

# Predictors of Outcome after Anterior Cruciate Ligament Reconstruction

## Akademisk avhandling

som för avläggande av medicine doktorsexamen vid Sahlgrenska akademien, Göteborgs universitet kommer att offentlig försvaras i hörsal Arvid Carlsson, Academicum, Medicinargatan 3, Göteborg, fredagen den 23 mars 2018, klockan 09.00

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## Avhandlingen baseras på följande delarbeten

- I. Hamrin Senorski E, Samuelsson K, Thomee C, Beischer S, Karlsson J, Thomee R. Return to knee-strenuous sport after anterior cruciate ligament reconstruction: a report from a rehabilitation outcome registry of patient characteristics. *Knee Surgery Sports Traumatology Arthroscopy*, 2017 May;25(5):1364-1374
- II. Hamrin Senorski E, Svantesson E, Baldari A, Ayeni OR, Engebretsen L, Franceschi F, Karlsson J, Samuelsson K. Factors that affect patient-reported outcome after anterior cruciate ligament reconstruction – a systematic review of the Scandinavian knee ligament registers. *British Journal of Sports Medicine*, Conditionally accepted
- III. Hamrin Senorski E, Svantesson E, Sundemo D, Musahl V, Zaffagnini S, Kuroda R, Karlsson J, Samuelsson K. Preoperative knee laxity measurements predict the achievement of a patient-acceptable symptom state after ACL reconstruction: a prospective multicenter study. *Journal of ISAKOS*, 2018, doi:10.1136/jisakos-2017-000186
- IV. Hamrin Senorski E, Alentorn-Geli E, Musahl V, Fu F, Krupic F, Desai N, Westin O, Samuelsson K. Increased odds of patient-reported success at 2 years after anterior cruciate ligament reconstruction in patients without cartilage lesions: a cohort study from the Swedish National Knee Ligament Register. *Knee Surgery Sports Traumatology Arthroscopy*, 2017, doi:10.1007/s00167-017-4592-9
- V. Hamrin Senorski E, Svantesson E, Beischer S, Grassi A, Krupic F, Thomee R, Samuelsson K. Factors affecting the achievement of a patient acceptable symptom state one year after ACL reconstruction - A cohort study on 343 patients from two registries. *Orthopaedic Journal of Sports Medicine*, 2018, Accepted
- VI. Hamrin Senorski E, Svantesson E, Beischer S, Thomee C, Grassi A, Krupic F, Thomee R, Karlsson J, Samuelsson K. Concomitant injuries may not reduce the likelihood of achieving symmetrical muscle function one year after anterior cruciate ligament reconstruction – a prospective observational study based on 263 patients. *Knee Surgery Sports Traumatology Arthroscopy*, 2018, doi:10.1007/s00167-018-4845-2
- VII. Hamrin Senorski E, Svantesson E, Beischer S, Thomee C, Thomee R, Karlsson J, Samuelsson K. Low one-year return to sport rate after anterior cruciate ligament reconstruction regardless of patient and surgical factors – A prospective cohort study on 272 patients. *American Journal of Sports Medicine*, 2018, Accepted
- VIII. Hamrin Senorski E, Sundemo D, Svantesson E, Sernert N, Kartus J, Karlsson J, Samuelsson K. Preoperative predictors of 16-year acceptable knee function and osteoarthritis after anterior cruciate ligament reconstruction – an analysis based on 147 patients from two randomized controlled trials. *Manuscript*
- IX. Hamrin Senorski E, Svantesson E, Spindler K, Alentorn-Geli E, Sundemo D, Westin O, Karlsson J, Samuelsson K. Ten-year risk factors of the Knee Injury and Osteoarthritis Outcome Score after anterior cruciate ligament reconstruction: a study of 874 patients from the Swedish National Knee Ligament Register. *Manuscript*

**SAHLGRENKA AKADEMIN**  
**NEUROVETENSKAP OCH FYSIOLOGI**



# Predictors of Outcome after Anterior Cruciate Ligament Reconstruction

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## Abstract

An anterior cruciate ligament (ACL) injury is one of the most common injuries to the knee joint. It is also one of the most researched areas within sports medicine, orthopedics and physical therapy. The goal of this thesis was to evaluate patient-related, surgery-related and injury-related factors that affect the outcome after an ACL reconstruction.

This thesis comprises nine studies covering three themes: *developing a foundation for research*, *short-term predictors* and *long-term predictors*. The primary statistical methods used in this thesis were univariable and multivariable regression analyses with the various binary or continuous dependent outcomes.

The first theme consists of two studies; a cross-sectional analysis of a rehabilitation outcome register, Project ACL, and a systematic review of the Scandinavian knee ligament registers. Based on the results of the study presenting Project ACL, patients who returned to knee-strenuous sport were characterized as having superior patient-reported knee function and a superior psychological state compared with patients who had not returned to knee-strenuous sport. Moreover, this study also illustrated the differences in results related to various definitions of return to sport. Modifiable factors identified in the Scandinavian knee ligament registers that favor superior patient-reported outcome include not smoking, pre- and postoperative specialized rehabilitation, using a hamstring tendon autograft and less time between ACL injury and reconstruction. The non-modifiable factors found in the registers that favor a superior patient-reported outcome included male sex, younger age and not having sustained a concomitant intra-articular injury.

The second theme consists of five prospective studies based on the Swedish National Knee Ligament Register, Project ACL and a multicenter trial. This theme covered the short-term outcomes related to patient-reported knee function, achieving symmetrical knee function defined as a limb symmetry index of  $\geq 90\%$  in five tests of muscle function and return to sport. In terms of patient-related factors, male sex and younger age had a positive influence on returning to sport and patient-reported knee function in the short term, but not on recovering symmetrical knee function. In addition, a higher pre-injury level of physical activity was associated with returning to sport. In terms of surgery-related factors, the use of a hamstring tendon autograft had a positive effect on patient-reported knee function. Finally, patients who had sustained concomitant injuries appeared to run an increased risk of inferior outcome in patient-reported knee function and returning to sport after an ACL reconstruction.

The third theme consists of two studies; an exploratory analysis of two randomized trials and a long-term analysis of the Swedish National Knee Ligament Register. This theme covered the long-term outcomes related to patient-reported knee function and the development of osteoarthritis, i.e. Kellgren-Lawrence grade  $\geq 2$ . In terms of patient-related factors, a minor effect on long-term knee function and osteoarthritis appears to be related to patient characteristics. A lower preoperative body mass index may, however, be an important attribute in understanding which patients report better long-term knee function. Surgery-related factors showed no clinically relevant effect on the long-term outcomes that were studied. The presence of concomitant injuries appears to have a negative influence on the long-term outcome, where cartilage lesions in particular are risk factors for inferior knee function.

**Keywords:** anterior cruciate ligament, ACL, reconstruction, physical therapy, concomitant injury, knee, predictors, outcome