

there was no significant difference in graft tear and synovial coverage. Radiologic findings comparing instability showed no significant difference.

Conclusions: Even though adjustable-loop system's intended flexibility has possibility of loop lengthening and subsequent graft displacement, compared with fixed-loop system, both group provided good functional and radiologic outcomes without significant differences. Also the second-look arthroscopy revealed no difference in graft tear and synovial coverage between fixed-loop and adjustable-loop device.

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B0638

Comparison of clinical outcomes and second-look arthroscopic findings after ACL reconstruction using a hamstring autograft or a tibialis allograft

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Background: The purpose of this prospective randomized clinical study was to compare the clinical and radiological outcomes, including tibial tunnel widening and the progression of osteoarthritis after ACL reconstruction using a hamstring autograft or a tibialis allograft. In addition, we compared the graft tear, and synovial coverage of grafts in patients that underwent the second-look arthroscopy.

Material and Method: Among 184 patients with an ACL injury underwent ACL reconstruction, 68 patients of autograft group and 64 patients of tibialis allograft group were included for this study after minimum of 2-year follow-up. The Lachman and pivot-shift tests, Tegner activity score, Lysholm knee score, and IKDC score were compared between the two groups. The quadriceps and hamstring isokinetic strengths using dynamometer were also compared. Degree of OA was determined using the Kellgren-Lawrence grading system on the weight-bearing radiographs. 51 patients (26 patients in autograft group and 25 in the tibialis allograft group) underwent the second-look arthroscopy, in which we compared the apparent tear of graft and synovial coverage of grafts.

Results: At the final follow-up, there were no statistical significances in the two groups in Lachman and pivot-shift tests (n.s.). The Tegner activity, Lysholm knee score, and IKDC scores were similar in the two groups. Moreover, no significant differences were observed in the muscle powers (n.s.). Some patients showed the progression of OA (5 in autograft and 4 in allograft groups) without intergroup difference (n.s.). Regarding the findings of second-look arthroscopy, although there was no significant difference in graft tear, synovial coverage was better in autograft group than in allograft group.

Conclusions: Even though hamstring autografts and tibialis allografts provided good functional outcomes without significant differences, the second-look arthroscopy revealed that hamstring autografts produced better synovial coverage than tibialis allograft.

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B0648

Partial-thickness rotator cuff tears in university baseball players

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Background: Rotator cuff tears are common shoulder injuries in baseball players. In some severe tears (i.e. through more than 50% of the cuff's thickness), conservative treatment does not work well, and surgical treatment is sometimes chosen in an effort to ensure return to play. In contrast, some partial thickness rotator cuff tears do not cause shoulder symptoms, even during throwing motion. Here, we assessed the rates and characteristics of symptomatic and asymptomatic partial thickness rotator cuff tears in baseball players.

Materials and Methods: We studied 57 university baseball players (age: 19.7 ± 0.8 years; baseball career: 11.5 ± 1.7 years; position: 25 pitchers and 32 position players). All subjects completed questionnaires about current and past shoulder pain; their rotator cuff tendons were then ultrasonographically examined.

Results: Twenty-two (39%) players were diagnosed with rotator cuff tears using ultrasonography. All tears were articular sided and of partial thickness. Eleven tears were in the supraspinatus, 5 in the infraspinatus, and 6 in both the supraspinatus and the infraspinatus. Tear depth was 3.6 ± 1.5 mm in the supraspinatus and 2.8 ± 1.4 mm in the infraspinatus. Only 23% of rotator cuff tears (5/22 tears) were accompanied by shoulder pain; the remaining 77% (17/22 tears) were asymptomatic. Six of the players with tears had had shoulder pain when throwing at high school or junior high school, although they had no pain at the time of our investigation. Five of the 25 pitchers (20%) and 17 of the 32 position players (53%) had rotator cuff tears.

Conclusions: Ultrasonographic examination showed that 30% of these university baseball players had asymptomatic articular-sided partial-thickness rotator cuff tears. The tear extended for less than 50% of the medial-to-lateral dimension of the rotator cuff's footprint on the greater tuberosity; this suggests that most of these were tears of the superior capsule but not the rotator cuff tendons, because the superior capsule is attached in the articular half of the greater tuberosity. Furthermore, 77% of tears were asymptomatic. Therefore, most so-called articular-sided partial-thickness rotator cuff tears may not be pathological tendon tear but instead adaptive changes in response to acquired laxity without any symptom.

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B0649

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.

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B0651

The experiment research of anatomic anterior cruciate ligament reconstruction assisting by 3D printing technology

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Background: Due to the individual differences of diameter and print of ligament, the requirements of individual anatomic precise reconstruction can not be met with traditional single positioning method. 3D printing technology may can help with this problem.

Method: The body knees are scanned with thin layer CT aimed to gain the data of bones which is used to establish knee joint model by computer software. The site and direction of the bone tunnels of femur and tibia is designed and calibrated on the knee joint model. The knee resin mold and ACL navigation template is replicated with the help of 3D printing, the accuracy of which is validated on the body knees.

Results: The internal opening of femoral and tibial bone tunnel is located in the central point of original ligament footprint area, and the site and direction is same as preoperative design.

Discussion: Anatomic single bundle ACL reconstruction assisting by 3D printing can greatly improve the accuracy of positioning and short the time of operation by means of careful preoperative design and preview.

Conclusion: This method of positioning is accurate, reliable and repeatability, which is expected to improve the success rate of ACL reconstruction and is feasible for further clinical research.

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B0652

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).

Patient: 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 bicruciate 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 $65.1 \pm 11.6\%$ (symptoms 72%, pain 69%, function 78%, sports 50%, QOL 56%), and that of the 1-stage management group reached $76.4 \pm 8.8\%$ (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.

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B0656

Femoral and tibial tunnel placement correlate with graft tunnel motion: A quantitative clinical imaging study

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Background: In ACL reconstruction, Once the reconstructed graft is not in isometric during knee motion, poor graft-bone healing, graft loose and potential bone tunnel enlargement may happen due to graft-tunnel motion (GTM) such as the effect of bungee cord or windshield wiper. Animal experiments and clinical MRI studies have proved that the amplitude of graft-tunnel motion correlated with bone-graft healing. Cadaver studies showed that femoral and tibial tunnel placement correlate with GTM. In surgical practice of ACL reconstruction, various amplitude could be notified. However, there's no clinical evidence to quantify this phenomenon.

So we managed to quantify the coordination of Femoral and Tibial Tunnel and the amplitude of GTM in order to find out how to minimize GTM with a proper set of femoral and tibial tunnel placement.

Method: Thirty patients were included in the study. ACL reconstruction was performed with use of a hamstring autograft in suspensory fixation technique by a single surgeon. The intra-articular part of the graft was marked with suture knots, one and the other at the tibial and femoral tunnel aperture, the third at the middle point between the previous two. The tibial tunnel was drilled along the anterior root of the lateral meniscus randomly. The femoral tunnel was drilled slightly above the residential ridge and near the elongation of bifurcate ridge randomly. During ACL reconstruction, we use an intra and an extra articular GTM measuring device to measure the amplitude of GTM while the knee was flexed from 0 degree to 120 degree. Notchplasty would be performed if impingement existed. After the surgery, the patient received a multi-slice computer tomography (MSCT) to locate the intra-articular tibial and femoral tunnel point through 3D reconstruction. Bernard-Hertel grid was used to quantify the coordinates (h, t) of the femoral tunnel. While a rectangle coordinate system was used to quantify the coordinates (a, b) of the femoral tunnel. Statistical correlation analysis was proceeded to evaluate the data.

Results: The average GTM was 2.36 ± 0.61 mm. There's no significant difference between the methodology of intra and extra articular GTM measurement. The average h and t was 0.263 ± 0.118 and 0.475 ± 0.094 , respectively. The average a and b was 0.532 ± 0.127 and 0.382 ± 0.144 . Notably, the minimum GTM was 0.4mm and the femoral and tibial coordinate was (h: 0.5201, t: 0.2117) and (a: 0.512, b: 0.441). h, t and b showed significant correlation with GTM with the factor of 0.581, 0.639 and 0.689 ($p < 0.05$)

Conclusion: We successfully developed a method to evaluate intraoperative GTM and quantify the tunnel on MSCT. Further investigation will focus on clinical outcomes correlation with GTM and tunnel placement.

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B0658

Association between pre-operative MRI of the supraspinatus muscle and reparability of rotator cuff tears

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Background: There are few reports of the assessment of the association of the occupation ratio (a marker of supraspinatus muscle atrophy), with reparability into account. To determine the correlation between supraspinatus muscle occupation ratio and reparability of the rotator cuff muscles, (especially the supraspinatus), to determine the correlation between each occupation ratio for 1-muscle (Only SST), 2-muscles (SST + Infraspinatus [IST] or SST + Subscapularis [SBC]), and 3-muscles (SST+IST+SBC) injury of rotator cuff tear.

Material and Methods: We evaluated 170 patients (average age, 62.3 years (range, 40-83 years)) who had only arthroscopic type II, III rotator cuff repair. Patients were divided into two groups: 96 patients had undergone a type II repair, 74 patients had undergone a type III repair. Also patients were separated into four groups: i) isolated supraspinatus tears, ii) supraspinatus and infraspinatus tears, iii) supraspinatus and subscapularis tears, iv) tears in all 3 muscles. Muscle atrophy of the supraspinatus was evaluated by using occupation ratio on the most lateral T1-weighted sagittal oblique view. Occupation ratio of supraspinatus muscle in supraspinatus fossa was evaluated visually. The area was measured by 2 independent observers using Centricity-Radiology RA1000 software (GE Healthcare., Barrington, IL, USA).

Results: On MRI, the supraspinatus muscle occupation ratio was significantly different between the completely repaired (Type II) and incompletely repaired (Type III) groups. As expected, the mean occupation ratio for completely repaired group (42.39 ± 10.1) was higher than incompletely repaired group (36.64 ± 6.94), with statistical significance. The cutoff value from complete repair (Type II) to incomplete repair (Type III) was 41 for supraspinatus muscle occupation ratio. As expected, the supraspinatus muscle occupation ratio was significantly smaller as the tear increases ($P < 0.001$).

Discussion: Our study shows that supraspinatus reparability (mobility to the greater tuberosity) can give some idea through the preoperative MRI sagittal-oblique view. Among the several MRI parameters mentioned in previous studies, our study shows that the pre-operative MRI supraspinatus occupation ratio is associated with reparability of rotator cuff tears, especially the supraspinatus. The supraspinatus occupation ratio cut off value between complete coverage versus incomplete coverage was 41. Several previous literature mentioned pre-operative MRI factors as one of the predictors of reparability of rotator cuff tear. However there are few papers analyzing the reparability of rotator cuff tears using supraspinatus occupation ratio, which is one of the pre-operative MRI factors. Our study shows that the supraspinatus muscle volume or atrophy measured via the occupation ratio can be effective in determining the supraspinatus-infraspinatus reparability. The supraspinatus occupation ratio < 41 suggested a high possibility in incomplete repair. Also we gave a schematic drawing showing the mean data of atrophy to have some estimation of the atrophy and cutoff value 41. It was surprising that even with mild atrophy surrounding the supraspinatus was about 60% atrophy. For other analysis, 2-muscle tear groups showed that the mean occupation ratio of SSP + SBC muscles tear group value higher than that of SSP + ISP muscles tear group. It indicates that the degree of atrophy is less severe in supraspinatus muscle when accompanied with anterior tear than posterior tear. This is somewhat obvious since the supraspinatus is separated by rotator interval with subscapularis tendon tear but posterosuperior tear is continuum with infraspinatus.

Conclusion: The occupation ratio of supraspinatus muscle less than 41 can be the cutoff value between coverage of greater tuberosity versus incomplete coverage. And there was a significant correlation between tendons (muscle) tear involvement and supraspinatus muscle atrophy ratio. Only SSP tear group had the least degree of muscle atrophy.

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B0659

Clinical and radiologic outcomes of arthroscopic "Hybrid" repair in large to massive rotator cuff tear

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Background: In some large to massive rotator cuff tears, the double row repair can be difficult or even impossible especially for the supraspinatus tendon. In such circumstances, partial repair or incomplete repair is an option. Incomplete repair (Type III) can be achieved by our concept of "hybrid" repair in this kind of tears. The basic principle behind "hybrid" repair is double row in infraspinatus tendon, single row in supraspinatus tendon, medialization of supraspinatus tendon footprint, and TOE augmentation. This definition is different from previous literature referring to