1 ANALYSIS OF ROTATOR CUFF REPAIR BY BMP-7 WITH GHS
Yukichi Kabuto, Toru Morihara, Tsuyoshi Sukenari, Yoshikazu Kida, Hiroyoshi Fujinawa, Ryo Oda, Ken-Ichi Matsuda, Mitsuhiro Kawata, Yasuhiko Tabata, Yoshikazu Kubo, Department of Orthopaedics, Graduate School of Medical Science, Kyoto Prefectural University of Medicine; Department of Anatomy and Neurobiology, Graduate School of Medical Science, Kyoto Prefectural University of Medicine; Department of Biomaterials, Institute for Frontier Medical Sciences, Kyoto University

Introduction: The purpose of this study was to analyze the effect of Bone Morphogenetic Protein-7 (BMP-7) with gelatin hydrogel sheets (GHS), on rotator cuff repair. Materials and Methods: Twelve-week-old Sprague-Dawley male rats were used in this study. Bilateral supraspinatus tendons were transected and sutured by the Mason-Allen technique. 1. 125i-labelled BMP-7 was injected into the subacromial bursa (B group), and GHS with 125i-labelled BMP-7 was set on the tendon-to-bone insertion (B+G group). BMP-7 concentration at the tendon-to-bone insertion site was measured at 1, 3, 7, 14, and 21 days after surgery. 2. Phosphate buffered saline (PBS) or BMP-7 was injected into subacromial bursa (P group, B group), GHS with PBS or BMP-7 was set on the tendon-to-bone insertion (P+G group, B+G group). Heterotopic ossification was evaluated by micro computed tomography at 2, 4, and 8 weeks after surgery, sections were stained with hematoxylin and eosin, and safranin O. Tissue repair was evaluated by tendon-to-bone maturing score. Results: 1. The BMP-7 residual rate in B+G group was significantly higher than that in B group at 21 days after surgery. 2. Heterotopic ossification was not observed in any group. Tendon-to-bone maturing score was highest in B+G group at 8 weeks after surgery. Discussion: GHS kept BMP-7 local concentration for 3 weeks. At 8 weeks, in BMP-7+GHS group, the tendon-to-bone insertion was most obviously matured especially in fibrocartilage formation and tendon regeneration. These findings suggest maintaining BMP-7 local concentration may promote the healing of the tendon-to-bone insertion.

2 DRILLING INTO THE FOOTPRINT STIMULATED PROLIFERATION OF CHONDROCYTES IN TENDON TO BONE INSERTION SITES
Haruhiko Nakagawa, Toru Morihara, Tsuyoshi Sukenari, Yukichi Kabuto, Hisaozaku Tachiiri, Yoshikazu Kida, Hiroyoshi Fujinawa, Ken-Ichi Matsuda, Mitsuhiro Kawata, Yoshikazu Kubo, Department of Orthopaedics, Graduate School of Medical Science, Kyoto Prefectural University of Medicine; Department of Orthopaedic Surgery, Maizuru Red Cross Hospital; Department of Anatomy and Neurobiology, Graduate School of Medical Sciences, Kyoto University

Purpose: The most effective bony surface for tendon-to-bone insertion healing after rotator cuff repair has not been clarified. We previously reported that bone marrow-derived cells from the footprint infiltrated the repaired rotator cuff. However histological analysis of healing insertion site with drilling has not been done. The purpose of this study was to clarify histologically the mechanism for reformation of tendon-to-bone insertion sites by drilling into the footprint. Methods: In Sprague-Dawley rats, a supraspinatus tendon was sharply transected at the insertion on the greater tuberosity. Any remaining soft tissue at insertion site was removed and the supraspinatus tendon was repaired. In group C, a cancellous bed was prepared using a bur, and the supraspinatus tendon was repaired. We examined the histology of the insertion of the supraspinatus tendon at 2, 4, and 8 weeks after surgery. The presence of fibrocartilage was assessed Microscopically. Results: Fibroblast-like cells were observed in tendon-to-bone insertion sites in all groups at 2, 4 and 8 weeks. Chondrocytes and metachromasia were observed between fibroblast-like cells and bone in group B at 4 and 8 weeks. Discussion: The tendon-to-bone insertion site can be categorized into four zones: tendon, non-mineralized fibrocartilage, mineralized fibrocartilage and bone. The role of fibrocartilaginous enthesis is in reducing the risk of wear and tear. Drilling could promote the reformation of the zone of fibrocartilage.

3 PREDICTION OF THE SUPRASPINATUS MUSCULOTENDINOUS UNIT’S EXTENSIBILITY USING ULTRASOUND ELASTOGRAPHY
Yoshiaki Itoigawa, Eiji Itoi, Department of Orthpaedics, Juntendo University Urayasu Hospital; Mayo clinic biomechanics lab, Tohoku University Graduate School; Department of Orthopaedics, Tohoku University Graduate School

Introduction: The purpose of this study was to determine if the combination of B-Mode ultrasound and Shear Wave Elastography (SWE) could be used to predict the extensibility of the rotator cuff muscle on cadaveric specimens with cuff tears of varying sizes. Materials and Methods: Eleven fresh-frozen cadaveric shoulders (mean age: sixty-seven years) were used. The size and distribution of rotator cuff tears across the eleven specimens was as follows: tear size (frequency), small(1), medium(3), large (1), massive(1), and intact/no tear(5). The SWE modulus of the superficial and deep muscles was measured using SWE on an Aixplorer ultrasound scanner. After the SWE ultrasound evaluation, the supraspinatus tendon was axially stretched along the direction of muscle line under forces ranging up to 30 N while the distance between the medial scapular spine and the lateral edge of the supraspinatus tendon was recorded via electromagnetic tracking sensors and the displacement force was recorded via a load cell. The length of the supraspinatus musculotendinous unit and the displacement of the supraspinatus tendon were calculated. Results: There was a significant negative correlation between the displacement of the supraspinatus tendon and the SWE modulus of the superficial muscle ($R^2=0.953$) and deep muscle ($R^2=0.852$), however no correlation was identified between the length of the supraspinatus musculotendinous unit and the SWE modulus of the superficial muscle or deep muscle, or the tendon displacement. Conclusion: SWE ultrasound can predict the extensibility of the supraspinatus musculotendinous unit, independent of the size of the supraspinatus tendon.

4 INFLUENCE OF ADVANCED GLYcation END PRODUCTS ON ROTATOR CUFF DERIVED CELLS
Yutaka Mifune, Atsuysuki Inui, Tomoyuki Muto, Yoshihumi Harada, Fumiaki Takase, Yoshihiro Ueda, Takeshi Kokubu, Department of Orthopaedics, Kobe University Graduate School of Medicine

Advanced glycation end products (AGEs) have recently been regarded as one of the notable factors for senescence. We hypothesized that AGEs have detrimental effects on rotator cuff derived cells. Rotator cuff derived cells were isolated from human supraspinatus tendons obtained during surgery. The cells were cultured in three treated mediums for 3 days; 1) regular medium supplemented with 500&mug/ml AGEs (High AGEs), 2) regular medium supplemented with...
with 100 µg/ml AGEs (Low AGEs), and 3) regular medium alone (control group). Cell viability was evaluated by WST assay. The amount of VEGF that was secreted by cultured cells into the supernatant was measured by ELISA. The expression of Hypoxia-inducible factor (HIF)-1α, and reactive oxygen species (ROS) was assessed by immunofluorescence staining. Immunofluorescence staining was also performed to detect cell apoptosis. Cell viability in High AGES group was significantly suppressed compared with the control group. The amount of VEGF in the supernatant was significantly greater in High and Low AGES groups compared with that measured in the control group. Immunofluorescence staining for apoptotic cell displayed significant induction of cell apoptosis in High and Low AGES groups compared to the control group. The results in this study indicated that AGES could cause age-related degenerative changes of rotator cuff, and the reduction of AGES might prevent rotator cuff from degenerating by senescence.

### 5 Effect of Platelet-Rich Plasma on Adipogenesis and Myogenesis in C2C12 Myoblast Cells

**Purpose:** The purpose of this study was to determine the effects of corticosteroid (CS) and hyaluronic acid (HA) on torn rotator cuff tendon in vitro, and in vivo. **Methods:** Cultured fibroblasts were exposed for 24h to the presence of CS and HA at various concentrations. The cell viability was evaluated using MTT assay (N=10) and FACS quantification (N=5). Biomechanical testing (N=8), histological analysis (N=5) and FIB/SEM analysis (N=3) were performed to evaluate the effect of CS and HA on torn rotator cuff in rat model. **Result:** The MTT assay and the FACS quantification showed that cell viability was significantly decreased in the CS-treated cells compared to the HA-treated cells (P<0.01). In biomechanical testing, the ultimate failure load was significantly decreased in the CS group (P<0.05) compared to the HA and Control groups at 2 weeks after the surgery. In histological evaluation, %PCNA was significantly lower in the CS group (P<0.05) at 2 weeks after the surgery, and CS-induced apoptosis of the tendon fibroblasts was detected at 24 hours after the surgery. **Discussion:** The present study showed CS inhibits cell proliferation and induces cell death of the tendon fibroblasts, thereby decreasing biomechanical strength at the repaired site in rotator cuff tear model. On the contrary, HA showed no adverse effects on the tendon fibroblasts. The different characteristics of these agents should be recognized for the treatment of rotator cuff tears.

### 6 Effect of Corticosteroids and Hyaluronic Acid on Torn Rotator Cuff Tendon

**Purpose:** The purpose of this study was to determine the effects of corticosteroid (CS) and hyaluronic acid (HA) on torn rotator cuff tendon.
9  ROTATOR CUFF CAN REGENERATE TO THE EDGE OF GREATER TUBEROSITY AFTER ATTACHING TO THE MEDIAL PORTION OF GREATER TUBEROSITY
Tomonobu Hotta, Shigeharu Kimura, Kanji-dori Higashi orthopaedic clinic

Introduction: Avoiding retear of rotator cuff, we sometimes attach the stamp of rotator cuff to the medial portion of greater tuberosity (medialization). We noticed some cases showed regeneratiion of rotator cuff up to the edge of greater tuberosity on MRI. The purpose of this study is to examine the rotator cuff lesions in reduced criteria named moderate limited shoulder. Methods: Subjects consisted of 376 patients with shoulder stiffness. We investigated using MRI or ultrasonography. Among them, 89 shoulders had symptomatic RCTs. Six of these 15 asymptomatic tears (40%) had no pain during the three years of follow up, while 9 had some symptoms. In conclusion, RCTs might become asymptomatic if the size of tear remains the same, while they seem to be symptomatic when a new tear occurs, or when there is enlargement of the tear size.

10  THE NATURAL HISTORY OF ROTATOR CUFF TEARS
Atsushi Yamamoto, Kenji Takagishi, Hitoshi Shiota, Tsoyoshi Ichinose, Daisuke Shimoyama, Tsoyoshi Sasaki, Tsutomu Kodayashi, Yoshishina Osawa, Department of Orthopaedic Surgery, Gunma University Graduate School of Medicine; Department of Physical Therapy, Takasaki University of Health and Welfare; Department of Orthopaedic Surgery, Takasaki General Medical Center

The purpose of this study was to elucidate the natural history of rotator cuff tears (RCTs) in the general population. The subjects consisted of 58 people with 116 shoulders who were investigated at the annual medical check-up for three consecutive years after 2009. Subjects comprised of 15 men and 43 women with a mean age of 69.2 years. At each time of check-up, we recorded the subjects' background and medical history and then performed a physical examination. We also investigated using ultrasonography to diagnose RCTs. In 2009, 15 shoulders had asymptomatic RCTs. Six of these 15 asymptomatic tears (40%) had no pain during the three years of follow up, while 9 had some symptoms. In comparison between these two groups, the size of tear became significantly larger in the symptomatic group. In 2009, 9 shoulders had symptomatic RCTs. Three of these 9 symptomatic tears (33%) had continuous pain during the three years of follow up, while six became asymptomatic. In comparison between these two groups, the size of tear was significantly larger in the symptomatic group. Among 93 shoulders which didn’t have RCTs in 2009, two people with 2 shoulders showed a new occurrence of RCT, and both of these two people had pain at the time of occurrence. In conclusion, RCTs might become asymptomatic if the size of tear remains the same, while they seem to be symptomatic when a new tear occurs, or when there is enlargement of the tear size.

11  ROTATOR CUFF LESIONS IN PATIENTS WITH FROZEN SHOULDER: AN ANALYSIS OF 376 STIFF SHOULDERS
Yusuke Ueda, Hiroyuki Sugaya, Norimasa Takahashi, Nobuaki Kawai, M Hiroshi Tokai, Keisuke Matsuki, Kazutomo Onishi, Shota Hoshika, Yoshiatsu Nakata, Joji Moriishi, Funabashi Orthopaedic Hospital, Funabashi, Chiba, Japan

Background: In our previous study we reported that if frozen shoulder is strictly defined as severe and global loss of passive range of motion, more than 90% of patients did not demonstrate any rotator cuff lesion. That suggests that full-thickness rotator cuff tear has different pathology from frozen shoulder. The purpose of this study is to examine the rotator cuff lesions in reduced criteria named moderate limited shoulder. Methods: Subjects consisted of 376 shoulders. Rotator cuff lesions in these patients were prospectively investigated using MRI or ultrasonography. Among them, 89 shoulders were defined as frozen shoulder: less than 100 degree in FF, 10 degree in ER, and 5 degree in IR. 46 shoulders demonstrated moderate and global loss of passive motion: less than 130 degree in FF, 30 degree in ER, and 10 degree in IR. The shoulder findings were defined as moderately limited shoulder. Frozen shoulder patients were not included in the moderately limited shoulder group. Results: Imaging study demonstrated intact cuff in 91% and partial-thickness cuff tears in 9% of shoulders in the frozen shoulder group. None of the patients demonstrated full-thickness rotator cuff tears in this group. On the other hand, intact cuffs were found in 59%, partial-thickness cuff tears in 24% and full-thickness tear in 17% of shoulders in moderately limited shoulder group. Conclusions: Rotator cuff lesion in patients with shoulder stiffness depends greatly on the criteria. If frozen shoulder is strictly defined as severe global range of motion loss, not a single patient demonstrated full-thickness rotator cuff tear.
Materials and methods: In total 55 cases were included in this study. Patch graft using Hybrid RC was performed on 28 cases (Hybrid RC group). Twenty-seven cases had patch graft using fascia lata performed (FL group). 32 cases were male, and 23 cases were female. The average age was 68.5 years old. We evaluated the clinical results using JOA score. The MRI findings were evaluated by using Sugaya criteria, and the clinical results were analyzed statistically. Results: The average JOA score improved from 53.9 points to 92.7 points postoperatively in the Hybrid RC group and from 53.3 points to 84.8 points postoperatively in the FL group. From the MRI findings, the Hybrid RC group showed the lower re-rupture ratio of 10.7% (3 cases) compared with the FL group 37.0% (10 cases). We found collagen tissues in the biopsy samples of the re-rupture case. Discussion and conclusion: We developed a hybrid type artificial rotator cuff material. We clinically used the Hybrid RC for the repair of massive rotator cuff injuries and reported good clinical results. MRI and pathological findings indicated regeneration of the rotator cuff. The analysis of the cases with poor clinical results was important.

13 EPIDEMIOLOGY OF SHOULDER AND ELBOW PAIN IN YOUNG BASEBALL PLAYERS
Tetsuya Matsuura, Naoto Suzue, Toshiyuki Iwame, Koichi Saiyio, Department of Orthopedics, University of Tokushima Graduate School; Dept. of Orthop. Surg., Tokushima prefectural central hospital

Background: Many risk factors for throwing injuries have been proposed. However, little is known about the difference between the risk factors for shoulder pain and those for elbow pain. Purpose: To investigate the risk factors for shoulder pain with a focus on comparison of those for elbow pain. Methods: In 2012, 1,563 players were subjected to a study of injury incidence in relation to specific risk factors. All players were examined by questionnaire. Data for the groups with and without shoulder/ elbow pain were analyzed using multivariate logistic regression models. Results: Among the 1,563 participants, 15.9% reported episodes of shoulder pain and 29.2% reported episodes of elbow pain. Multivariate analysis showed that 5th grade and 6th grade were risk factors for shoulder pain. On the other hand, 4th grade, 5th grade, 6th grade, and being catcher were risk factors for elbow pain. Conclusions: Playing positions are not related to shoulder pain, but being catcher is related to elbow pain.

14 VASCULARITY ALTERATIONS IN DIFFERENT ROTATOR CUFF REPAIR TECHNIQUES USING CONTRAST-ENHANCED ULTRASOUND
Atsushi Urita, Tadanao Funakoshi, Yukinori Tsukuda, Norimasa Iwasaki, Department of Orthopaedics, Hokkaido University Graduate School of Medicine

Purpose: Contrast-enhanced ultrasound is a useful method to clarify visualization of vascular patterns in basic and clinical investigations. The purpose of this study is to clarify vascularity alterations in different rotator cuff repair techniques using contrast-enhanced ultrasound. Methods: 12 shoulders in 12 patients (5 men and 7 women with an average age of 66 years) underwent arthroscopic rotator cuff repair (ARCR). We performed ARCR using two techniques (Surface-holding technique, SH group, and Suture-bridge technique, SB group). The patients underwent an ultrasound scan at 1, 2, 3 and 6 months after surgery. Enhanced ultrasound images were recorded for 70 seconds after intravenous injection of contrast reagent. Four regions of interest inside the cuff and bone tunnel in SH group, and lateral anchor hole in SB group were superimposed on the obtained images. Calculated areas under the time-intensity curves were expressed in acoustic units (AU). Results: Vascularity of the distal area in SH group increased compared with that of the proximal area. On the other hand, in SB group, more vascularity was found in the proximal area at each time point. Vascularity of bone tunnel in SH group was superior to that of the lateral anchor hole in SB group. Conclusion: This study showed vascularity alterations in different rotator cuff repair techniques. This result indicates that vascularity in SH group was superior to that in SB group.

15 THE ASSESSMENT OF JAPANESE NORMAL GLENOID-COMPARISON WITH FRENCH NORMAL GLENOID-
Naoko Mizuno, Shinshuke Nonaka, Ritsu Ozaki, Masahito Yoshida, Gilles Walch, Department of Orthopaedics, Toyonaka Municipal Hospital; Nonaka Orthopaedic hospital; Department of Orthopedics, Nagoya city university; Centre Orthopedique Santy

The reverse total shoulder arthroplasty (RSA) was approved and became available in Japan from April 2014. We were concerned about the size of the baseplate because Japanese patients are usually smaller than European patients. The purpose of this study was to assess Japanese normal glenoid and to compare it with French normal glenoid. One hundred and sixteen Japanese shoulders without any glenoid lesion were assessed. There were 64 males and 52 females in the study. The mean age was 52 years. All patients had computed tomography, which was used to measure glenoid size, retroversion and tilting angle. In order to make a comparison, 30 French shoulders without any glenoid lesion were assessed using the same methods. Regarding the Japanese normal glenoid, the mean glenoid width was 25.8mm (male 27.3mm, female 23.9mm), and mean glenoid length was 32.7mm. The mean retroversion angle was 0.42 degrees and mean tilting angle was superior tilt 7.41 degrees. The cut off value of body height for the 25mm glenoid width was 1.56.5cm. Regarding the French normal glenoid, the mean glenoid width was 27.1mm (male 29.3mm, female 25.3mm). The mean glenoid length was 34.6mm. The mean retroversion angle was 4.13 degrees and mean tilting angle was inferior tilt 1.54 degrees. Comparing Japanese and French normal glenoid, Japanese glenoid was significantly smaller than the French one. The retroversion angle of French glenoid was significantly larger than the Japanese one and Japanese glenoid had significantly superior tilt. These results might help in selection of patients and performing RSA.

16 CHANGE OF PENNATION ANGLES OF THE SUPRASPINATUS BETWEEN PRE- AND POST-OPERATIVE ROTATOR CUFF REPAIR
Ikuta Hayashi, Makota Enokida, Takahiro Yamashita, Department of Orthopaedic Surgery, Faculty of Medicine, Tottori University

Purpose: Pennation angle is an important factor for the function of muscle. In this study, we evaluated the change of pennation angle of the supraspinatus between pre- and post-operative rotator cuff repair. Methods: 68 shoulders, which underwent arthroscopic rotator cuff repair, were enrolled in this study. The sizes of tears were divided into four groups (incomplete, small, medium, large and massive) according to Cofield classification. Pennation angle, which subtended the central axis of intramuscular tendon and anterior muscle fiber of supraspinatus, was measured by pre- and post-operative MRI. Repair cuff integrity was evaluated by using Sugaya’s classification. Results: Pennation angle was significantly enlarged in correlation with the size of tear. Rates of retear were 29% in the medium tear group and 59% in the large/massive tear group. Odds ratio between pre-operative pennation angle over 20 degrees and rotator cuff retear was 20.4. Post-operative pennation angle of repair cuff in the medium tear group was significantly decreased (11.8/9.9 degrees: pre-/post-operative), but was not changed in the large/massive tear group (23.8/23.8 degrees). Conclusion: Pre-operative pennation angle is an important factor associated with the size of tear and post-operative retear. Furthermore, pre-operative pennation angle in the large/massive tear group was without change if the tear was repaired.