Patient reported outcomes are associated with lower-limb muscle strength and functional performance in Acl-patients – A cross-sectional study

Holsgaard-Larsen, Anders; Jensen, Carsten; Aagaard, Per

Published in:
Osteoarthritis and Cartilage

DOI:
10.1016/j.joca.2014.02.222 showArticle Info

Publication date:
2014

Document version
Submitted manuscript

Citation for pulished version (APA):

Terms of use
This work is brought to you by the University of Southern Denmark through the SDU Research Portal. Unless otherwise specified it has been shared according to the terms for self-archiving. If no other license is stated, these terms apply:

• You may download this work for personal use only.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying this open access version

If you believe that this document breaches copyright please contact us providing details and we will investigate your claim. Please direct all enquiries to puresupport@bib.sdu.dk

Download date: 22. Feb. 2020
moment, knee adduction angular impulse) and varus degrees on the frontal plane of knee joints after operation (P < 0.05). Besides, significant changes were also found in spatiotemporal variables and VAS pain score (P < 0.05). But, there were no gait difference between cemented and cementless cases.

**Conclusions:** Our data suggested that both cemented and cementless TKA can help to improve walking ability of subjects but no significant differences were found between them. So further long term follow up comparison research are urgent needed and the results may help to further understand the advantages and disadvantages between them.

### Table 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cemented Pre-operation</th>
<th>Six month follow up</th>
<th>Cemented Pre-operation</th>
<th>Six month follow up</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st knee adduction moment</td>
<td>0.30 ± 0.06</td>
<td>0.22 ± 0.04*</td>
<td>0.28 ± 0.06</td>
<td>0.21 ± 0.04*</td>
</tr>
<tr>
<td>2nd knee adduction moment</td>
<td>0.26 ± 0.04</td>
<td>0.19 ± 0.03*</td>
<td>0.25 ± 0.04</td>
<td>0.17 ± 0.07*</td>
</tr>
<tr>
<td>Knee adduction angular impulse</td>
<td>0.13 ± 0.03</td>
<td>0.11 ± 0.03*</td>
<td>0.12 ± 0.04</td>
<td>0.1 ± 0.03*</td>
</tr>
<tr>
<td>Peak knee varus impulse</td>
<td>15.2 ± 3.0</td>
<td>10.0 ± 2.0*</td>
<td>14.5 ± 3.1</td>
<td>9.6 ± 1.5*</td>
</tr>
<tr>
<td>Visual analog scale for pain</td>
<td>7.4 ± 1.3</td>
<td>5.0 ± 1.4*</td>
<td>7.3 ± 1.4</td>
<td>4.9 ± 1.27*</td>
</tr>
<tr>
<td>Walking speed (m/s)</td>
<td>0.75 ± 0.17</td>
<td>1.01 ± 0.14*</td>
<td>0.78 ± 0.15</td>
<td>0.99 ± 0.15*</td>
</tr>
</tbody>
</table>

**Figure 1.** Longitudinal symmetry indices (SI) (mean ± SEM) of hind limb (A) swing: stance and (B) paw area in the CBA and Str/ort mice.

**Figure 2.** Longitudinal gait moderation indices (GMI) (mean ± SEM) of hind limb (A) swing: stance and (B) paw area in the CBA and Str/ort mice.

### 187 GAIT ASYMMETRY AND IMBALANCE AS POTENTIAL MARKERS OF NATURAL OSTEOARTHRITIS DEVELOPMENT IN MICE

M. Piles 1, B. Poulet 1, R. de Souza 5, A.A. Pitsillides 1, Y.-M. Chang 1, 1Royal Vet. Coll., London, United Kingdom; 2Univ. Coll. London, London, United Kingdom; 3Universe Federal do Mato Grosso, Cuiabá, Brazil

**Purpose:** Gait changes may non-invasively monitor osteoarthritis (OA) progression. We have recently found that OA-prone Str/ort mice show increasing non-compliance in a treadmill task with age and OA development. The aim herein was to evaluate use of asymmetry and imbalance indices, as predictors of treadmill task non-compliance in Str/ort mouse OA development.

**Methods:** Twenty-two male Str/ort and 20 CBA mice (non-OA prone) were monitored longitudinally and gait measurements (Digipati™ system) taken at 4wk intervals from age 8-36wks or until treadmill task non-compliance; a period encompassing pre-OA and overt, active OA phases in Str/ort mice. Spatiotemporal gait measurements including swing, brake, propel and stance times, stride length and frequency, and paw area were each used to calculate: symmetry index (SI = 100 * [R-L]/[0.5*(R+L)]), and symmetry ratio (SR) = max[R,L] / min[R,L], where R and L were right and left contralateral hind- or fore-limbs. We also defined gait moderation index (GMI) as max[(RR-LF),(LR-RF)], where RR, LR, RF, LF referred to right-hind, left-hind, right-fore and left-fore limbs. Linear mixed effects models were employed to assess the effects of strain, age and strain-age interaction, as well as random mouse effect.

**Results:** Twenty-two male Str/ort and 20 CBA mice completed treadmill tasks until 36wks of age; 9 Str/ort mice dropped-out between 16-28wks and a further 10 at 32 wks. Results were consistent for both SI and SR for all gait characteristics. Longitudinal pattern of SI differed in hind- and fore-limbs for swing: stance ratio, in hind-limb paw area (Figure 1) and stance time (p = 0.03) in CBA and Str/ort mice. Str/ort had lower fore-paw area SI than CBA mice. SI did not differ in CBA and Str/ort for stride length, frequency, swing, propel or brake time; the majority remained stable in hind- but not in fore-limbs. Longitudinal GMI patterns differed between strains (swing: stance, paw area (Figure 2); propel time p = 0.001) except stride length and frequency. SI for hind-limb swing:stance (HR = 1.72, 95% CI: 1.20-2.48, p = 0.004 for per 10 units increase) and GMI for paw area (HR = 0.52, 95% CI:0.27-1.04, p = 0.04, for per 0.1 units increase) were predictors of treadmill non-compliance in Str/ort mice.

**Conclusions:** Longitudinal differences in symmetry and imbalance patterns between CBA and Str/ort mice indicate different gait modification during normal growth periods and OA development. Assuming treadmill task non-compliance is linked with OA, our data suggest that hind-limb asymmetry is more closely related to OA development, but that fore-limb asymmetry tempers these hind-limb OA effects. Vital, capacity for swing: stance asymmetry and paw area gait moderation index to predict Str/ort mouse non-compliance in the treadmill task supports their use as early OA markers.

### 188 PATIENT REPORTED OUTCOMES ARE ASSOCIATED WITH LOWER-LIMB MUSCLE STRENGTH AND FUNCTIONAL PERFORMANCE IN ACL-PATIENTS – A CROSS-SECTIONAL STUDY

A. Holsgaard-Larsen 1, C. Jensen 1, P. Aagaard 1, 1Orthopaedic Res. Unit, Inst. of Clinical Res., Univ. of Southern Denmark, Odense, Denmark; 2Inst. of Sports Sci. and Clinical Biomechanics, Muscle Res. Cluster, Univ. of Southern Denmark, Odense, Denmark

**Purpose:** Is it possible to improve patients’ perception of function and quality of life by improving their physical function and muscle strength? While considered as two distinct constructs, association analysis between objective measures and self-reported outcomes may be used to specify focus areas in the rehabilitation of ACL-patients. Thus,
we used self-reported questionnaires and a set of performance-based objective tests to investigate associations between the two constructs, in ACL-reconstructed patients, a population known to be at high risk of developing osteoarthritis.

Aim: To investigate the extent to which an objective test-battery of 4 separate tests of functional and/or muscle performance are associated with Knee osteoarthritis outcome score (KOOS) subscale scores Sport/Recreation (Sport/Rec) and Quality of life (QOL) in ACL-reconstructed patients, with the perspective of specifying future areas of intervention, that potentially may facilitate rehabilitation in this patient population.

Methods: This cross sectional study was performed in 23 ACL-reconstructed men (mean age: 27.2 ± 5.7 years and BMI: 25.4 ± 3.2) 18-30 month post-surgery. KOOS-questionnaires were completed and subsequently, all patients performed a test-battery composed of: (i) one-leg maximal jump for distance (OLJD), (ii) isometric maximal voluntary contraction (MVC) strength for (iii) knee extensors and (iv) unilateral maximal counter movement jump (CMJ). Sagittal kinematic data was synchronously recorded during CMJ using a 6-camera Vicon MX system. KOOS Sport/Rec and QOL were a priori defined as the depended variables. Furthermore, we defined 4 models of non-dependend variables to be tested using outcomes from the 4 separate tests (Table 1). Multivariate regression analysis was used to determine coefficient of determinations for the 4 defined models.

Results: Moderate associations between OLJD and Sport/Rec (r = 0.26, p < 0.01) and QOL (r = 0.26, p < 0.01) were observed (Model 1; Table 1). Adding either knee extensor or flexor MVC to the analysis (Model 2a,b) increased the strength of the associations (up to r = 0.53, p < 0.01, and r = 0.31, p = 0.02 for Sport/Rec and QOL respectively). Adding both knee extensor and knee flexor MVC strength to the analysis (Model 3) did not improve the regression model. Minor increases in regression strength were observed when including kinematic data from the motion analysis of CMJ (Model 4a,b,c) (up to r = 0.55, p < 0.001, and r = 0.40, p = 0.04 for Sport/Rec and QOL respectively).

Conclusions: A large proportion (31–53%) of the variation in KOOS (Sport/Rec and QOL) was explained by OLJD and knee extensor-flexor strength. Adding CMJ kinematics to the model had only minor additional impact. Thus, the present findings suggest that ACL-patients should be evaluated using both functional performance (OLJD) and lower limb muscle strength testing. This may add to our understanding on how to effectively design future rehabilitation interventions for this patient population, at high risk of osteoarthritis. To examine if patients' self-perceived function and quality of life can be improved by enhancing physical function and muscle strength, more research should be directed towards understanding the association between objective measures and self-reported outcomes.

### Table 1

<table>
<thead>
<tr>
<th>Model 1</th>
<th>Model 2a</th>
<th>Model 2b</th>
<th>Model 3</th>
<th>Model 4a</th>
<th>Model 4b</th>
<th>Model 4c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sport/Rec</td>
<td>QOL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>P</td>
<td>R²</td>
<td>P</td>
<td>R²</td>
<td>P</td>
<td>R²</td>
</tr>
<tr>
<td>0.256</td>
<td>0.012</td>
<td>0.259</td>
<td>0.011</td>
<td>0.516</td>
<td>0.001</td>
<td>0.311</td>
</tr>
</tbody>
</table>

Model 1: One Leg Jump for distance (OLJD) vs. Knee Osteoarthritis Outcome Score (KOOS)

Model 2a: OLJD + extensor isometric maximal voluntary contraction (MVC) vs. KOOS

Model 2b: OLJD + flexor MVC vs. KOOS

Model 3: OLJD + extensor MVC + flexor MVC vs. KOOS

Model 4a: OLJD + extensor MVC + flexor MVC + Counter movement jump (CMJ) Jump height vs. KOOS

Model 4b: OLJD + extensor MVC + flexor MVC + CMJ knee range of motion vs. KOOS

Model 4c: OLJD + extensor MVC + flexor MVC + CMJ deepest knee angle vs. KOOS

**189 INCREASED MEDially ORIENTED GROUND REACTION FORCE DURING gait IN PATIENTS WITH Varus KNEE OSTEOARTHRITIS CAN BE TREAT TARGET TO REDUCE MEDIAL COMPARTMENT LOADS**

T. Nagaura, Y. Niki, K. Harato, Y. Kuroyanagi, Y. Kiryama, T. Mochizuki, Y. Suda 1, Kyo Ushu, Tokyo, Japan; 2 Fussa Hosp., Tokyo, Japan; 3 Kamagaya Gen. Hosp., Chiba, Japan

**Purpose:** Knee abduction moment (KAM) during gait is known to indicate disease severity and prognosis of varus knee osteoarthritis (OA) [Baluinas2002, Hurwitz2002]. Thus, to reduce KAM is a key strategy in treatment of knee OA. KAM is primarily calculated as the product of the resultant ground reaction force (GRF) in the frontal plane and the perpendicular distance from the GRF to the knee joint center (frontal plane lever arm). The GRF and frontal plane lever arm are independent variables and modification of either variable can alter the KAM. Associations between peak KAM and peak frontal plane lever arm, and static alignment in coronal plane (femorotibial angle: FTA) in OA knees have been reported [Hunt2006, Hurwitz2002]. However, correlation between KAM and dynamic parameters during gait, such as toe-out angle, is still controversial [Shull2013]. Purpose of the study was to investigate dynamic index affecting KAM during gait, and to propose possible treat target to reduce KAM in varus OA knees.

**Methods:** Gait analysis was performed on 56 knees of 43 patients (all female) who had varus knee OA of K-L grade 3 (6 knees) and grade 4 (50 knees), and 12 knees of 12 healthy subjects to obtain baseline data. The subject information is summarized in Table 1. After approval of IRB for this study and the informed consent, the subjects were tested at gait laboratory, using an opto-electronic motion capture system (Pro-reflex, Qualysis, Sweden) and a force plate (AM6110, Bertec, USA) at synchronized frequency of 120 Hz. Total of 6 skin makers were placed on the subjects on each segment of the lower limb and iliac crest. All the subjects performed level walking on a 10 m walk-way with their comfortable walking speed. KAM was calculated using an inverse dynamics approach and normalize to percent bodyweight times height (%BW x Ht), and GRF was normalized to percent bodyweight (%BW). Two components of GRF (medial: perpendicular to progression of gait and medially oriented, and vertical: vertical to anterior-posterior and mediolateral axis) were analyzed. GRF frontal plane lever arm was defined as the distance between knee joint center and maximum ground reaction force vector during stance phase of gait. KAM and gait parameters (toe-out angle, medial and vertical GRF, frontal plane lever arm) were statistically compared between OA and healthy groups using student T-test. Correlation between KAM and limb alignment (FTA in standing radiography), and the gait parameters were statistically evaluated in patients group by Pearson’s regression analysis. Correlation coefficients and significance levels were indicated in the text.

**Results:** Overall, KAM, medial and vertical GRF, and frontal plane lever arm of the OA group were statistically greater than those in healthy group, but there was no difference in toe-out angle between these two groups (Table 1). In OA knees, KAM was significantly correlated with FTA and medial GRF but not with toe-out angle and vertical GRF (Figures 1-3, Table 2). In addition, medial GRF was significantly correlated with frontal plane lever arm (R = 0.38, P = 0.04) but not with FTA (R = 0.22, P = 0.1).

**Discussion & Conclusions:** Although this cohort includes more severe OA knees than past studies [Baluinas2002, Hurwitz2002, Hunt2006], our results agree with those studies that KAM closely correlates with FTA and frontal plane lever arm. This fact suggests that static and dynamic limb alignment on the coronal plane is primary factor to determine KAM during gait, and explains validity to correct coronal plane limb alignment by surgeries such as high tibial osteotomy or total knee arthroplasty. Both medial and vertical GRF were increased in OA knees, however only medial GRF correlated with KAM (Figures 1-3 and Table 2). Also, toe-out angles in OA group did not show any correlation with KAM or other gait parameters (data not shown). Thus, increased medial GRF is thought to be a secondary factor to increase KAM. The results indicate that modification of gait pattern to reduce medial GRF by non-surgical interventions (insole, gait training, etc) may be effective to reduce KAM and medial compartment loads, but effect of changing toe-out angle remains unclear.