

### IS CERVICAL COLLAR USEFUL AFTER LAMINOPLASTY?--A RANDOMIZED CONTROLLED TRIAL

**KC Leung, PWH Cheung, K Law, V Borse, YM Lau, LF Mak, A Cheng, D Samartzis, JPY Cheung, KMC Cheung**

*Department Orthopaedics & Traumatology, Queen Mary Hospital, Hong Kong*

**Introduction:** Cervical myelopathy is commonly treated with laminoplasty, the open-door technique being one of the most widely adopted. Rigid cervical collar immobilization has been thought to be useful after laminoplasty in protecting the hinge opening, preventing hinge fracture and spring-back phenomena. However, not only was there limited evidence on its efficacy, but it may also be detrimental to the patient's static postural control and dynamic balance with prolonged neck movement restriction. Therefore, we propose that with the advancement of fixation devices such as the miniplates, the need for cervical collar immobilization could possibly be precluded. This could in turn lead to earlier neck mobilization and less neck stiffness, hence better patients' outcomes.

**Methodology:** Study Design and participants - The study was a prospective, parallel single-blinded randomized controlled trial conducted during the study period from April 2015 to February 2018. Patient recruitment was performed at two tertiary referral centers by the attending spine specialists. Inclusion criteria was any male or female patient aged over 18 years, clinical and radiological signs compatible with cervical myelopathy undergoing open-door laminoplasty for one or more spinal compression levels. Patients were required to be literate and able to comprehend the study to be enrolled. Exclusion criteria included all patients with previous cervical spine surgery, congenital deformities, spine infection or inflammation, tumor, previous spinal fusion surgery, non-Chinese ethnicity, undergoing workman's compensation and unable or refuse to follow the standardized rehabilitation protocol. All patients were given information sheets regarding the study protocol and both verbal and written informed consents were obtained at the time of recruitment. Ethics approval was obtained from the local institutional review board (UW 15-102) and the study was registered under ClinicalTrials.gov identifier NCT03400644. There were no changes to the methods after trial commencement. Sample size calculation - Due to lack of previous available data comparing patients with collar immobilization after open-door laminoplasty, we performed a pilot study and periodically assessed the difference in axial neck pain (primary outcome) between the two groups measured by the visual analogue scale (VAS). Based on the 2 weeks postoperative data for the first 20 subjects recruited, we found that a sample size of 16 patients in each group could achieve a power of >80% with a significance level of 0.05 to detect a minimal VAS difference of 1.5 as reported as the minimal clinically important difference (MCID). Hence, based on this, we included a total of 35 patients assuming a 10% attrition rate. Randomization and masking - A total of 35 participants (15 female, 20 male) were consecutively recruited and randomized by an independent investigator using a computer program at the time of surgery to either the collar group (n=16) (to receive a Philadelphia collar for 3 weeks postoperatively) or the non-collar group (n=19) (to be allowed free mobilization without any collar immobilization). It was not possible for patients and operating surgeons to be blinded to the group allocation. However, all assessors (range of motion, outcome scores, radiographs) were blinded to the group allocation. All patients randomized to the neck collar group had the collar removed prior to range of motion and outcome assessments to maintain blinding of the assessors. Operative techniques were standardized using titanium miniplates for fixation and performed by four surgeons from the same institute. For patients allocated to the collar group, they were allowed to remove the collar temporarily whilst resting in bed. All patients were prescribed the same doses of analgesics and standardized postoperative rehabilitation protocol. Study parameters and outcome measures - All primary and secondary outcome measures were recorded immediately preoperatively (day before surgery), at 1, 2, 3 and 6 weeks postoperatively, and at 3, 6 and 12 months postoperatively. This was standardized and followed without any changes during the trial. A 1-year follow-up was deemed adequate as collar use was only an early postoperative intervention with unlikely long-term influences. The primary outcome measure was reported axial neck pain by VAS. Secondary outcome measures were divided into clinical (via standardized range of movement measurements, mJOA scores), radiological (serial lateral radiographs for anteroposterior canal diameters and any radiological complications), as well as objective scores, namely short-form 36-item questionnaire (SF-36) and neck disability index (NDI). All clinical, radiological and outcome assessments were performed by investigators blinded to the patient details. All patients were out of collar before clinical and radiographic assessments were performed to avoid bias. There was no dropouts or complications.

## AP01

**Results and Analysis:** There was no baseline differences preoperatively. Postoperatively, the only statistically significant difference lied in the reduction of postoperative axial neck pain (VAS). There was statistically significantly lower mean VAS for the collar group at postoperative 1 ( $3.5 \pm 2.0$  versus  $5.4 \pm 2.5$ ,  $p=0.038$ ), 2 ( $1.5 \pm 1.4$  versus  $3.5 \pm 2.4$ ,  $p=0.028$ ) and 3 ( $1.3 \pm 1.0$  versus  $2.8 \pm 1.9$ ,  $p=0.031$ ) weeks. Significant reductions in postoperative VAS compared to preoperative VAS were observed only at postoperative 1 ( $0.8 \pm 2.4$  versus  $3.8 \pm 3.5$ ,  $p=0.016$ ) and 2 ( $-0.9 \pm 3.4$  versus  $1.8 \pm 3.2$ ,  $p=0.004$ ) weeks for the collar group. There were no differences at postoperative 3 weeks to 12 months follow-up assessments. However, this did not translate to differences in patient-perceived outcomes via NDI and SD-36, probably owing to the predominant impact of myelopathy resolution. Both groups showed similar gradual recovery in mJOA score. There was no statistically significant differences in the cervical alignment, canal diameter and range of motion.

**Discussion and Conclusion:** The authors conclude from the randomized controlled trial that postoperative cervical collar immobilization would not prevent complications, affect neurological recovery, or reduce cervical range of motion. It helps reduce axial neck pain only in the initial postoperative two weeks, without impact on the overall quality of life of patients. Hence, the authors recommend a temporary two-week use of rigid neck collars postoperatively only for better pain relief. Strict compliance is deemed unnecessary as there is no additional benefit.



### VIBRATION THERAPY ENHANCES OSTEOPOROTIC FRACTURE HEALING BY TARGETING THE FIBRINOLYTIC PATHWAY

**RMW Wong<sup>1,2</sup>, VMH Choy<sup>2</sup>, KS Leung<sup>2</sup>, SKH Chow<sup>2</sup>, WH Cheung<sup>2</sup>, JCY Cheng<sup>2</sup>**

<sup>1</sup>Prince of Wales Hospital, Hong Kong

<sup>2</sup>The Chinese University of Hong Kong, Hong Kong

**Introduction:** It has been long postulated that the fracture hematoma, or fibrin clot, serves as a source of promoting signaling molecules for initiation of healing. However, this long-standing concept has recently been challenged. In fact, a recent study showed fibrin was entirely dispensable and inefficient fibrinolysis caused a derangement in diaphyseal fracture repair in mice. The removal of the hematoma clot was essential for initiation of vascular invasion and fracture healing. Importantly, impaired fibrinolytic activity and bone healing is strongly associated with advanced age and osteoporosis. Therefore, further studies that target fibrinolysis to improve osteoporotic fracture healing are warranted. Tissue plasminogen activator (tPA) is a catalyst that converts plasminogen to plasmin, which degrades the hematoma clot. On the other hand, plasminogen activator inhibitor-1 (PAI-1) inhibits tPA, and both enzymes are expressed in skeletal muscle and endothelial cells. Vibration therapy provides mechanical stimulus to increase physiological responses of muscle activity and perfusion. Clinical studies have proven its effect on increasing tPA and reducing PAI-1 serum concentrations in healthy young men. More importantly, most osteoporotic fractures occur at the metaphyseal region and the effect of vibration therapy on the fibrinolytic pathway in healing is unknown. We hypothesized that vibration therapy enhances fibrinolysis, which accelerates breakdown of the hematoma clot for rapid angiogenesis to improve osteoporotic fracture healing. The primary objective of this study is to target fibrinolysis with vibration therapy to enhance healing in a new clinically relevant osteoporotic metaphyseal fracture model.

**Methodology:** 144 six-month old female Sprague-Dawley rats (n=144) were obtained from Laboratory Animal Services Center of CUHK. Rats were randomized to 4 groups: ovariectomized metaphyseal fracture (OVX-MF; n=36), ovariectomized metaphyseal fracture with low-magnitude high-frequency vibration (LMHFV) (OVX-MF-VT; n=36), sham metaphyseal fracture (Sham-MF; n=36) and sham metaphyseal fracture with LMHFV (SHAM-MF-VT; n=36). Both OVX-MF and OVX-MF-VT rats underwent bilateral ovariectomy (OVX). Sham groups underwent the same procedure but ovaries were left intact. LMHFV was 35Hz vertical vibration, peak-to-peak magnitude 0.3g, 20 minutes/day, 5 times/week. Metaphyseal fracture: after general anesthesia, the left femur was disinfected and draped. A 3 cm skin incision was made over lateral aspect of left thigh and the lateral femur was exposed from lateral condyle to mid-shaft. A 6-hole T-shaped miniplate with two 8mm screws and three 6mm screws were used to fix the plate to distal femur. A small oscillating saw was used to perform an osteotomy at the distal femur. After normal saline irrigation, the wound was closed in layers. Rats were euthanized at 3 days, 1, 2, and 6 weeks post-surgery (n=6 per time-point). Assessments were Clinical, X-rays, Micro-computed tomography, Histology: Hematoxylin-Eosin (H&E), Safranin O (SO: stain for proteoglycans), Martius Scarlet Blue (MSB: stain for fibrin), Immunohistochemistry: tPA, PAI-1, VEGF (at fracture site), ELISA: tPA, PAI-1 (at hamstring muscle and serum) were performed. Mechanical testing was performed at 2 and 6 weeks (n=6 per time-point). Analysis of variance tests were used to compare means for continuous variables.

## AP02

**Results and Analysis:** All rats resumed weight bear as tolerated. 94% OVX-MF, 97% OVX-MF-VT, 97% Sham-MF and 94% Sham-MF-VT rats survived without complications. The cause of death was general anesthesia. All rats achieved healing at 6 weeks. X-ray relative radiopacity for OVX-MF-VT and Sham-MF-VT were significantly higher compared to respective controls on week 2. Micro-computed tomography revealed significantly higher bone volume fraction (BV/TV) at day 3 for OVX-MF-VT compared to OVX-MF. At week 6, BV/TV and bone volume (BV) for Sham-MF-VT was significantly higher than Sham-MF. Vibration therapy enhanced osteoporotic fracture healing at early stages. H&E staining showed trabecular bone was much decreased after ovariectomy, signifying successful osteoporosis. SO staining showed lack of proteoglycans with minimal cartilage. Healing was a process of intramembranous ossification with trabecular bone formation. Vibration therapy increased osseous tissue and had more mature and consolidated healing. tPA from hamstring muscle was significantly higher for OVX-MF-VT and SHAM-MF-VT compared to controls on day 3. As for PAI-1, SHAM-MF-VT was significantly lower compared to SHAM-MF at day 3. The trend could also be seen for OVXMF-VT. Vibration therapy enhanced tPA and inhibited PAI-1 release from muscle. Serum PAI-1 was significantly lower for SHAM-MF-VT compared to SHAM-MF at day 3. The trend was also shown with OVX-MF-VT at day 3. Immunohistochemistry of tPA at the fracture site showed a significantly lower amount for OVX-MF-VT compared with OVX on day 3. The same trend was seen for Sham-MF-VT on day 3. This signifies increased tPA consumption as it binds to plasminogen to form plasmin, which breaks down the hematoma clot. MSB revealed a significant decrease of fibrin at fracture site for OVX-MF-VT compared with OVX-MF on day 3 ( $p=0.02$ ). There was also a lower fibrin content in SHAM-MF-VT on day 3. Vibration therapy accelerated breakdown of hematoma clot. VEGF was significantly higher for SHAM-MF-VT compared to SHAM-MF on day 7. The trend was also seen with OVX-MFVT on day 7. Angiogenesis occurs rapidly after hematoma breakdown. Mechanical testing revealed that energy to failure was significantly higher for OVX-MF-VT and SHAM-MF-VT compared to respective controls on week 2. Furthermore on week 6, OVX-MF-VT was higher compared to OVX-MF. Vibration therapy enhanced biomechanical strength.

**Discussion and Conclusion:** With the aging population rising, osteoporotic fractures will continue to be a major challenge to both the surgeon and the patient. Validation of interventions with a clinically relevant model is crucial. We have demonstrated that our metaphyseal fracture model heals through intramembranous ossification and trabecular bone formation. Vibration therapy was shown to enhance the fibrinolytic profile from the muscle and fracture site at day 3. This allowed an accelerated breakdown of the hematoma clot and angiogenesis to occur rapidly afterwards. X-ray, Micro-CT and biomechanical strength were improved with vibration therapy. No complications were observed and vibration therapy was safe. We have successfully targeted the fibrinolytic pathway to enhance osteoporotic fracture healing. This study serves as a platform for future clinical trials.

### **A NOVEL MOBILE APP FOR DECISION MAKING IN KNEE PRESERVATION SURGERY: RELIABILITY BETWEEN ARTHROPLASTY NURSE, ORTHOPAEDIC TRAINEE AND JOINT SPECIALIST**

**CK Wong, KB Kwok, SW Wong, KM Lo, YW Hung, JCH Fan**

*Department of Orthopaedics and Traumatology, Alice Ho Miu Ling Nethersole Hospital, Hong Kong*

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## AP04

### **A NOVEL HOSPITAL DESIGNED POSTERIOR-STABILIZED KNEE CEMENT SPACER: STABILITY AND RIGIDITY VERSUS A COMMERCIAL SPACER BY CADAVERIC STUDY AND FINITE ELEMENT ANALYSIS**

**LCM Lau<sup>1,2</sup>, CKB Kwok<sup>1</sup>, ECS Chui<sup>3</sup>, JMK Yu<sup>4</sup>, KKW Ho<sup>3</sup>, KY Chung<sup>5</sup>, YW Hung<sup>1</sup>, JCH Fan<sup>1</sup>**

<sup>1</sup>Department of Orthopaedics and Traumatology, Alice Ho Miu Ling Nethersole Hospital, Hong Kong

<sup>2</sup>Prince of Wales Hospital, Hong Kong

<sup>3</sup>Department of Orthopaedics and Traumatology, The Chinese University of Hong Kong, Hong Kong

<sup>4</sup>Prosthetics and Orthotics Department, Alice Ho Miu Ling Nethersole Hospital, Hong Kong

<sup>5</sup>Department of Orthopaedics and Traumatology, Prince of Wales Hospital, Hong Kong

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### 10-16 YEAR FOLLOW UP OF HIGHLY CROSSLINKED POLYETHYLENE IN TOTAL HIP ARTHROPLASTY: WHAT FACTORS AFFECT WEAR?

**AYL Cheung<sup>1</sup>, CH Yan<sup>2</sup>, H Fu<sup>1</sup>, MH Cheung<sup>1</sup>, PK Chan<sup>1</sup>, PKY Chiu<sup>2</sup>**

<sup>1</sup>Department of Orthopaedics and Traumatology, Queen Mary Hospital, Hong Kong

<sup>2</sup>Department of Orthopaedics and Traumatology, The University of Hong Kong, Hong Kong

**Introduction:** Metal on polyethylene is the most common choice of articulation in total hip arthroplasty (THA). Conventional non-crosslinked ultra-high molecular weight polyethylene has inferior wear resistance and therefore generates wear debris that induces osteolysis affects the survivorship of THA. Increase in acetabular component abduction in THA's with conventional polyethylene has been demonstrated to result in increase in liner wear which in turn, results in higher rates of osteolysis and revision. Whether this same finding holds true for HXLPE liners is still a subject of controversy. To date, only a handful of studies with sufficient follow up durations and cohort sizes have examined this relationship. It has been shown that wear rates of thinner conventional liners are higher than their thicker counterparts. Thinner HXLPE liners have demonstrated higher wear rates in laboratory studies. Asian patients have a smaller body build than their western counterparts. Therefore, it is likely that with use of the same size femoral head ball, a thinner polyethylene liner would need to be used. Understanding of this relationship between liner thickness and wear rate is imperative when performing total hip replacements in the Asian population. We sought therefore to determine (1) the long term clinical and radiological performance of HXLPE, (2) the effect of acetabular component positioning on HXLPE wear, (3) to examine the relationship between polyethylene thickness and wear and (4) determine the influence of patient demographics e.g. age and sex on wear.

**Methodology:** 93 THA's using a single brand of HXLPE liner (Marathon, Depuy, Warsaw, IN, USA), cementless cup (Duraloc, Depuy, Warsaw, IN, USA) and 28mm hip ball were performed in 87 patients. This represents the largest single cohort of THA's using this brand of liner in the literature. Patient demographics including age, sex and activity level were recorded. Clinical outcomes were evaluated using the Harris Hip Score and need for revision surgery. Linear and volumetric wear were determined using the Martell method, which utilizes a computerized, semi-automated, edge-detection technology ((Martell Hip Analysis Suite, version 8.0.4.3; University of Chicago, Chicago IL). Presence of osteolysis and acetabular abduction angle was also assessed.

**Results and Analysis:** Mean age at operation was 51.4 (29-78+/-14) years. Mean duration of follow up was 12.7 years (range 10-16 years). Osteolysis was not present in any of the latest follow up radiographs. Two patients underwent revision procedures at 9.8 years and 6 weeks post-operation for reasons unrelated to polyethylene wear or osteolysis. Mean linear wear that occurred in the first year (creep) after operation was 0.199 mm (0 – 0.995 +/- 0.209). Mean linear wear rate was 0.0331 mm / year (0-0.101 +/-0.0268). Mean volumetric wear was 5.569 mm<sup>3</sup> per year (0-74.962 +/-14.798). Patients over the age of 50 were found to have higher rates of linear wear compared to those aged less than 50 years (0.0275 v.s. 0.041mm per year respectively, p=0.015). Positive correlation (Spearman's rho 0.256) was found between acetabular component abduction angle and linear wear rate (p=0.014). Thinner liners ( $\leq 8$ mm) had similar rates of linear and volumetric wear compared to thicker polyethylene ( $\geq 8.9$ mm) (0.0312 v.s. 0.0332 mm / year respectively, p=0.781 and 8.694 v.s. 4.441, p=0.447).

**Discussion and Conclusion:** This is the only study in the literature with over 10 years of follow up to demonstrate a significant relationship between acetabular abduction angle and linear wear rates of HXLPE in total hip replacement. Other studies with shorter durations of follow up have demonstrated this relationship, whereas those with sufficient follow up durations have smaller cohort sizes and may therefore be underpowered to determine any significant relationship. Linear wear rates of younger (under 50 years) patients were significant higher compared to their older counterparts (50 years and above). Aging is associated with decreases in activity level and number of gait cycles per year. Moreover, prior studies have found that reduction in speed of walking and number of gait cycles resulted in 40% decrease in PE wear over a 10-year period. HXLPE has shown good performance in patients with THA with minimum wear even at long term follow up. No evidence of osteolysis was present in any of the latest follow up radiographs. Increase in acetabular component abduction angle and age less than 50 years at time operation was associated with a significant increase in rates of linear wear. Therefore, proper acetabular cup positioning for THA with HXLPE liners is important in minimizing wear rates. Liner thickness does not appear to significantly affect wear rates and therefore, this has implications towards supporting the use of thinner HXLPE liners e.g. in small acetabuli, large femoral hip balls.



## AP06

**VIBRATION TREATMENT AND  $\beta$ -HYDROXY- $\beta$ -METHYLBUTYRATE TO MANAGE SARCOPENIA – AN ANIMAL STUDY****YN Chim, JY Wang, KS Leung, SKH Chow, WH Cheung***The Chinese University of Hong Kong, Hong Kong*

**Introduction:** Sarcopenia is an aging-induced deterioration of skeletal muscle mass and function. The European Working Group on Sarcopenia in Older People (EWGSOP) defined sarcopenia as 'a syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength with a risk of adverse outcomes such as physical disability, poor quality of life and death'. Adipose tissue is considered to play an important role in muscle physiological and pathological processes, thus contributing to the progression of sarcopenia. Low Magnitude High Frequency Vibration (LMHFV) is a non-invasive biophysical intervention which has been considered as a potential approach to improve musculoskeletal system.

$\beta$ -hydroxy- $\beta$ -methylbutyrate (HMB) is a metabolite of leucine and studies have shown that HMB has positive effects on lean mass increase and muscle strength. Muscle derived stem cells (MDSCs) are a kind of stem cells isolated from muscle tissue and they were shown to play a role in muscle degradation and regeneration. Therefore, we hypothesized that 1) co-application of LMHFV and HMB could reduce fat infiltration in sarcopenic senescence-accelerated mouse (SAM) P8 mice model; 2) LMHFV and HMB combined treatment could suppress in vitro MDSC adipogenic activity through regulating putative signaling pathways.

**Methodology:** This study was divided into 2 parts including the in vivo part and the in vitro part. In part 1, a total of 96 SAMP8 male mice were included in this part, which were randomly divided into 4 groups: Control (CTL), LMHFV treatment only (VIB), HMB only (HMB) and the combined treatment (COM) group. In brief, the interventions started at the age of month 7. There were three time points: 1, 2 and 3 months post-intervention, which were equivalent to the age of month 8, month 9 and month 10 respectively. All the assessments including functional test, histological staining and radiological measurements were evaluated at each end point in all the four groups. In part 2, MDSCs were isolated from gastrocnemius of SAMP8 mice model. After characterization, the isolated cells were randomly allocated to either one of the four groups similar to part 1, control group (CTL), HMB only group (HMB), vibration only group (VIB) and combined group (COM). Assessments including histological staining, mRNA analysis and protein level analysis were evaluated at each end point in all the four groups. Data analysis was done with one-way ANOVA; the significant level was set at  $p < 0.05$ .

**Results and Analysis:** In the first part, the percentage lean mass of control SAMP8 mice was significantly lower than the HMB group, the VIB group and the COM group. Twitch force, tetanic force and specific tetanic force of the COM group showed significantly higher value than the CTL group at month 10. Specific twitch force of both VIB and COM groups were significantly higher than the CTL group at month 10. The grip strength of HMB group, VIB group and COM group were significantly higher than CTL group at month 10. HMB group, VIB group and COM group presented lower fat mass percentage than in control SAMP8 mice. Both the VIB and COM groups presented significantly lower oil red O (ORO) area than CTL group at month 10. Type I muscle fiber in CTL group was significantly higher than HMB group, VIB group and COM group at month 10. In the second part, after 10-day adipogenic induction in MDSCs, HMB group, VIB group and COM group presented significantly lower ORO area than CTL group. Relative expression of PPAR  $\gamma$  mRNA of MDSCs in CTL group was significantly higher than HMB group, VIB group and COM group. Relative expression of PGC1  $\alpha$  mRNA of MDSCs in CTL group was significantly higher than VIB group and COM group. Relative expression of C/EBP  $\alpha$  mRNA of MDSCs in CTL group was significantly higher than COM group and marginally higher than HMB group. Relative expression of  $\beta$ -catenin mRNA in CTL group was significantly lower than HMB group and COM group. Relative expression of  $\beta$ -catenin protein in CTL group was significantly lower than HMB group, VIB group and COM group.



**Discussion and Conclusion:** Our *in vivo* data suggested that combined intervention of HMB and LMHFV could further enhance muscle strength as compared to either treatment given alone and decrease percentage fat mass and intramuscular fat infiltration as well in the sarcopenic mice. MDSCs are a kind of stem cells isolated from muscle tissue, with the potential to differentiate into muscle fibers, lipocytes, osteocytes, etc. Wnt/ $\beta$ -catenin signaling pathway was investigated by studying the mRNA expression level and protein level of some key factors of  $\beta$ -catenin signaling pathways in MDSCs. The additive effect of LMHFV and HMB combined treatment was remarkable on  $\beta$ -catenin protein expression level as compared with corresponding single treatment. The repressive effects of HMB, LMHFV and the combined intervention might alter MDSCs cell fate from adipogenesis to myogenesis lineage, which could lead to the inhibition of intramuscular lipid accumulation. These evidences might help explain the reduction of the intramuscular fat tissue by combined treatment of HMB and LMHFV in the *in vivo* part of this study. Therefore, based on both *in vivo* and *in vitro* results, we can speculate that combined intervention of HMB and LMHFV activated the Wnt/ $\beta$ -catenin signaling pathway to alter MDSCs from adipogenesis to myogenesis, thus leading to the decrease of intramuscular fat infiltration, and ultimately improve muscle mass and muscle strength in the sarcopenic SAMP8 mice. Co-application of LMHFV and HMB could improve both muscle mass and muscle function by reducing fat infiltration, which suggested this combined treatment could be used as an intervention for age-related sarcopenia. Wnt/ $\beta$ -catenin signaling pathway is the predominant regulatory mechanism by which LMHFV and HMB combined treatment suppresses MDSCs adipogenesis, which may be the key mechanism of retarding sarcopenia by co-application of LMHFV and HMB in sarcopenic SAMP8 mice. This project was supported by the Direct Grant (2017.047), OTC (2015-SCNT) and NSFC(81472097).

## AP07

### REDEFINING GUIDELINES FOR BRACE WEANING IN ADOLESCENT IDIOPATHIC SCOLIOSIS BASED ON STANDARDIZED SKELETAL MATURITY PARAMETERS

**PWH Cheung<sup>1</sup>, KDK Luk<sup>1</sup>, JPY Cheung<sup>12</sup>**

<sup>1</sup>*The University of Hong Kong, Hong Kong*

<sup>2</sup>*Queen Mary Hospital, Hong Kong*

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### JOINT LINE RESTORATION AND ALIGNMENT AFTER CONVENTIONAL VERSUS ROBOTIC UNICOMPARTMENTAL KNEE ARTHROPLASTY

H Fu<sup>1</sup>, J Manrique<sup>2</sup>, CH Yan<sup>1</sup>, KY Chiu<sup>1</sup>, JH Lonner<sup>2</sup>

<sup>1</sup>Department of Orthopaedics and Traumatology, Queen Mary Hospital, Hong Kong

<sup>2</sup>Rothman Institute, Sidney Kimmel Medical College, Thomas Jefferson University, Philadelphia, PA, United States

**Introduction:** Unicompartmental knee arthroplasty (UKA) is an effective procedure but is technically demanding with outcomes and survivorship directly related to surgical precision. Robotic technique improves accuracy with use of real-time feedback. The commonly utilized semi-autonomous robotic technologies can either be a computed tomography(CT)-based or image-free, relying exclusively on intraoperative registration. This study directly compares radiological coronal alignment, joint line restoration and posterior slope using one of two robotic or conventional techniques in UKA.

**Methodology:** Patients - This retrospective case control study compared 175 matched UKA performed using a conventional spacer block technique (n=52), image-free robotic system (Navio) (n=57) or CT-based robotic system (Mako) (n=66) by a single surgeon. Only medial UKAs were included. Indications for surgery were medial compartment arthritis or medial femoral condyle osteonecrosis. Baseline demographics including age, gender and body mass index(BMI) were comparable between groups. Measurements - Preoperative and postoperative weight-bearing short films were measured by a single observer. Anatomical axis of the limb was measured. Tibial posterior slope was measured on lateral radiographs, using the angle between the tibial plafond and the tibia intramedullary axis. Joint line height was measured on films with calibration for magnification using two validated methods. An angle was defined between a line through the most distal point of the distal femoral condyles and either the lateral femoral cortex (method 1) or the femoral intramedullary axis (method 2). These angles were recreated in postoperative radiographs with reference to the most distal point on the lateral femoral condyle. The height difference between preoperative joint line and the most distal part of the femoral component were recorded. Statistical analyses were performed using IBM SPSS statistics version 22. One way Anova and independent Student's t test were used. A p value of < 0.05 was considered significant. Surgical technique - Fully cemented UKA systems with femoral, tibial components and fixed bearing polyethylene insert were used. An anteromedial incision with medial parapatellar arthrotomy was utilized. In all techniques the surgical plan was to make the tibial coronal cut perpendicular to the tibial mechanical axis, and a posterior tibial slope that matched the native slope but no more than 7°. The femoral position was planned neutral to the mechanical axis, with 0° of rotation. Depth of resection of either component was dependent on creation of a laxity curve that left 1-2 mm of laxity through a full range of motion. CT-based robotics - Mako Robotic Interactive Robotic Arm(RIO) haptic-guided robotic system with Restoris implant was used. A preoperative CT scan was obtained and surgical plan was made using computer software. After attachment of optical tracking arrays, mechanical axis was determined by establishing hip, knee and ankle centre. A probe was used to register bony landmarks and paired with preoperative CT based surgical plan. A real time haptic constrained burr which delineates boundaries was then used for bone removal. Image-free robotics - Navio robotic system with Smith & Nephew Stride implant was used. Preoperative CT scan was not necessary. Similar setup and registration was carried out as for Mako, but osteophytes were first removed prior to registration for accurate soft tissue balancing. Registration was mapped by "painting" the surface anatomy of the femoral condyle and tibial plateau. Intraoperative planning based on 3D images of the registered anatomy was done, followed by bone removal with a burr that offers speed and start-stop control. Conventional - Zimmer ZUK implant was used. Extramedullary tibial cutting guide was used with cut thickness at 2-4mm depending on cartilage wear. Femoral cut was performed using the spacer block technique with distal femur cut parallel to tibial cut. Chamfer cuts over the femur and peg holes were completed with saw. The surgeon targeted an under-correction of mechanical axis individualized based on pre-existing deformity.

## AP08

**Results and Analysis:** Mean age was 61.9 (37-88.9) and mean BMI was 28.5(18.3-42). Mean pre-operative anatomical axis was varus  $1.7^{\circ} \pm 3.12$ . Mean preoperative posterior slope was  $9.8^{\circ} \pm 2.96$ . Age, BMI, laterality, preoperative anatomical axis and slope showed no significant differences. The mean postoperative posterior slope was highest in the conventional group ( $8.98^{\circ} \pm 2.83$ ), followed by Mako ( $7.1^{\circ} \pm 2.5$ ), then Navio ( $5.56^{\circ} \pm 2.18$ ). The differences between groups were statistically significant ( $p < 0.001$ ). The percentage of posterior slope outliers  $> 7^{\circ}$  were 25%, 5% and 3.5% for conventional, Mako and Navio, respectively. Postoperative mean anatomical axes were  $1.49^{\circ} \pm 2.75$  valgus for conventional,  $1.25^{\circ} \pm 2.61$  valgus for Navio and  $0.27^{\circ} \pm 2.93$  valgus for Mako. Conventional produced more overcorrection into valgus when compared to Mako ( $p = 0.023$ ) but not to Navio ( $p = 0.64$ ); nor were there significant difference between overcorrections between Mako and Navio ( $p = 0.053$ ). For joint line height, 33 conventional, 50 Navio and 51 Mako with calibrated radiographs were compared. The joint line was significantly lower in conventional (method 1:  $-1.95\text{mm} \pm 1.77$ ; method 2:  $-1.57\text{mm} \pm 1.62$ ) when compared with Navio (method 1:  $-0.53\text{mm} \pm 1.27$ ; method 2:  $-0.3\text{mm} \pm 1.06$ ) ( $p < 0.001$ ) or Mako (method 1:  $-0.28\text{mm} \pm 1.25$ ; method 2:  $-0.26\text{mm} \pm 0.98$ ) ( $p < 0.001$ ). There were no differences in joint line between Mako and Navio ( $p = 0.65$ ).

**Discussion and Conclusion:** Compared to conventional methods of UKA, both robotic systems produced significantly fewer outliers beyond  $7^{\circ}$  of posterior slope. The Navio produces the smallest excess in slope. For joint line height, both Mako and Navio allow accurate planning and remove bone adjusted to the thickness of the implant, especially over the femur. Conventional spacer block technique makes the femoral cut rely heavily on tibial bone cut and soft tissue tension and is prone to removing less bone and distalising the joint line with potential for overcorrection or compensating for thicker tibial resections. This may have kinematic implications. The lower limb alignment goal for medial UKA is under-correction. Using conventional techniques, soft tissue tension and alignment are achieved by surgeons' intraoperative assessment, relying on surgeons' experience and crude methods of assessment. Coupled with a tendency to lower the joint line, overstuffing the medial joint space with overcorrection into valgus may occur. These findings have significant impact on lateral arthritis progression and may impact implant survivorship. Both robotic techniques can improve joint line restitution and reduce outliers for posterior slope. Further research is needed to confirm the clinical importance of joint line restitution, coronal alignment and posterior slope adjustment in durability and functional outcomes in UKA.



### VALIDATION OF AN OPTICAL TRACKING SYSTEM FOR PATELLOFEMORAL JOINT KINEMATICS IN ANTERIOR CRUCIATE LIGAMENT INTACT AND REMOVED KNEES - A CADAVERIC STUDY

**WH Huang, SC Fu, Y Liu, MTY Ong, PSH Yung**

*Department of Orthopaedics and Traumatology, Faculty of Medicine, The Chinese University of Hong Kong, Hong Kong*

**Introduction:** Patellofemoral joint (PFJ) tracking and biomechanics is important when it comes to the etiology of patellofemoral joint problems. In recent years some researchers reported that the prevalence of degenerative changes in PFJ increased after Anterior Cruciate Ligament (ACL) deficiency and the mechanism remains unknown. The first aim of this research was to validate the reliability of PFJ kinematics using a customized algorithm based portable optical tracking system. The second aim was to investigate whether the differences of kinematics and biomechanics exists in between ACL intact knees and removed knees.

**Methodology:** Ten fresh-frozen cadaveric knees were placed on a customized testing jig, with the femur fixed and the tibia mobile free through 120° of flexion. The cadaveric knees were reviewed by X-ray scanning and Arthroscopy inspection to fulfill the inclusion criteria. Each specimen included the femur, the tibia, and the fibula together with all associated tendons, muscles, fasciae and ligaments. The kinematic data were acquired using a customized algorithm based portable optical tracking system with previously validated coordinate system. The set-up for this experiment consisted of a femur/tibia/patella unit. The quadriceps tendon was loaded in anatomic directions with a 175-newton load which has been used in some previous studies. All three bone segments were identified by optical rigid body equipped with bone pin markers so that relative movements of the three segments could be monitored with respect to each other and in the six degrees of freedom. The PFJ kinematics, including patellar tilting and medial-lateral translation was measured to describe patellar tracking. The ACL was removed by Arthroscopy after the measurement in ACL intact knees. The PFJ contact pressure and contact area were measured through the range of knee flexion using an I-Scan 5051 pressure sensor (I-Scan, Tekscan, Boston, Massachusetts). After calibration, it was inserted through a superior incision in the patellofemoral pouch beneath the quadriceps and anterior to the trochlea. Once positioned to cover the patellar, it was secured into place with sutures into the local soft tissue at either of the distal corners to prevent it from moving in the joint cavity during knee extension. The sutures were positioned distal to the medial and lateral retinacula. Three trials were conducted from knee extension to 120° of knee flexion. The peak contact pressure value, mean contact pressure, and contact area in medial and lateral patellar facet during knee flexion were measured and analyzed. The minimal detectable changes (MDDs) and intra class correlations (ICCs) of kinematics in the PFJ at 0°, 30°, 60°, 90°, 120° of knee flexion were calculated. Mean pressure in medial and lateral patellar facet and peak pressure in medial and lateral patellar facet were also analyzed during knee flexion. Paired t test was used to detect the differences of different outcomes between two ACL conditions (intact and removed) in 5 selected flexion angles (0°, 30°, 60°, 90°, 120°).

**Results and Analysis:** ICC values of kinematics in PFJ are greater than or equal to 0.924. The MDDs of rotational motion is 0.91° and 0.60 mm for translational motion. Regarding medial-lateral rotation, the patellar showed a simplified movement pattern, demonstrating progressively lateral rotation up to 4.8±7.4° at 120° of knee flexion. After ACL removed, the patella show reduced lateral rotations however not statistically different. For patellar tilting, during knee flexion, the patella showed medial tilting and peaked (4.9±6.5°) at 30° of knee flexion. After that, it tilted reversely till the end of flexion, but it kept medial tilt during the whole procedure. The ACL removed knees have a similar pattern. For translation, in general, the patellar showed simplified moving pattern along the medial-lateral axis during knee flexion. The patella shifted laterally increasingly and peaked at around 3.9±6.6 mm at 120° of knee flexion. After ACL removed, the patella show reduced lateral translations however not statistically different ( $P>0.05$ ). Regarding the biomechanics, in ACL intact knees the contact areas shifted from distal patellar facet to proximal patellar facet during knee flexion. No statistical differences of mean contact pressure were found between the medial and lateral PFJ compartment during the whole flexion. No statistical differences of mean contact pressure were found between the ACL intact knees and ACL removed knees in the medial and lateral PFJ compartment during the whole flexion. Regarding the peak contact pressure, in ACL intact knees lateral PFJ compartment demonstrated averagely 0.28 MPa ( $SD=0.3$ ) higher than those in medial compartment during the whole flexion procedure. For ACL intact and removed comparison, significant increased peak contact pressure were found in both medial and lateral patella facet ( $P<0.05$ ) at all selected knee flexion angles.

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**Discussion and Conclusion:** Excellent intra-rater reliability was achieved for this portable optical tracking system. The PFJ kinematics collected by this system is in line with those reported in other similar studies. The small MDDs can be regarded as the threshold to spot significant changes in an individual sample with this system. These results facilitate to improve interpretability of this measurement technique and indicate that this system is reliable and highly sensitive. The current study showed that ACL removed knees show increased medial patellar shift but no significant changes in contact pattern were observed compared with ACL intact knees. Increased peak contact pressure in both medial and lateral patellar compartment indicated that removed ACL leads to altered contact pattern in the PFJ. The increased peak contact pressure may lead to the onset of PFJ degeneration after ACL injury despite of no significant kinematic alterations.



### IDENTIFICATION OF MICRORNA-145 AS NOVEL BIOMARKER FOR PREDICTING CLINICAL CURVE PROGRESSION IN ADOLESCENT IDIOPATHIC SCOLIOSIS – FROM CROSS-SECTIONAL TO LONGITUDINAL STUDY.

JJ Zhang<sup>1,2</sup>, YJ Wang<sup>1,2</sup>, KL Cheng<sup>1,2</sup>, KY Cheuk<sup>1,2</sup>, ALH Hung<sup>1,2</sup>, TP Lam<sup>1,2</sup>, BKW Ng<sup>1,2</sup>, JCY Cheng<sup>1,2</sup>, WYW Lee<sup>1,2</sup>

<sup>1</sup>Department of Orthopaedics and Traumatology, SH Ho Scoliosis Research Laboratory, The Chinese University of Hong Kong, Hong Kong

<sup>2</sup>Joint scoliosis Research Center of Chinese University of Hong Kong and Nanjing University, The Chinese University of Hong Kong, Hong Kong

**Introduction:** Adolescent Idiopathic Scoliosis (AIS) is a three-dimensional spinal deformity occurring predominantly in 10-13 years old girls with a prevalence of 1-4% worldwide. In view of the discordance of curve magnitude and pattern in identical twin study, the etiopathogenesis of AIS has been conceptually divided into a two-phase disease model including initiation and progression. Areal bone mineral density at femoral neck and cortical vBMD at distal radius are reported prognostic factors for curve progression of AIS, suggesting the involvement of systemic bone metabolism in AIS pathogenesis. Our most recent published paper provided experimental evidence on the inhibitory effect of aberrant miRNA-145/ $\beta$ -catenin expression on the structural and functional activity of osteocyte – the most abundant bone cell orchestrating bone homeostasis in AIS. As miRNA is relatively stable and detectable in biofluids, miRNA-based diagnostic and prognostic biomarkers have been explored in clinical management of many multifactorial disease. This study aimed to explore the association of circulating miRNA-145 level to curve severity in a case-control cohort and its prognostic value for curve progression in a longitudinal cohort of AIS patients.

**Methodology:** Subjects recruitment - This study consisted of a case-control cohort and a longitudinal cohort of AIS patients. Anthropometric, volumetric bone density and bone qualities were documented according to standard protocol. (A) In the case-control study, ninety AIS girls (with Cobb angle distributing evenly from 15 -80o) were recruited from Scoliosis Research Clinic, and forty aged matched healthy girls were recruited randomly from local secondary school as control. Areal BMD (aBMD) of bilateral femoral necks was measured by DXA (XR-46; Norland Medical Systems) and bone qualities in the non-dominant distal radius with HR-pQCT. (B) In the longitudinal study, fifty-two AIS girls sequentially recruited were followed up longitudinally for 6 years with blood taking and curve severity measurement at first visit and radiological Cobb angle assessment at every 6 months interval. The subjects were subclassified into progressive or non-progressive stable group based on changes in the Cobb angle according to SRS criteria ( $> 6$  degrees or  $< 6$  degrees respectively) after completing the 6 years follow-up and reaching skeletal maturity. Materials and Methods - miRNA was isolated from plasma with miRNA isolation kit (Qiagen). Level of miRNA-145 was assayed in real time PCR with designed Taqman probe (Life technologies) after reverse transcriptase reaction (Life technologies). The data were expressed as mean  $\pm$  SD. Mann-Whitney or Student's T test were used to compare miRNA-145 level between groups. Spearman's rank correlation test was used for correlation analysis. Area under ROC curve (AUC) were used to estimate diagnosis efficiency. Significance level was set at  $p < 0.05$ .

**Results and Analysis:** A case-control cohort was introduced to investigate potential of plasma miRNA-145 in estimating curve severity. AIS had a numerically higher level of miRNA-145 in plasma than control. Positive correlation was found between plasma miRNA-145 level and Cobb angle ( $r = 0.236$ ,  $p = 0.026$ ). At end of 6 years follow up, twenty-two AIS subjects were classified as the progressive group and thirty as stable non-progressive group. The Progressive AIS showed significant lower level of miR-145 in plasma than non-progressive stable group ( $p = 0.028$ ). ROC result indicated high prognostic efficacy of miR-145 for curve progression in AIS (AUC=0.66, 95%IC=0.511-0.809).

**Discussion and Conclusion:** The outstanding research question is whether we can reliably predict who is likely to have curve progression at the early presentation of AIS with validated biomarkers in addition to the clinical features. This will be of important clinical implications to inform timely clinical decisions on bracing treatment for the potential progressive group and also to avoid over-treatment of the likely non-progressive AIS. This is the first study to translate an experimental result of mechanistic investigation into clinical implication. Although not reaching statistical significance likely related to the sample size in this pilot study, higher level of miRNA-145 in plasma in AIS is consistent with *in vitro* observation of overexpression of miRNA-145 in primary culture of AIS osteoblasts and osteocytes. Significant association to Cobb angle reveals that plasma miRNA-145 could be an independent and promising prognostic factor that is linked to curve severity. Longitudinal study provides supportive evidence on prognostic value of miRNA-145 as indicated by lower plasma level of miRNA-145 in AIS patients with progressive curve. This pilot study shed light on the good potential of development of miRNA-145 as a novel prognostic biomarker for curve progression in AIS. Future multi-centers longitudinal studies with expanded cohorts will be necessary to further validate the important potential of great clinical implications.