a shortened activity latency.
of the VL before heel grounding, while the GM and GL showed a shortened an increase in their active mass after heel grounding.

[Discussion]
A decrease in knee joint flexion and an increase external tibial rotational displacement during walking were seen in the PCL group, and it is thought that this kinematic change during walking decreases knee joint instability. In addition, this current study proved that the VL and gastrocnemius muscles compensate earlier and to a larger extent during walking to induce stability of the PCL-damaged knee joint.
Arthroscopic-Assisted Posterolateral Corner Reconstruction of the Knee: Our Technique, Classification, Surgical Algorithm, and Midterm Results

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Arthroscopic-Assisted methods allow more definite assessment of anatomic landmarks, less limitation of range of motions, and less risk of arthrofibrosis, thus they favourably provide the most visualization with the least site morbidity. The aim of this study is to introduce a new arthroscopic method to reconstruct the Popliteus tendon. The minimally invasive technique introduced is performed through the postero-patellar corner (PLC) of the knee to reconstruct the posterolateral rotary instability (PLRI) of the knee.

39 patients (8 females, 31 males) with PLC injury and normal knee alignment have undergone arthroscopic Popliteus tendon reconstruction. Among them 27 patients had combined ACL and PLC injuries and 9 had been involved in PCL and PLRI. In 3 of them, injuries involved ACL, PCL and PLC. Physical examinations, imaging and arthroscopic evaluations were performed to evaluate instability stages. In the case of grade I instability, when the Popliteus tendon had not been injured, they were treated by modified Larson Technique, using Semitendinosus Autograft. If injury was evaluated as grade II, involving the Popliteus tendon component, arthroscopic reconstruction of the Popliteus tendon was the preferred technique. In the event of grade III, the arthroscopic Popliteus tendon reconstruction and the modified Larson Technique were applied concurrently.

All patients were followed up for 58 ± 1 months postoperatively. Varus and external rotation instabilities were restored with arthroscopic PLC reconstruction. All patients had gained near normal knee stability and significant improvements in the level of pain and performing activities of daily living. In cases of varus the external rotation and the reverse pivot shift were improved substantially. There were no cases of arthrofibrosis and/or limitations in the knee motions.

In this study, the novel arthroscopic procedure for reconstruction of the PLC has been accompanied with less morbidity and preserving the native intact structures. The probability of a neurovascular injury has been minimized and there was no case of infection or arthrofibrosis in short term and long term follow-ups. Our findings proved that the combination of Popliteus tendon reconstruction and the modified Larson Technique has favourite results in grade III instabilities. We have shown in a relatively large number of patients and long term multi-phase follow ups that functional static and dynamic stability have been achieved in almost all cases tracking by IKDC scores in multi-stage assessments.
Dual-plane High Tibial Osteotomy to treat the Posterolateral Corner Injuries combined with Varus Deformity of knee joint

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Background
The dual-plane high tibial osteotomy can be use not only to correct the varus deformity but also to adjust the tibial slope. This will be better to improve the stability of knee joint. This paper introduced the preoperative planning, surgery technique and clinical results of the high tibial osteotomy to treat the posterolateral corner injuries combined with varus deformity.

Method
From 2008 to 2015, there were 12 patients (13 knees) underwent the high tibial osteotomy. All the patients were double or triple varus knee combined with posterior cruciate ligament (PCL) and posterolateral corner (PLC) injuries. The weight-bearing full length x-ray was performed before the surgery to calculate the open angle needed to correct the varus deformity. During the surgery, the alignment of the lower extremity was set to 62.5% position of the tibial plateau. When the osteotomy plane was confirmed, two k-wire was drilled into the tibia navigated with the drill guide to mark the plane of osteotomy. To improve the posterior stability and diminish the hyperextension, the tibial slope should be increased. Full-length weight bearing x-ray, stress graph and Opticknee gait analysis system were used for pre- and post-operative evaluation.

Results
The femoral-tibial angle was $172.7°±3.8°$ preoperatively and improved to $177.2°±4.9°$ postoperatively, $p=0.037$. The mechanical axis of the lower extremity was corrected from $21.5% ± 14.0%$ preoperatively to $38.5% ± 18.5%$ postoperatively, $p=0.004$. The tibial slope was increased from $7.5°±4.5°$ preoperatively to $14.5°±3.8°$ postoperatively, $p=0.018$. There was no limited of range of motion in knee joint. 61.5% patients had sufficient improvement in knee function that a subsequent posterolateral corner reconstruction was not necessary.

Conclusions
The dual-plane medial open high tibial osteotomy can improve the alignment of the lower extremity. 61.5% patients do not need a staged posterolateral corner reconstruction.
Patient-Reported Outcomes Following Surgical Treatment for Multiligament Knee Injuries

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[Background] Surgical treatment has been recommended for multiligament knee injuries. However, the most effective treatment or timing for multiligament knee injuries remains variable and controversial. The purpose of this study was to evaluate the patient-reported outcomes following surgical treatment for multiligament knee injuries using the Knee injury and Osteoarthritis Outcome Score (KOOS).

[Patients] From January 2004 to February 2014, 40 patients with multiligament knee injury underwent surgical treatment in our institution. Twenty-four patients (16 males and 8 females) with KD III according to Schenck’s classification (medial or posterolateral injury and biconcuate ligament injuries) were involved in this study. The mean age at the time of surgery was 48.8 years (range, 14 to 80 years). The mean follow-up was 32.8 months.

[Methods] Patients were treated with one of the following 3 fashions, (1) primary repair group of medial collateral ligament including posteromedial complex or lateral collateral ligament including posterolateral complex (2) 2-stage surgical management group in which medial or lateral ligament complexes were repaired in the first surgical stage, and once nearly full range of motion was obtained 3 to 6 months later, anterior cruciate ligament (ACL) or posterior cruciate ligament (PCL) was reconstructed in the second surgical stages, (3) 1-stage surgical management group in which medial or lateral ligament complex was repaired, and ACL and PCL reconstruction done simultaneously. ACL and PCL reconstruction were performed with double-bundle technique using hamstring tendon. KOOS was used to measure patient-reported outcomes, and compared between operative procedures. ANOVA was used for statistical analysis, and the level of significant difference was set at p<0.05.

[Results] Four of the 24 patients underwent primary repair (mean age was 59.4 years and Tegner activity score was 4.2), 12 underwent in 2-stage management (mean age was 47.6 years and Tegner activity score was 4.8), and 1-stage management was performed in 8 (mean age was 39.5 years and Tegner activity score was 5.3). The KOOS score of primary repair group reached 68.9±10.5 (symptoms 76%, pain 68%, function 82%, sports 56%, QOL 62%), that of 2-stage management group reached 65.1±11.6% (symptoms 72%, pain 69%, function 78%, sports 50%, QOL 56%), and that of the 1-stage management group reached 76.4±8.8% (symptoms 79%, pain 72%, function 91%, sports 68%, QOL 73%). No KOOS subscales showed a significant difference between 3 groups.

[Discussion] All surgical management group including primary repair and 1-stage or 2-stage surgery group provided satisfactory outcomes in symptom, pain and function subscales of KOOS.
but not in sports and QOL. In the primary repair, the collateral ligament complex including the posterolateral and posteromedial structures was repaired anatomically, because treatment for these posteromedial and posterolateral structures is very important for stability of the knee joint. It has been reported that repair of posteromedial and posterolateral complex prevent posterior subluxation to aid the natural healing of the cruciate ligament in the proper position. After primary repair, if necessary, reconstruction of the ACL or PCL was performed in the second surgical stage. Therefore, the elderly and low activity patients received only primary repair, as a result, the KOOS score of primary repair group had outcomes equivalent to the 2-stage or 1-stage management group.

【Conclusion】The KOOS score of primary repaired patients was not significantly different compared to the patients reconstructed ACL and PCL. The primary repair of the medial or lateral complex was a very important and effective procedure to restore function in a multiligament-injured knee.
The Diagnosis and Treatment of The Medial Rotatory With Button Locked Irreducible Knee Dislocation

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Background The medial rotatory with button locked irreducible knee dislocation (MRBLIKD) is often irreducible with closed means as the medial femoral condyle button holes through the medial joint capsule, forcing the medial collateral ligament or other medial structures to invaginate into the joint. This type KD is the medial femoral condyle anterolateral rotatory in relation to tibia, the LCL and PLC is the center axis and the lateral condyle and tibia did not dislocation. These type of dislocation was described as posterolateral type in Kennedy `s classification, and not mentioned in Schenck `s classification. Delay in diagnosis or missed diagnosis can result in skin and locked tissue necrosis.

Methods Over a 5-year period, we treated 22 patients with medial rotatory with button locked irreducible knee dislocations. The Ligamentous injury patterns, locked tissue, methods of reduction, and surgery strategies were defined and concluded. These patients were contacted, and valgus stress, ROM, prospectively measured clinical outcomes scores (Lysholm) were obtained.

Results The most frequently locked medial structures included medial collateral ligament, medial capsule, muscle of vastus medialis, and MPFL. the methods of reduction included open reduction, reduction under the arthroscopy assist, reduction with limited open. The surgery strategies consisted releasing the locked, reducing joint, and repair/reconstructing PCL and medial structures. The medial structures were repair at anatomic site. All the patients` valgus and varus stress testing was normal and PDT was less than 6mm. IKDC Score was B and the mean Lysholm score was 90.12. No patient need further operation expect one patient received skin transplanted.

Conclusion The medial rotatory with button locked irreducible knee dislocation is a special knee dislocation, the MRBLIKD is emphasize the injured structures at the medial, the situation of locked and irreduction of KD. Prompt open reduction or reduction under the arthroscopy assist is the treatment of choice.