

B0330

The detrimental gelling effect of plate-rich plasma when exposed to human tenocytes in small diameter culture wellC.-H. Chiu^{1,2,3}, A.C.-Y. Chen^{1,2}, K.-F. Lei³¹Department of Orthopaedic Surgery, Chang Gung Memorial Hospital, Linkou, Taiwan²Bone and Joint Research Center, Chang Gung Memorial Hospital, Linkou, Taiwan³Graduate Institute of Medical Mechatronics, Chang Gung University, Taiwan

Background: Tenocytes of chronic rotator cuff tendon tears are not able to synthesize normal fibrocartilaginous extracellular matrix. Biological strategies are proposed to enhance tissue healing. Platelet-rich plasma (PRP) with different growth factors is believed to be helpful for tenocytes proliferation. Tenocytes from different age, gender of patients and passages has different characteristics. The best-fit PRP for each individual is unknown regarding the protocol of preparation, methods of activation, ratio between different growth factors and role of white blood cell. It needs large number of preparation conditions to screen the personalized best-fit PRP. Small diameter culture wells should be used to screen as much PRP preparation as possible at the same time with limited source of tenocytes from each patient. Results of tenocytes interaction with PRP in smaller culture wells may be different when compared with conventional studies using larger diameter culture wells.

Material: Human tenocytes were isolated from edge of torn human rotator cuff tendons when performing arthroscopic rotator cuff repair. First passage of tenocytes of each individual was used in the following experiment.

Method: Tenocytes were seeded in 4 different commonly used culture plates (96 well, 24 well, 12 well and 6 well) with same seeding density (2×10^4 cells/cm²). PRP was prepared and added inside each well with adjusted volume according to the diameter of each culture well. Cell proliferation was measured by WST-1 assay.

Results: Tenocytes proliferation was increased in 6 and 12 well culture plate when exposed to PRP. However, it was decreased when exposed to the same condition of PRP (well diameter adjusted) in 24 and 96 well culture plate. The culture medium in small culture wells became gel-like material after PRP was added, which may be responsible for decreased tenocytes proliferation.

Discussion: PRP can enhance tenocytes proliferation by the delivery of various growth factors and cytokines from the α -granules contained in platelets. However, the clinical benefit when applying it for augmentation during rotator cuff repair is still controversial. This may be explained by lacking of standardization of preparation protocol for each individual's best-fit PRP. To test as much preparation conditions at one time, small diameter culture wells should be used to decrease total tenocytes needed at the same experiment because tenocytes over 3 passages will show phenotypic drift, which will hinder the result of PRP research. The gelling effect of PRP was noted when they were tested in small sized culture wells, which might be detrimental to tenocytes proliferation. The phenomenon disappeared when they were tested in large diameter culture well as published articles. Above condition should be noticed when performing PRP experiment in small diameter culture wells.

Conclusion: The detrimental gelling effect to human tenocytes is noted when performing PRP experiment in small diameter culture well. This condition is avoided when using larger diameter culture wells.

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B0334

The comparative study of arthroscopically and open subpectoral tenodesis for the treatment of bicep tendonitis

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Background: The long head of the biceps tendonitis is a common pathological situation which causes shoulder pain for patients. Normally it can be treated with tenotomy or tenodesis when nonoperative measures are not effective. The tenodesis of bicep tendon can be achieved arthroscopically or open surgery. It is not clear whether arthroscopic or open biceps tenodesis has a clinical advantage.

Material and method: A prospective comparative study was designed for patients undergoing an all-arthroscopic in joint or open subpectoral biceps tenodesis. Patients undergoing a concomitant rotator cuff or labral repair were excluded. The groups were matched to age within 5 years, sex, and time to follow-up within 1 months. Time length of tenodesis surgery, amount of blood loss, early pain improvement (day 1-7 after surgery, late pain improvement (day 7-1 month), postoperative American Shoulder and Elbow Surgeons scores, and complications were evaluated.

Results: 25 patients (14 all-arthroscopic, 11 open) with an average age of 50 years (range, 45-55 years) were evaluated. There is a significant difference between two groups regarding the time length of surgery. The mean time length of arthroscopically tenodesis in joint is 25 mins (range, 20-35 mins) and that of open tenodesis is 10 mins (range, 5-18 mins). There is a significant difference between two groups regarding the blood loss. The mean amount of blood loss is 5ml (range 3-10 ml) for arthroscopically and 30ml (range, 20-50ml) for open tenodesis. There is significant difference regarding the early pain improvement between two groups. Open tenodesis shows more early pain improvement than arthroscopically. There was no significant difference in mean American Shoulder and Elbow Surgeons scores as well as the late pain improvement between the open and arthroscopic groups (90.4 vs 85.6; $P=0.36$); There were no complications in both all-arthroscopic group and open group.

Discussion: The long head of biceps tendon starts at the top of glenoid labrum and run through the tendon sheath around the intertubercular groove. Once it gets inflammation, the

arthroscopically fixation in joint still leave certain length of inflammatory tendon in the tendon sheath which might cause symptoms for the patient. Also if the tendon sheath gets inflammation, the tenodesis of biceps tendon in the joint might not have effect on the symptoms relieve because there is still a part of tendon in the tendon sheath is in motion while arm moves. However, open subpectoral tenodesis has the tendon fixed below the inferior end of tendon sheath which leave nothing in the inflammatory tendon sheath. It might be a better method to treat the biceps tendonitis with inflammation of tendon sheath.

Conclusion: Biceps tenodesis remains a reliable treatment for the long head of the biceps tenodesis. Open subpectoral biceps tenodesis takes less time than arthroscopically surgery, but with more blood loss. Patients undergoing open subpectoral tenodesis showed more early pain improvement as compared with patients undergoing an arthroscopically tenodesis. There is no significant difference regarding the late pain improvement, shoulder score and complications between two groups.

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B0335

Primary reconstruction of ACL and PMC of the knee

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Background: Combined injury of ACL (anterior cruciate ligament) and PMC (posteromedial corner) is common in acute sports injury. It is in consensus that ACL need primary reconstruction, but the treatment of acute PMC injury is controversial. Controversy lies mainly in dealing with 3 degree injury. Some advocated conservative treatment, some advocated suture repair, but reconstruction was rarely advocated. Author found that some patients had seriously damaged PMC fibrous structure. Conservative treatment can't restore ligament tension, and seriously damaged fibre could not return to normal structure by suture repair. For this kind of the special cases, primary reconstruction of PMC was necessary. ACL and PMC was primarily reconstructed, and had obtained good clinical results.

Materials: From September 2005 to June 2013, 35 cases of acute ACL and PMC injury got primary reconstruction. There were 20 male and 15 female cases. 35 cases had obvious anterior, valgus and rotational instability. The MRI revealed anterior cruciate ligament injury, medial collateral ligament injury and PMC injury. Preoperative Lysholm score was 26.3 ± 6.6 (16 ~ 72), IKDC was 28.3 ± 8.7 (18 ~ 63).

Methods: Two allograft tibialis anterior tendons was used, one for ACL reconstruction, the other for PMC reconstruction, including sMCL (superficial medial collateral ligament) and POL (posterior oblique ligament). Single bundle for ACL reconstruction was used, with RigidFix for femoral fixation, and Intrafix for tibial fixation. sMCL and POL had a common insertion in a tunnel on medial epicondyle, and two separate insertion in two tibial tunnels. Interference screws were used for ligament fixation. Clinical evaluation includes symptoms and physical signs, Lysholm and IKDC scores.

Results: ALL cases got successful operation, no infection or ligament failure was found. All patients received follow-up for 24 ~ 84 months (average 48 months). All of the knee had regained anterior, lateral and rotational stability. Valgus test in 0° and 30° flexion was negative, and Slocum test was negative. Anterior drawer test and Lachman test was negative or positive of I degree. 21 cases (60%) returned to sports as the preoperative level, 14 cases (40%) returned to sports a bit lower than the preoperative level. Terminal Lysholm score was 89.4 ± 5.1 (82 ~ 93), and IKDC was 87.2 ± 7.2 (80 ~ 94) ($P < 0.05$).

Discussion: It is in consensus that ACL need primary reconstruction, but the treatment of acute PMC injury is controversial. In clinical practice, the author strictly follow the indications for reconstructive surgery. ①Preoperative MRI showed completely torn of the medial structure with scattered fibre. ②Under arthroscopy, the medial gap widened significantly with positive dive through sign. The positive dive through sign did not disappear after ACL reconstruction. ③While opening, the medial structure was completely torn, unable to repair with suture. These particular cases need primary reconstruction to restore stability and normal function of the knee.

Conclusion: Primary reconstruction of ACL and PMC of the knee for acute sports injury can restore the knee stability. And the reconstructed PMC can protect the reconstructed ACL. It is safe and effective to reconstruct ACL and PMC with allograft tibialis anterior tendon.

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B0344

Influence of surgery timing and meniscus tear on the recovery of muscle torque after ACL reconstruction

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Background: Muscle strength, especially higher quadriceps strength, is one of the essential aspects among the multiple factors contributing to a return to sports after anterior cruciate ligament (ACL) reconstruction. However, there is only weak evidence associated with the factors affecting muscle recovery after ACL reconstruction. The purposes of this study were to evaluate the influences of duration from ACL injury to reconstruction and complicated meniscus injury. We hypothesized that delayed reconstruction and complicated meniscus injury delays the recovery of muscle strength after ACL reconstruction.

Materials and Methods: From April 2010 to March 2014, 199 consecutive double-bundle ACL reconstructions using ST grafts were performed. The inclusion criteria were primary ACL reconstruction and at least a 1 year follow-up period. The exclusion criteria were revision surgery,

multiligament lesion, osteoarthritis and chondral lesions requiring treatment. A total of 151 knees were enrolled in this study and grouped by the period from injury to reconstruction (Group 1 was 0 to 28 days (n=51), Group 2 was 29 to 56 days (n=45), Group 3 was 57 to 84 days (n=17) and Group 4 was more than 84 days (n=38)). During surgery, a ruptured ACL was confirmed arthroscopically, and meniscal injury was managed according to the injury status. After ACL reconstruction, all patients underwent postoperative management using the same rehabilitation protocol. Peak isokinetic torque of the quadriceps and hamstrings was measured at 60 deg/s of angular velocity with the Cybex II (Lumex) in both knees before surgery and 3, 6, 12 months after surgery. Muscle torque in the uninvolved knee was represented as a ratio (percentage) compared with the involved knee. Pearson correlation coefficient was used to assess the association between the duration from injury to reconstruction and preoperative muscle strength. Two sample t-test and one-way ANOVA was used to compare the preoperative muscle strength between the groups of intact meniscus and injured meniscus or sub-groups (lateral meniscus (LM) injury (n=56), medial meniscus (MM) injury (n=18), and LM/MM injury (n=35)). Comparisons of muscle recovery and duration after ACL injury, or meniscus status, or type of meniscus treatment among all time intervals were performed using two-way ANOVA.

Results: Preoperative muscle strength was not correlated with duration from ACL injury to reconstruction. Group 2 had significantly delayed quadriceps recovery compared to Groups 1 and 4. Regarding the meniscus status, preoperative quadriceps strength in the group with injured meniscus was significantly weaker than that in the intact group. In detail, the LM/MM injury group was significantly weaker than the intact group. Regarding the muscle recovery, LM injury and LM/MM injury had significantly delayed quadriceps recovery compared to intact meniscus. Furthermore, the meniscus repaired group was significantly delayed in muscle recovery compared to the intact or untreated injured-meniscus groups.

Discussion: An early reconstruction after ACL injury was advantageous for the early recovery of muscle strength. Furthermore, meniscus injury especially in cases requiring repair, also delayed the muscle recovery especially in the quadriceps. As ACL-deficient knees have a possible risk of secondary meniscus injury, an early reconstruction is preferred also from that perspective.

Conclusion: Delayed ACL reconstruction and complicated meniscus injury delayed the recovery of muscle strength after ACL reconstruction.

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B0346

Serial evaluation of the graft maturity after anterior cruciate ligament reconstruction using autologous quadriceps tendon by contrast enhanced magnetic resonance imaging: Comparison between remnant bundle preservation vs. non-preservation

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Introduction: In order to determine the rehabilitation course, it is important to understand the biological processes that occur during graft remodeling and maturation. Autograft quadriceps tendon with a bone block might have a better remodeling process given that bone-to-bone healing at the tunnel is superior to tendon-to-bone healing; however, little is known about the remodeling process of quadriceps tendon graft including the healing effects of ACL remnant bundle.

Objectives: The purposes of this study were 1) to confirm graft maturity & revascularization of quadriceps tendon graft through serial evaluation by contrast enhanced MRI and 2) to compare graft maturity & clinical outcome between remnant preserving group and non-preserving group.

Methods: Twenty-one patients who underwent an ACL reconstruction with quadriceps tendon between January 2012 and September 2014 were studied and evaluated by MRI at 3 days, 3, 6 and 12 months after surgery. 12 of 21 patients were evaluated by MRI at 12 months. In 15 cases, remnant bundles were preserved and in 6 cases, they were not. The MRI evaluation focused on 4 measurements as follows: (1) Signal-to-noise quotient (SNQ) was calculated for 3 graft sites (proximal, middle and distal region) on oblique coronal MRI scan before gadolinium administration to evaluate graft maturity (2) SNQ(enhanced) was calculated for 3 graft sites on subtraction image (post - precontrast image) to evaluate graft revascularization more clearly by facilitating enhancement demonstration. (3) The orientation of the ACL ligament was measured using sagittal and coronal ACL angle, ACL-blumensaat angle and tibial tunnel placement. IKDC score, Lysholm score, Tegner activity scale and KT-2000 arthrometry were also evaluated.

Results: In the proximal and middle region, SNQ was increased between 3 days and 3 months and decreased between 3 and 6 months. The middle region showed a significant increase between postoperative 3 days and 3 months (p=0.008). In the distal region, SNQ continued to increase until 6 months and showed a significant increase between postoperative 3 days and 3 months (p=0.049). SNQ of 12 patients were decreased at 12 months in all site. SNQ(enhanced) in all site continued to increase over time and the proximal region showed a higher SNQ(enhanced) value compared with middle and distal region. Comparing remnant bundle preservation group and non-preservation group, it showed similar changing pattern of SNQ to that of quadriceps tendon graft; SNQ was increased between 3 days and 3 months and decreased between 3 and 6 months in the proximal and middle region. In the distal region, SNQ continued to increase until 6 months. In the remnant preservation group and non-preservation group, SNQ(enhanced) continued to increase for 6 months postoperatively. In the preservation group, SNQ(enhanced) at the distal region was significantly lower compared to SNQ(enhanced) at the proximal and middle region on 3 months period (proximal vs distal : 0.028, middle vs distal : 0.049). Remnant preservation group showed higher SNQ(enhanced) value compared with remnant non-preservation group at the middle and distal region. The two groups did not differ significantly in the orientation of ACL and clinical outcome

Conclusion: SNQ representing graft maturity demonstrated faster recovery of proximal portion of the graft. Proximal portion near bone to bone contact area showed faster revascularization compared to distal portion and revascularization process continued until six months. And there

was overall tendency of remnant preserving group having higher vascularity than non-preserving group.

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B0347

Accuracy of backward traction test for the diagnosis of bicipital sheath lesions and bicipital tendonitis: Comparison with arthroscopic examination

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Background: To explore and describe the reasons for variation in diagnostic accuracy of clinical examination using Yergason's and Speed's tests in predicting the pathological changes of biceps tendon, shoulder arthroscopy is still used as the gold standard. Clinical tests are key elements in diagnosing bicipital sheath lesions and bicipital tendonitis. The purpose of this study is To evaluate clinical application of a new diagnostic method named as the backward traction test for the diagnosis of bicipital sheath lesions and bicipital tendonitis with the comparison with arthroscopic examination.

Material and Methods: Between February 2012 and February 2015, a consecutive cohort including 280 patients (131 women and 149 men) with the age range of 18-79 years old (mean age, 46 years old) was conducted to examine shoulder pain through Speed's test and a new test named as backward traction test. Patients who fulfilled the following criteria underwent surgery: persistent pain and functional disability for more than 6 months, no responsiveness to adequate conservative treatment, positive impingement test confirmed by local anesthesia, or clinical or investigative signs of rotator cuff tears, labrum, biceps lesions or bicipital sheath lesions and bicipital tendonitis. The results of these tests were also confirmed through arthroscopic examination. Backward traction test is conducted during the patient was in the stand position coupled with the arm with natural fall. The examiner sits adjacent to the patient on the same side as the shoulder, grasps the patient's wrist gently, fixes at the scapula and backward traction for the examined arm at 120° external rotated position and 120° internal rotated position. The test is considered as positive if the patient has the complaint of pain or clicking joint at the front of the shoulder during the test. The test is considered as negative if pain is not elicited during the test. Surgical findings were recorded for true and false positives and true and false negatives for the pathology of biceps. Sensitivity, specificity, accuracy, and positive and negative predictive values were calculated for backward traction and Speed's tests.

Results: The arthroscopic findings associated with the pathological changes of biceps were observed in 58 patients with bicipital tendonitis, 78 patients with bicipital sheath lesions, 54 patients with SLAP lesions, and 90 patients with rotator cuff tears. In addition, 56 patients had the compound pathological characteristics of rotator cuff tears, labrum, biceps lesions or bicipital sheath lesions and bicipital tendonitis.

Among these patients with bicipital tendonitis and bicipital sheath lesions, the sensitivity, specificity, and positive and negative predictive values were 91%, 89.8%, 89%, and 91.7% for backward traction test and 26.5%, 54.9%, 35.6%, and 44.1% for Speed's test, respectively. The likelihood ratios were 8.9 and 0.1 for backward traction test and 0.59 and 1.3 for Speed's test. In addition, among the 136 patients, 85 patients at 120° external rotated position and 51 patients at 120° internal rotated position were positive for backward traction test, respectively.

Discussion: The pathology of the shoulder pain may involve lesions within the long head of the biceps tendon (LHBT). Along its course in bicipital tendonitis, bicipital sheath lesions and or labrum lesions, the pathological changes of LHBT were classified into 3 categories : 1) the degeneration of biceps tendon (bicipital tendonitis); 2) the instability of tendon (bicipital sheath lesions); and 3) original disorders (SLAP lesions). Biceps tendonitis may be a secondary phenomenon caused by impingement. Decreased space in the coracoacromial arch may lead to the irritation and mechanical symptoms of biceps. Others pathological changes included rotator cuff tears and labral lesions (SLAP). Yergason's and Speed's tests are not sensitivity for bicipital sheath lesions and bicipital tendonitis. An accurate clinical diagnosis of bicipital sheath lesions and bicipital tendonitis is difficult.

The backward traction test in the present study reveals the sensitivity of 91%, the specificity of 89.8%, and the accuracy of 90.4% for bicipital sheath lesions and bicipital tendonitis although the arthroscopic examination is used as a gold standard. The likelihood ratios are 8.9 and 0.1 for backward traction test and 0.59 and 1.3 for Speed's test. Therefore, the backward traction test is much better than Speed's test. It is not clear if the surgeon in that study is blinded to the clinical examination at the time of surgery. The backward traction test is evaluated in a tertiary clinic, and patients have surgery for various pathologic conditions, indicating an appropriate spectrum of patients. The arthroscopic findings associated with the pathological changes of biceps include bicipital tendonitis, bicipital sheath lesions and SLAP lesions. Among these patients with bicipital tendonitis and bicipital sheath lesions, 85 patients at 120° external rotated position including the tears of the supraspinatus are positive, suggesting the medial walls of bicipital sheath lesions; 51 patients with 120° internal rotated position including the tears of the subscapularis are positive, suggesting the lateral walls of bicipital sheath lesions. Among patients with SLAP lesion, the positive rates are 92.9% for backward traction test and 91.7% for Speed's test, respectively. The correlation between Speed's test and anatomic location of type II SLAP lesions has also explored¹⁷. The sensitivity is reported as 29% for posterior lesions, 100% for anterior lesions, and 78% for combinatorial lesions.

Conclusion: The backward traction test is an effective diagnostic strategy for bicipital sheath lesions and bicipital tendonitis.

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