

Generalized Joint Hypermobility and Specific Knee Laxity

Aspects of Influence of the Anterior Cruciate Ligament-injured Knee

AKADEMISK AVHANDLING

Som för avläggande av medicine doktorsexamen vid Sahlgrenska akademien, Göteborgs universitet kommer att offentlig försvaras i hörsal aulan, R-huset, Sahlgrenska Universitetssjukhuset/Möndal

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av

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Avhandlingen baseras på följande delarbeten

- I. Generalized joint hypermobility increases ACL injury risk and is associated with inferior postoperative outcome – A systematic review. Sundemo D, Hamrin Senorski E, Karlsson L, Horvath A, Karlsson J, Ayeni O, Juul-Kristensen B, Samuelsson K. Manuscript under revision for BMJ Open Sport & Exercise Medicine
- II. Sport-specific patient-reported outcome is positively associated with Beighton score in patients one year after ACL reconstruction. Sundemo D, Karlsson J, Samuelsson K, Beischer S, Thomeé R, Thomeé C, Hamrin Senorski E. Manuscript
- III. Correlation between quantitative pivot shift and generalized joint laxity: a prospective multicenter study of ACL ruptures. Sundemo D, Blom A, Hoshino Y, Kuroda R, Lopomo N.F, Zaffagnini S, Musahl V, Irrgang J.J, Karlsson J, Samuelsson, K and The PIVOT Study Group. Knee Surgery Sports Traumatology Arthroscopy. 2018, 26(8):2362-2370
- IV. Contralateral knee hyperextension is associated with increased anterior tibial translation and fewer meniscal injuries in the anterior cruciate ligament-injured knee. Sundemo D, Mikkelsen C, Cristiani R, Forssblad M, Hamrin Senorski E, Svantesson E, Samuelsson K, Stålmán A. Knee Surgery Sports Traumatology Arthroscopy. 2018, 26(10):3020-3028
- V. Increased postoperative manual knee laxity at 2 years results in inferior long-term subjective outcome after anterior cruciate ligament reconstruction. Sundemo D, Sernert N, Kartus J, Hamrin Senorski E, Svantesson E, Karlsson J, Samuelsson K. American Journal of Sports Medicine. 2018, 46(11):2632-2645

**SAHLGRENKA AKADEMIN
INSTITUTIONEN FÖR KLINISKA VETENSKAPER**



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Abstract

Injury to the anterior cruciate ligament (ACL) is one of the most serious sports-related injuries, with significant short- and long-term morbidity. Generalized joint hypermobility (GJH) and specific knee laxity are factors that have been associated with an increased risk of ACL injury and inferior postoperative outcome, but the state of the evidence is unclear and the available information is limited. This thesis consists of five studies with the overall aim of investigating how two main concepts, GJH and specific knee laxity, affect the outcome after ACL reconstruction and how the two concepts affect each other.

Study I is a systematic review aiming to investigate the influence of GJH on ACL injury risk and postoperative outcome. Study I comprised 21 studies. While the data synthesis demonstrated GJH as a risk factor for ACL injury in males, the results were conflicting in females. Moreover, there was limited evidence indicating that GJH is associated with increased postoperative knee laxity and inferior patient-reported outcome after ACL reconstruction. Study II is a register-based cohort study comprising 142 patients undergoing ACL reconstruction. The outcome variables were assessed one year after ACL reconstruction and were analyzed using two methods: (1) dichotomization based on the presence of GJH and (2) linear regression to investigate continuous associations with the Beighton score. Interestingly, and contrary to the hypothesis, the analysis revealed that the KOOS sports and recreation subscale was associated with the continuous Beighton score. Functional performance, evaluated with hop and strength tests, was acceptable, regardless of the presence of GJH. Study III is an international multicenter cohort study investigating the correlation between the Beighton score and rotatory knee laxity in 96 ACL-injured patients. Rotatory knee laxity was evaluated using the pivot-shift test, using two devices to quantify laxity. No correlations between GJH and quantitative rotatory knee laxity were observed in the ACL-injured knee. However, in the contralateral healthy knee, a weak yet significant correlation was observed. Study IV is a retrospective register-based cohort study comprising 8,502 patients undergoing ACL reconstruction. The patients were divided into four subgroups based on the degree of hyperextension of the contralateral healthy knee. The degree of contralateral hyperextension was analyzed in relation to anterior tibial translation (ATT), using the KT-1000 arthrometer, and in relation to the frequency of concomitant intra-articular injuries in the ACL-injured knee. The ATT was examined six months postoperatively. The study identified an association between contralateral knee hyperextension and greater ATT in the ACL injured knee. Interestingly, there was an inverse relationship between the degree of contralateral hyperextension and the frequency of meniscal injuries. Study V is a retrospective cohort study, based on two previous randomized, controlled cohorts, comprising 147 patients undergoing ACL reconstruction. The study analyzed the influence of increased knee laxity assessed two years postoperatively on clinical outcome variables 16 years postoperatively. This study determined that increased ATT, measured with the Lachman test and the anterior drawer test, was associated with inferior patient-reported outcome 16 years postoperatively. Moreover, increased rotatory knee laxity, measured with the pivot-shift test, was associated with inferior patient-reported outcome and a lower level of physical activity after 16 years.

Taken together, this thesis provides an overview of all the currently available studies on the subject of the influence of GJH on ACL injury risk and postoperative outcome. It further demonstrates that acceptable short-term functional results could be found in patients with GJH after ACL reconstruction and that patients with increased hypermobility may have short-term subjectively perceived advantages. Moreover, the thesis provides the first correlation analysis between quantitative pivot shift and GJH, finding no association in the ACL-injured knee but a weak correlation in the contralateral healthy knee. Knee hyperextension, a part of GJH, is demonstrated to be associated with increased anterior knee laxity. As identified by Study V, increased anterior and rotatory knee laxity is associated with inferior long-term patient-reported outcome and a lower level of activity after 16 years, results that elucidate the importance of reducing postoperative knee laxity. Considering the accumulated evidence from the current thesis, reduction of postoperative knee laxity is probably particularly important in the susceptible group of individuals with GJH.

Keywords: Knee, anterior cruciate ligament, anterior cruciate ligament reconstruction, generalized joint hypermobility, knee laxity, patient-reported outcome