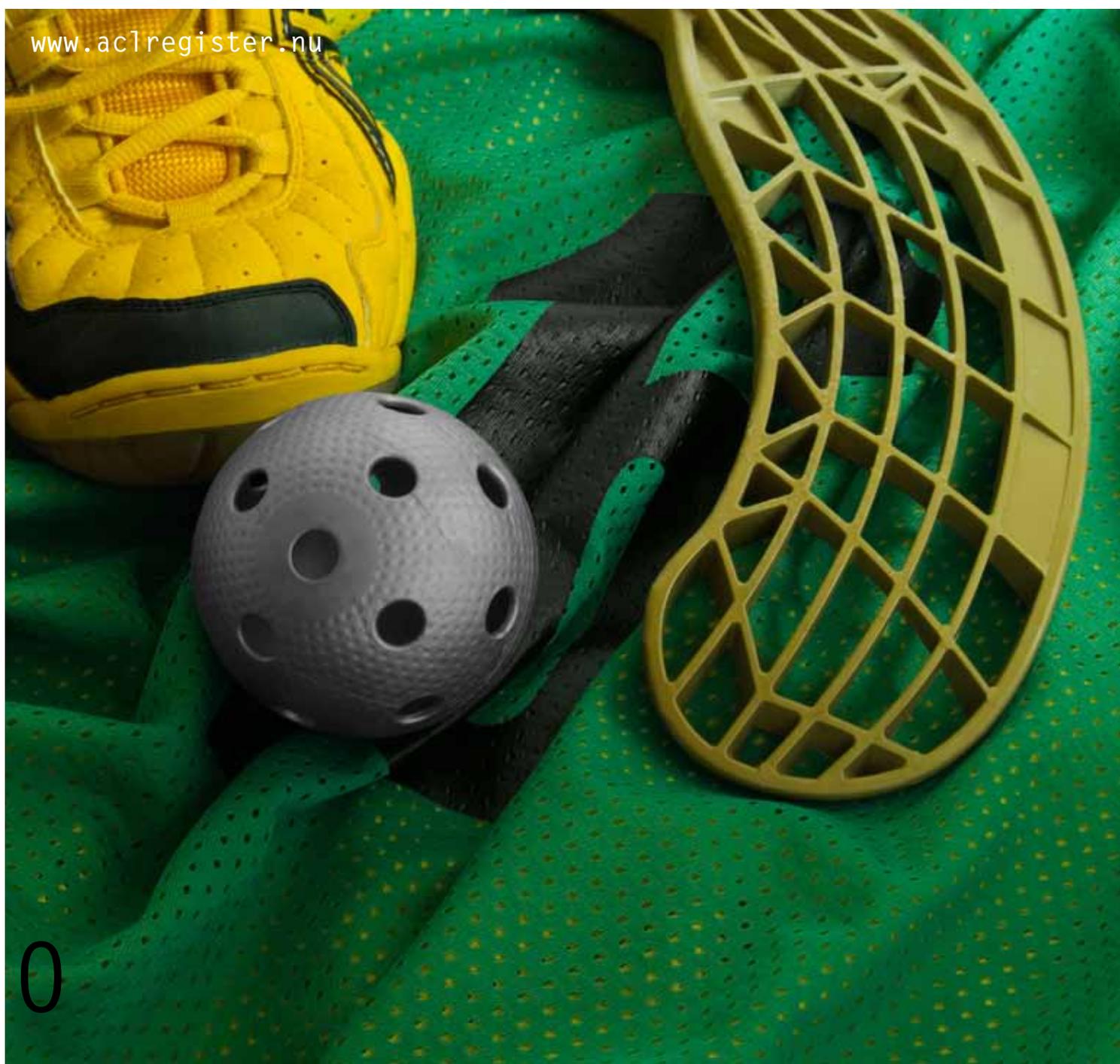


XBase

THE SWEDISH NATIONAL
KNEE LIGAMENT REGISTER

The Swedish National ACL Register Annual Report 2010

www.ac1register.nu



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3331 Primary Operations and 227 Revisions.

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NORRLANDS UNIVERSITETSSJUKHUS UMEÅ NORRTÄLJE SJUKHUS NU-SJUKVÅRDEN NYKÖPINGS LASARETT
ODENPLANS LÄKARHUS ORTHOCENTER STOCKHOLM ORTHOCENTER/IFK-KLINIKEN ORTOPEDISKA HUSET
OSKARSHAMNS SJUKHUS PITEÅ ÄLVDALS SJUKHUS PROXIMA ORTOPEDI ÄNGELHOLM SAHLGRENSKA
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VRINNEVISJUKHUSET VÄSTERVIKS SJUKHUS ÖREBRO USÖ

Preface

Anterior cruciate ligament injury is a serious knee injury that often prevents young people from engaging in heavy labour or physical exercise without adequate treatment. Regardless of primary treatment, studies have shown that around 50% of patients exhibit radiological signs of knee arthrosis within 10-15 years of the initial injury. More recent studies show that roughly 20% of the postoperative patients require repeat surgery within a few years due to complications, due primarily to meniscal or cartilage injury, restricted mobility or failure of the reconstructed cruciate ligament. The results of the secondary surgery are probably poorer than those of the primary surgery. Good short-term results have been reported after primary surgery, but only a few studies are randomised or have a long follow-up period. The incidence of anterior cruciate ligament injury is unknown, but it is assumed to be in the range of 32-70/100,000 inhabitants/year. Recent Swedish studies indicate a slightly higher incidence, around 80/100,000 inhabitants/year. The frequency of ACL surgery in Norway is 42/100,000 inhabitants/year. However, it is estimated that almost half of all ACL injuries are never treated surgically for various reasons. An incidence of approximately 80 per 100,000 inhabitants in Sweden would mean that 7,200 individuals suffer ACL injury annually, of whom more than 3,000 undergo surgery. The number of operations per surgeon is unevenly distributed and 74 of 167 surgeons perform fewer than 10 operations a year. This is, however, an improvement compared with previous years and there is a trend towards an increasing number of operations per surgeon.

Goal fulfilment

The goal of ACL reconstruction is a satisfied patient with optimal knee function and normalised health-related quality of life. The results should also be long lasting.

The main indication for ACL reconstruction is functional instability, which is described mainly as a feeling that “the knee buckles” or “the knee gives way”.

A total of 3,331 primary operations were reported in 2010, compared with 3,089 in 2009. The number of reported revision surgeries was 227 in 2010, compared with 191 in 2009.

The register performs continuous data validation. The online data entry program has instructions, manuals, definitions and help functions, plus a number of mandatory variables, which are available interactively.

National and international discussions on surgical techniques, such as the single- versus the double-tunnel technique, are also being held and it is now possible to start comparing analyses. They will include patient-reported outcomes and the results are expected to have a large impact both nationally and internationally.

Areas of improvement and measures

Preoperative patient-reported data

National coverage of registrations in the register in relation to surgeries performed remains good (90%), but the patients' own entry of patient-reported preoperative data declined by a total of 5% during the year, from 74% to 69% of all registrations. One reason for this is probably the regional changes that have occurred, where Sahlgrenska University Hospital, for example, has fallen from 53% to 23%, Linköping from 73% to 57% and Umeå from 75% to 71%. The Arthro Clinic, which once again performed most procedures in the country in 2010, continues to have a high level of reporting of patient-relevant preoperative data (95%). The board takes a serious view of the reduced frequency of reported baseline data and has instructed its members to contact the clinics that had a negative trend during 2010 to determine the reasons for the change. These reasons will be presented at an upcoming meeting, where specific measures will also be proposed.

Loss to follow-up (LFU)

The follow-up of patient-reported data takes place as before using questionnaires sent to the patient's home address by conventional mail one, two and five years after surgery. After one year, LFU is currently 40%, about 50% after two years and about 65% after five years. These figures are alarming and there may be several reasons. After careful consideration, the board has agreed that the main reason is probably the age and high mobility of the population. The opportunity for using social media in the follow-up work is therefore going to be investigated. In consultation with Richard Frobell, Magnus Forssblad and Joanna Kvist, Anna Pappas has been tasked with exploring the potential for using Facebook or a mobile phone app in the future follow-up work. Very high priority is being given to obtaining a sharp reduction in LFU in 2011.

Non-operated patients with anterior cruciate ligament injuries

The register is still a surgery register, even though the aim for several years has also been to include non-operated patients with anterior cruciate ligament injuries. In 2011, a group consisting of board members Richard Frobell, Magnus Forssblad and Joanna Kvist will begin the pilot registration of all injured patients at a number of clinics in the country. If the outcome is positive, additional clinics will be involved and the plan is that the register should be able to have a functioning national system for registration starting in 2013.

Reporting

- At the present time, there are about 80 clinics in Sweden providing orthopaedic care. Of these, 60 have reported to the Swedish National ACL Register that they perform ACL surgery. A total of 3,331 primary ACL operations and 227 revision operations were registered in 2010. In 2010, 167 ACL surgeons were registered.
- The information is entered into the database via a website: www.acregister.nu. Patients can log into this website to complete questionnaires. Each patient is given a unique user ID and a password that cannot be traced via his/her personal ID number. The completed questionnaires cannot be re-opened by either the patient or any unauthorised person. Security is guaranteed by a temporary password sent via SMS (text message) or by e-ID. The register thereby complies with the security requirements specified by the Swedish Data Inspection Board.
- The individual doctors who register data and use register data in their analyses also have a unique login, which is time limited and updated regularly. This login also takes place using e-ID or double login with a temporary password sent via SMS.
- After each ACL reconstruction, the surgeon reports the operation plus associated patient-related details. The patient questionnaires are completed just before surgery. The patient can be registered even if he or she does not undergo ACL reconstruction surgery but has a diagnosed ACL injury. The patients are then contacted and asked to respond to KOOS and EQ-5D surveys one, two, five and 10 years postoperatively. This work is done at central level.

Reporting back

Each surgeon can process the results himself (or herself) in the register with statistical functions that are posted on the website and also perform calculations on different variables. A printed annual report is sent to clinical directors and health care units that are expected to have an interest in the report. An electronic interim report can also be produced and sent to all clinics and users.

Coverage and response rate

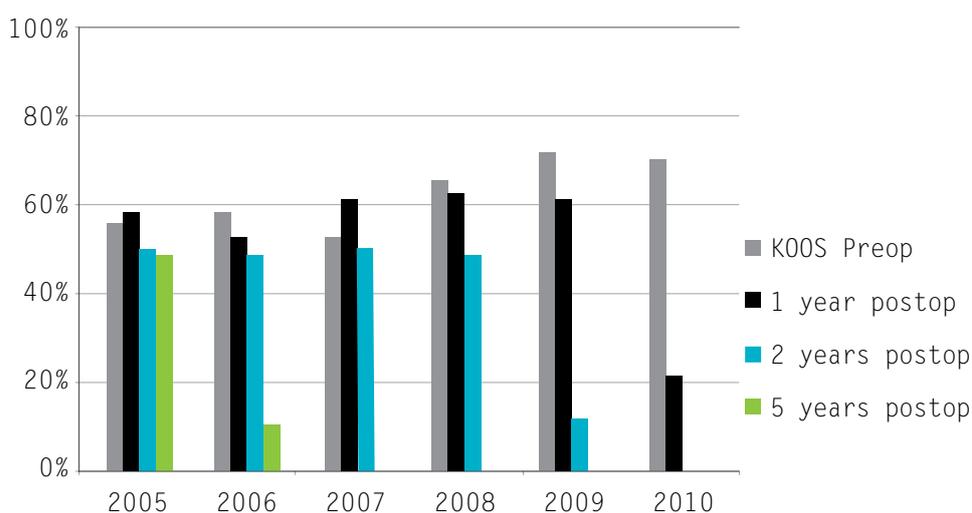
The National Board of Health and Welfare registered 3,318 ACL operations (both primary and revision surgery with surgery code NGE41) in 2009. The Swedish National ACL Register contained 3,257 registered operations in 2008.

The estimated coverage of the national ACL register is more than 90 per cent of all ACL operations in the country. Data from 2010 are not yet available, which explains why the comparison has been made with 2009. The National Board of Health and Welfare's patient register appears to have unreliable reporting, however, since some private care providers are completely absent and the validity of diagnosis/surgery codes is unclear.

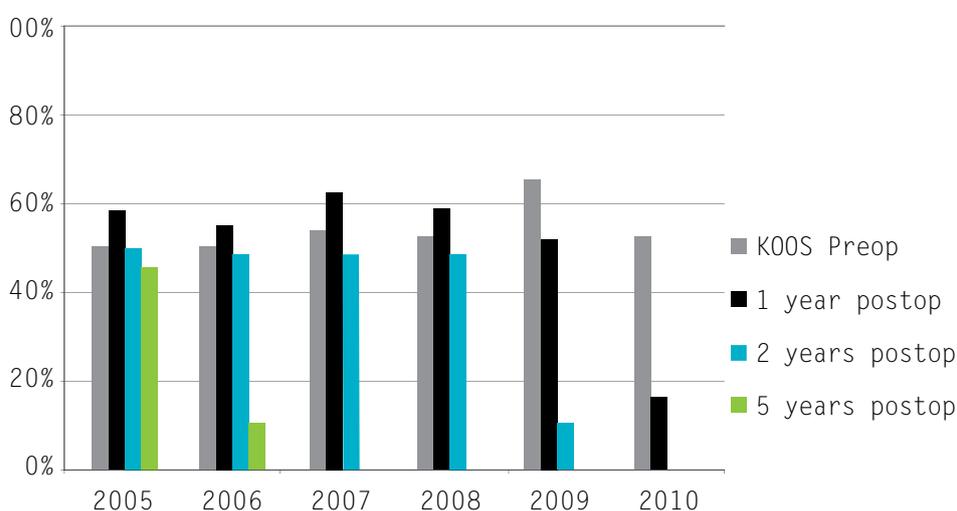
Matching at the personal ID number level shows that the national ACL register and the patient register together have 3,989 unique ACL operations. It is impossible to estimate the actual number.

The increase in the coverage of PROM (Patient Related Outcome Measures) data is one of the main financial costs for the national ACL register and we advocate that joint efforts should be made to set up national web portals, for example.

Response rate for K00S preop,
1, 2 and 5 years postop



Response rate for EQ5 preop,
1,2 and 5 years postop



In order for the results to be credible, the response rate should be high. The preoperative response rate for KOOS declined in 2010 compared with 2009. The preoperative response rate for EQ-5D is lower compared with KOOS, but the postoperative response rate is slightly higher. KOOS and EQ-5D are supposed to be answered by the patients one, two and five years postoperatively.

Funding the ACL register

SKL allocated SEK 600,000 to the national ACL register to cover running costs in 2010. The register is administered in co-operation with the Stockholm Sports Trauma Research Centre, Karolinska Institutet, housed in the premises of the Capio Arthro Clinic at Sophiahemmet in Stockholm. The register provides 50% funding for one employee. Approximately 7,000-10,000 questionnaires are sent out centrally each year by regular mail, resulting in a postage cost of almost SEK 200,000 a year. The register attempts to maintain the list of Sophia addresses and mobile phone numbers so that the questionnaires in these cases can be initiated by a Sophia or text message and refer to the register's website for completion of the questionnaire. There is no cost coverage or funding today for IT, rent and office costs, statistical consultants and the hours put in by registrars, persons in charge of running the register and the board. This work is still done on a voluntary basis. The total funding need for this type of register is estimated at SEK 800,000-1,000,000 a year.

Organisation

The Head of Register is Professor Li Felländer-Tsai, Karolinska University Hospital, Huddinge. The contact person is Anna Pappas, Stockholm Sports Trauma Research Centre, Karolinska Institutet and Capio Arthro Clinic. The board consists of representatives from different regions in Sweden:

1. Johanna Adami, Associate Professor, Karolinska Institutet, Stockholm
2. Lars-Gunnar Elmqvist, Associate Professor, Umeå University Hospital, Umeå
3. Magnus Forssblad, MD, Capio Arthro Clinic and Stockholm Sports Trauma Research Centre, Karolinska Institutet, Stockholm
4. Richard Frobell, MD, Lund University
5. Joanna Kvist, Associate Professor, Linköping University
6. Pär Herbertsson, MD, Lund University Hospital
7. Professor Jon Karlsson, Sahlgrenska University Hospital, Gothenburg
8. Professor Jüri Kartus, NU-Hospital Organization, Trollhättan/Uddevalla

Register data

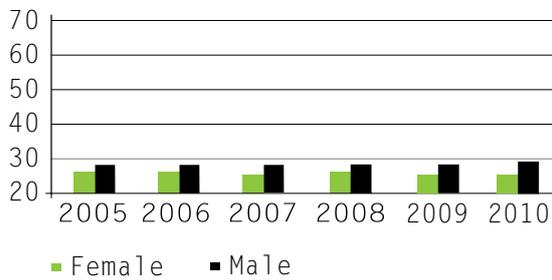
The register contains data on ACL reconstructions in Sweden from January 2005. The information is individually based and the patient's personal ID number shows age and gender. The diagnosis is based on manually entered data. During the period 2005-2010, 16,738 primary ACL reconstructions and 1,026 revision surgeries were registered from a total of 65 clinics.

Age at surgery

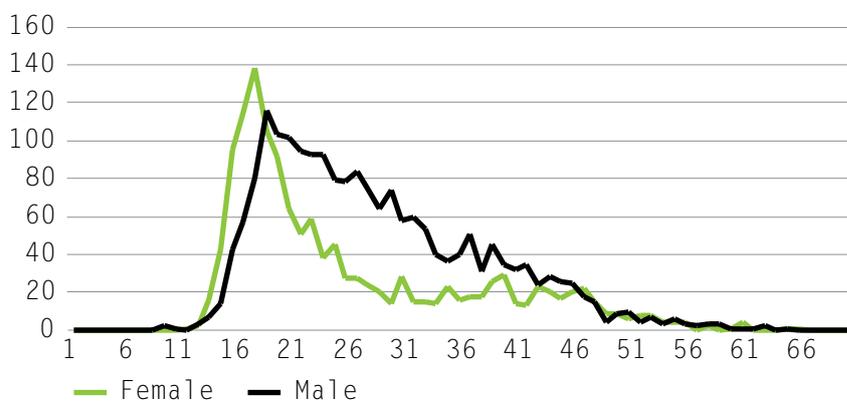
The average age of patients undergoing ACL surgery in the whole country is 27 years. This can be interpreted as meaning that not only young active sportsmen and women but also slightly older people with unstable knees undergo surgery. Women generally have surgery at a younger age than men, 26 versus 28 years in 2010, which does not deviate substantially from the previous year. The probable explanation is that women reach the senior level in ball sports earlier than men and thereby expose themselves to greater risks of a knee ligament injury at a younger age. Men are probably also active in sports for a longer period of time than women.

The age at revision surgery is 27 years for women and 28 years for men. This age varies from year to year: 27 years for women in 2008, 24 years in 2009 and now 27 years again. This is probably due to the small number of revision surgeries in relation to the number of primary operations.

Average age primary ACL



Age distribution primary ACL (no of procedures)



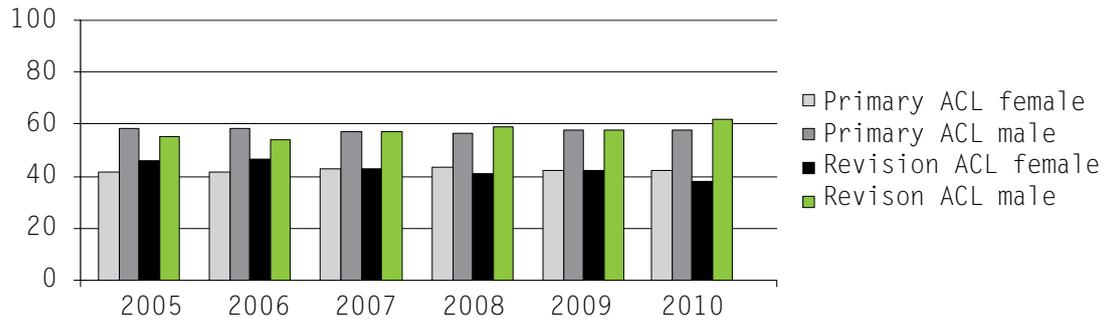
Gender distribution of ACL surgery patients

As in several previous studies conducted in Sweden, roughly 40% of the patients who undergo knee ligament surgery are women and this percentage remains constant year after year. In 2009, 1,300 ACL reconstructions were performed on women and 1,789 on men; the equivalent figures for 2010 were 1,374 women and 1,957 men. This may seem somewhat strange, as we also know that women run a significantly higher risk of suffering a knee ligament injury than men. One explanation could be a trend among women voluntarily to reduce their activity level, take part in a conservative rehabilitation programme and thereby never undergo surgery for their knee ligament injury. It is therefore urgent that ACL-injury patients who seek care for their injury but are treated conservatively are also carefully registered and followed up in the future. No major change has therefore taken place since 2009 when it comes to gender distribution among patients undergoing primary ACL reconstruction.

In terms of revision surgery, 81 such operations were performed in 2009 on women and 110 on men. The corresponding figures for 2010 were 89 women and 138 men.

In other words, an analysis of gender distribution among revision surgery patients reveals a preponderance of men. This probably reflects the true need for revisions, as men return to their previous activity level to a greater extent than women. It is gratifying that the number of revisions on patients with a new ACL injury in the previously operated knee or with unsatisfactory results after the first operation is relatively small compared with the number of patients who undergo primary reconstruction.

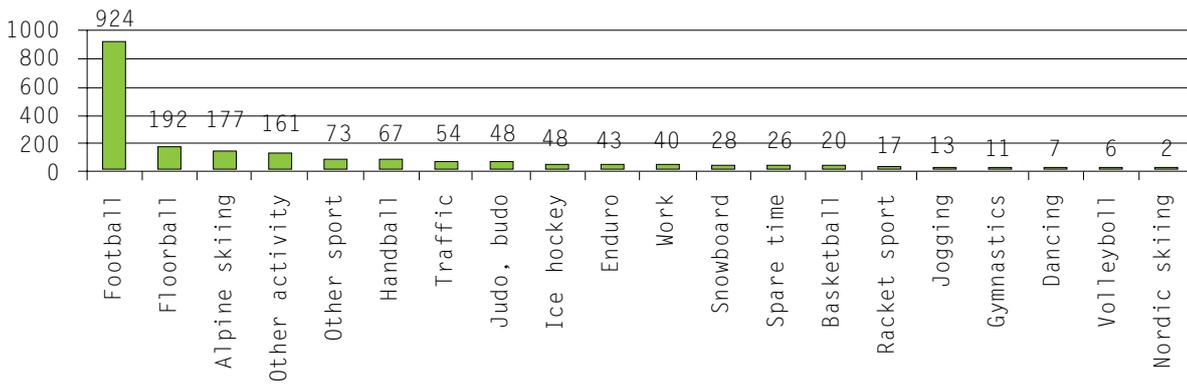
Gender distribution in %



Activity among injured men

By far the most common activity among injured males is football (soccer), followed by floorball and downhill skiing. Traffic accidents come in seventh place, while basketball and other ball sports come further down the list when it comes to the number of operations. If the number of operations is correlated to the number of active participants and the number of training and match hours, the ranking among the different sports is different.

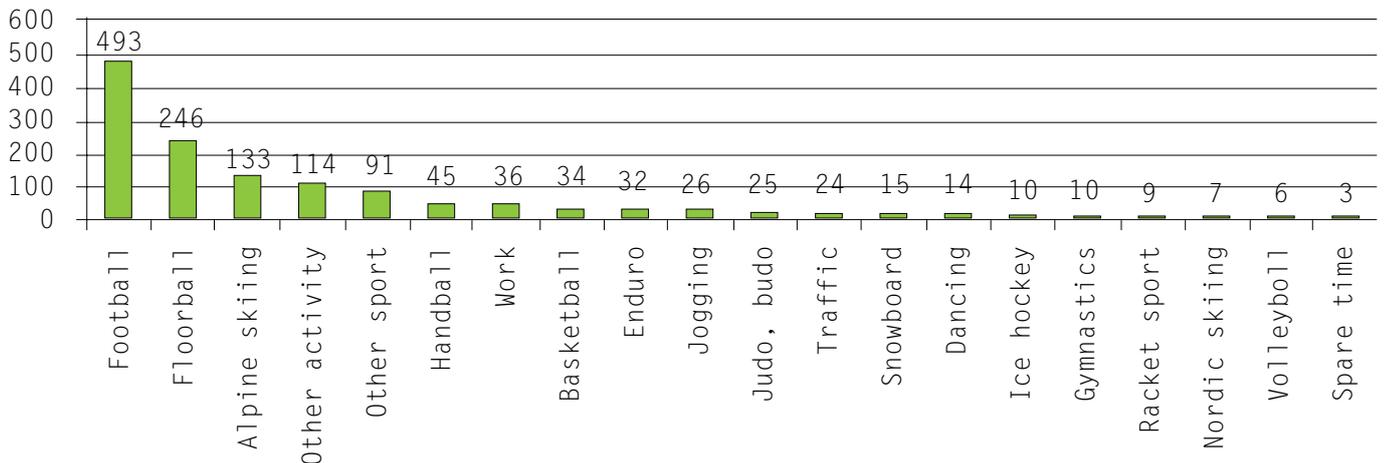
Aetiology men 2010



Activity among injured women

Football (soccer) is the most common activity among injured females, even if it is not as common as it is among men. In contrast to men, gymnastics is a relatively common cause of injury among women.

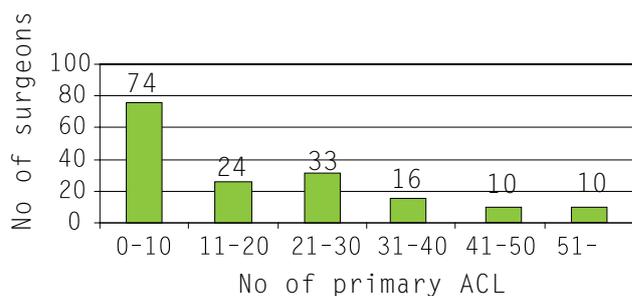
Aetiology women 2010



Duration of surgery and number of surgeons

The average duration of surgery for primary reconstruction in 2010 was 73 minutes, which is slightly lower than in 2009. The average duration of revision surgery is 89 minutes. So, revision surgery does not differ much from primary surgery in terms of time. However, revision surgery may have to be performed in two sessions: previous fixation material is removed in the first session and a bone transplant may also be performed. Only a few surgeons perform more than 50 reconstructions a year and 43% of Sweden's ACL surgeons perform fewer than 10 ACL operations a year.

Surgeons/procedures 2010

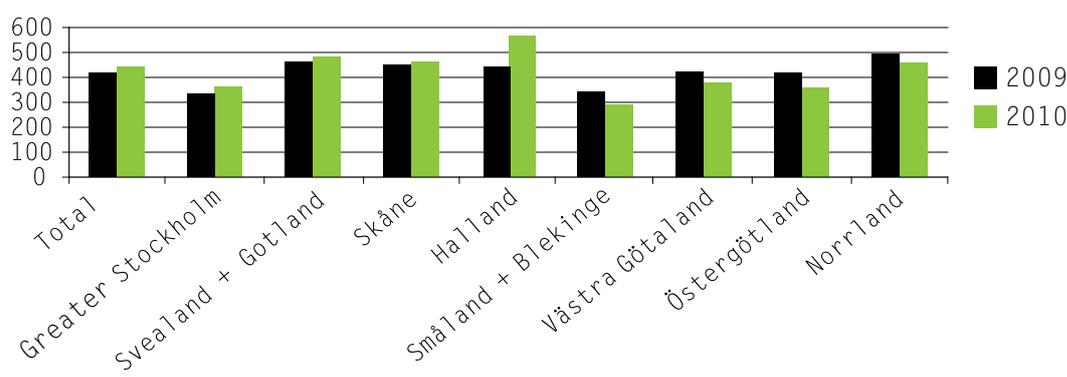


Time between injury and surgery

The average time between injury and surgery in 2010 was 432 days for all patients in the entire country. The corresponding time for 2008 was 402 days, while it was 412 days for 2009. The County of Halland has the longest time between injury and surgery, which it also had in 2008. However, this calculation is based on only 46 patients from the County of Halland. Gender analyses reveal that men have a slightly longer time between injury and surgery than women: 451 versus 405 days. In 2009, the equivalent period was 436 days for men and 380 days for women. This difference is probably not important in reality.

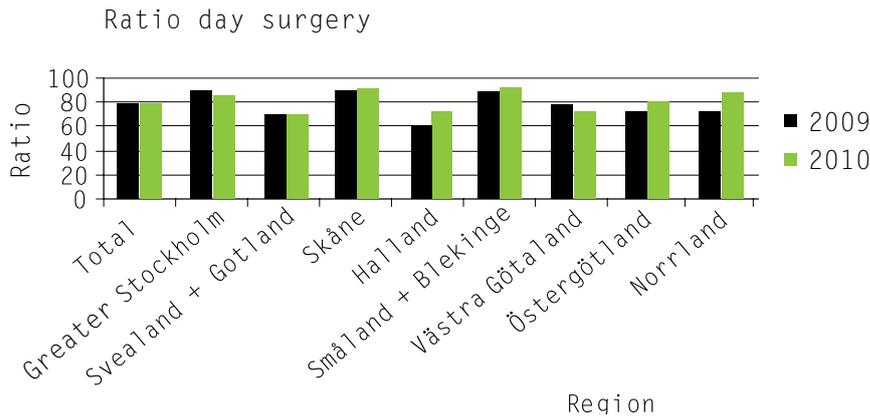
It is not known why the time between injury and surgery is so long. However, it could be that many ACL injuries are not diagnosed by the casualty wards or primary care. Such a long period between injury and surgery is not good, especially for young women, who have a greater tendency to suffer a new injury. Another reason could be that Sweden adopts a treatment algorithm where most patients undergo a non-surgical regimen before the surgical route is chosen. This is in line with the recent discussion regarding the fact that the surgical treatment of knee ligament injuries is not always necessary and satisfactory outcomes can be achieved by means of training and adjustments of activity levels.

Time from injury to surgery



Percentage of day surgery in relation to in-patient care

The percentage of day surgery is rising slowly and remains at around 80%. In Sweden as a whole, 74% of ACL operations were performed as day surgery in 2008. The figure for 2009 and 2010 was almost 80%. More than 90% of ACL reconstructions in Skåne (southern Sweden) were performed as day surgery in both 2009 and 2010. One reason for opting for in-patient surgery is if the patients live so far away from the hospital that they cannot be sent home the same day. Nevertheless, Norrland (northern Sweden) is not distinguished by a lower percentage of day surgery. It now appears to be established practice that ACL surgery should be performed as day surgery.



Surgery variables

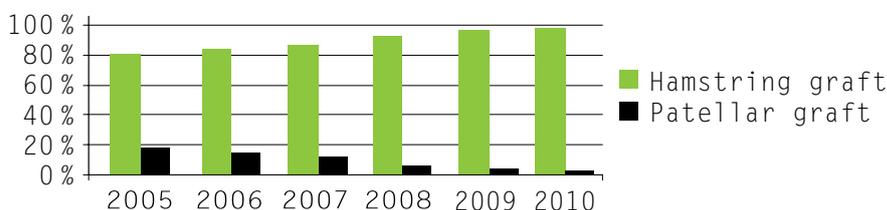
Graft selection

Hamstring tendon grafts have dominated since the start of the national ACL register in 2005. They can be performed with only the semitendinosus tendon or only the gracilis tendon and they must then be doubled, tripled or quadrupled. It is also possible to use both the semitendinosus and gracilis tendons, which can then be sextupled (or more).

Every year, the hamstring tendons have become increasingly popular for grafts, increasing from 82% in 2005 to 98% today. This probably indicates that this is a simpler graft for the surgeon to use and that there is no difference in results between the two methods. The main reason for using the patellar tendon today is that the patient has already undergone surgery with a hamstring tendon for the primary reconstruction. Patellar tendon grafts are therefore mainly used for revision surgery and so there is a risk that new knee ligament surgeons will not learn how to use the patellar tendon.

Allografts as a primary reconstruction alternative are still unusual in Sweden. In 2008, there were nine allo-grafts, in 2009, there were 15 and, in 2010, there were 30 allografts for primary anterior cruciate ligament reconstruction. This is probably influenced by the price. The price of an allograft has more than doubled during the past year and is now almost SEK 20,000. Allografts are probably mainly used for revision surgery and multiple ligament reconstructions (knee dislocation).

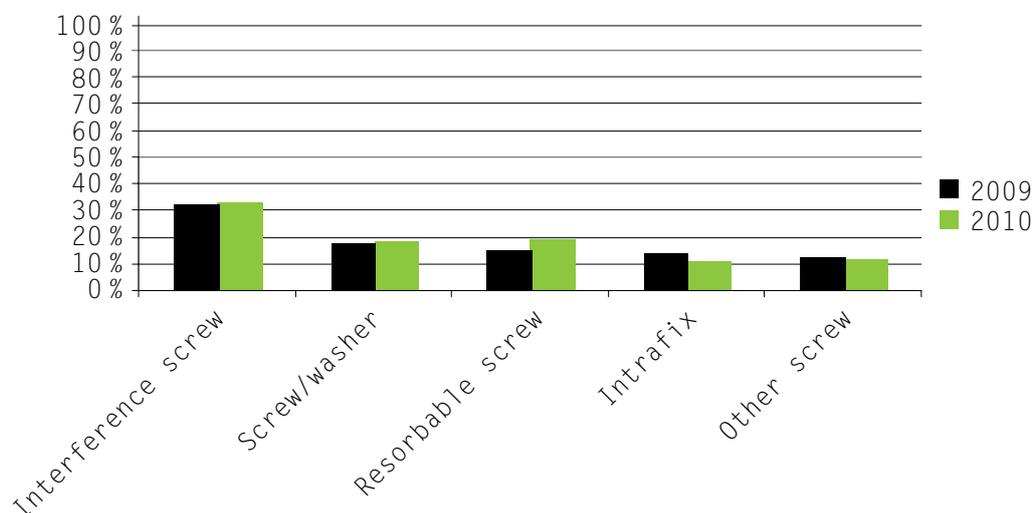
Graft selection 2005-2010



Tibial fixation

In this context, screw fixation still dominates and has once again increased. A standard titanium interference screw is most often used, but the use of resorbable screws and the AO screw has also increased. Sometimes, the interference screw is reinforced with a staple or an osteosuture below the screw anchor.

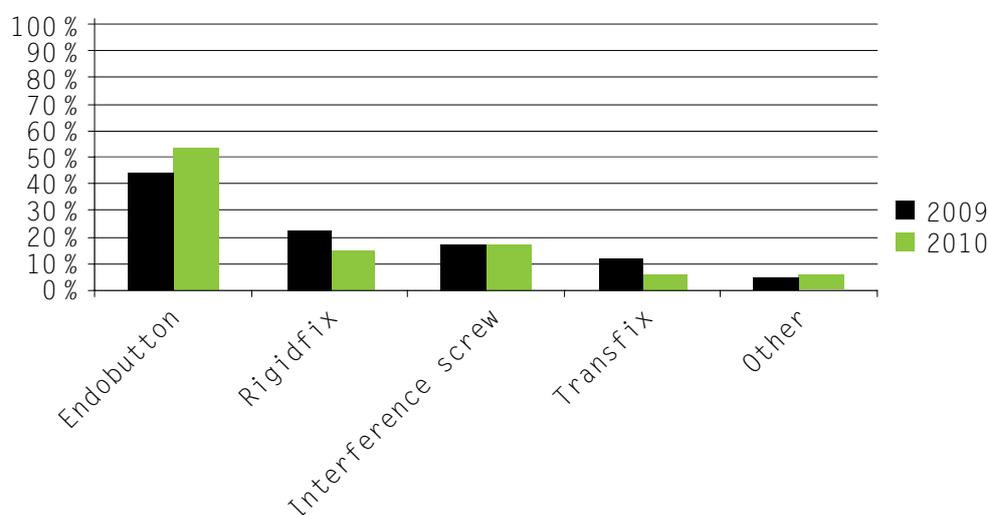
Top 5 Fixation tibia hamstring graft



Femoral fixation

Over the years, a major change has taken place in this area. Previously, resorbable cross-pins were the most widely used form of femoral fixation, but by far the most frequently used fixation nowadays is the cortical button. The use of the cortical button has increased every year and, since 2008, it has increased from 37% to 55% for femoral fixations. All the other femoral fixation methods have decreased, apart from the three fixation methods tested in 2009. These three have not previously been included, but they probably had a trial period at certain clinics. At present, the use of the cortical button is a very popular fixation method. The reason is that it is easy to use and can be applied without any alignment instrument. It can be inserted through the medial portal and, unlike the transtibial method, the surgeon is not obliged to use the tibial tunnel.

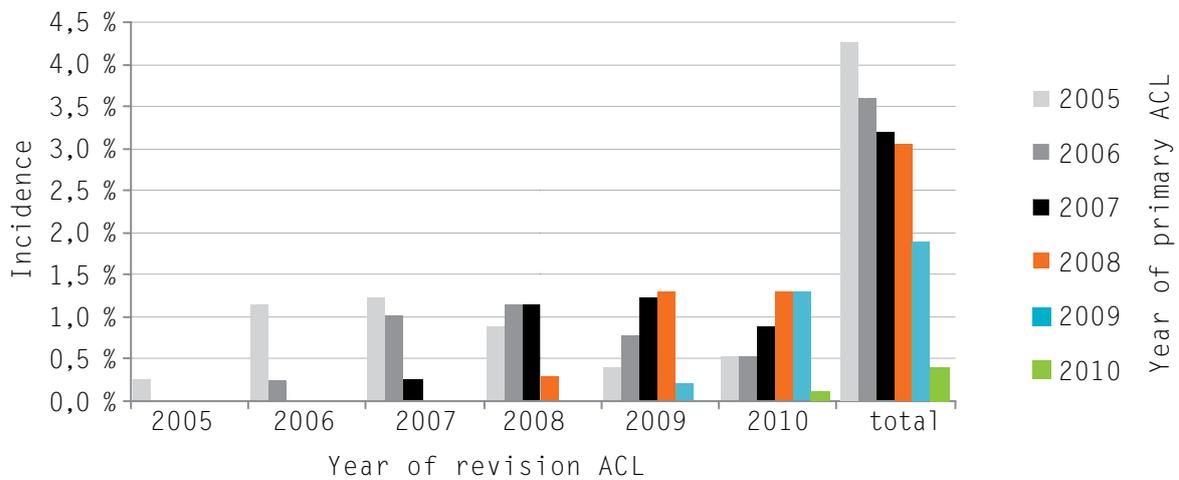
Top 5 Fixation femur hamstring graft



Revision surgery, re-operations and operations on the contralateral side

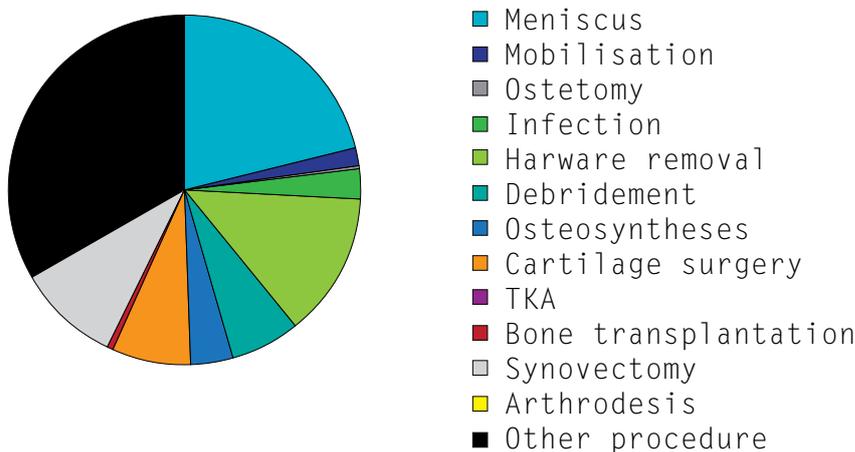
In the national ACL register, a total of 1,023 revision surgeries were registered during the period 2005–2010. Of the patients who underwent primary surgery during the period 2005-2010, a total of 421 have undergone a revision with a new ACL reconstruction. This means that 602 revisions have been performed on patients who underwent primary surgery prior to 2005.

The figure below shows the time of primary and revision surgery. Of the patients who were operated on during the first two years of the register, 2005 and 2006, 4.2% and 3.5% respectively have now undergone a revision operation. The revision rate is still highest during the first two years after the primary operation. The total revision rate for the whole period is 2.4%. The revision rate is higher for patients who were under the age of 18 years at the time of the primary operation: 3.8%.

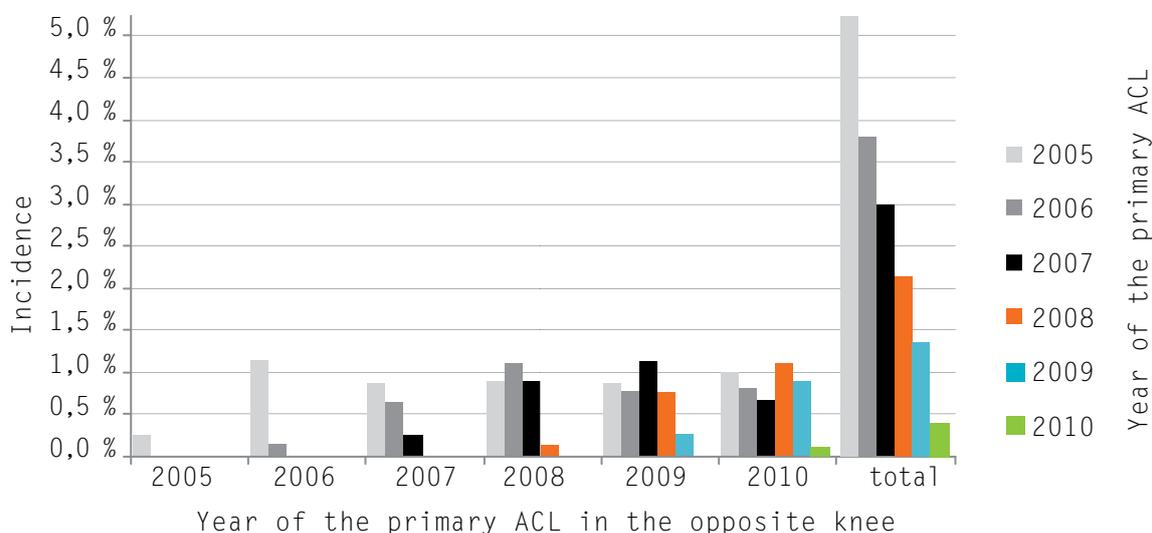


In 2010, the number of patients who underwent a re-operation, i.e. not ACL revision surgery, was 188, an increase of about 20% over 2009. There is clear under-reporting from all clinics, however. The four most common indications for surgery were no other specified procedure 33%, meniscectomy 21%, the extraction of osteosynthesis material 13% and synovectomy 10%. In some cases, when the number of surgical procedures exceeds the number of operated patients, more than one procedure has been performed. Re-operations due to infection totalled 7/188 in 2010 (3.7%), compared with no cases in 2009. The total infection rate in 2010 was 0.2%. There is probably also under-reporting in this area.

Additional surgery 2010



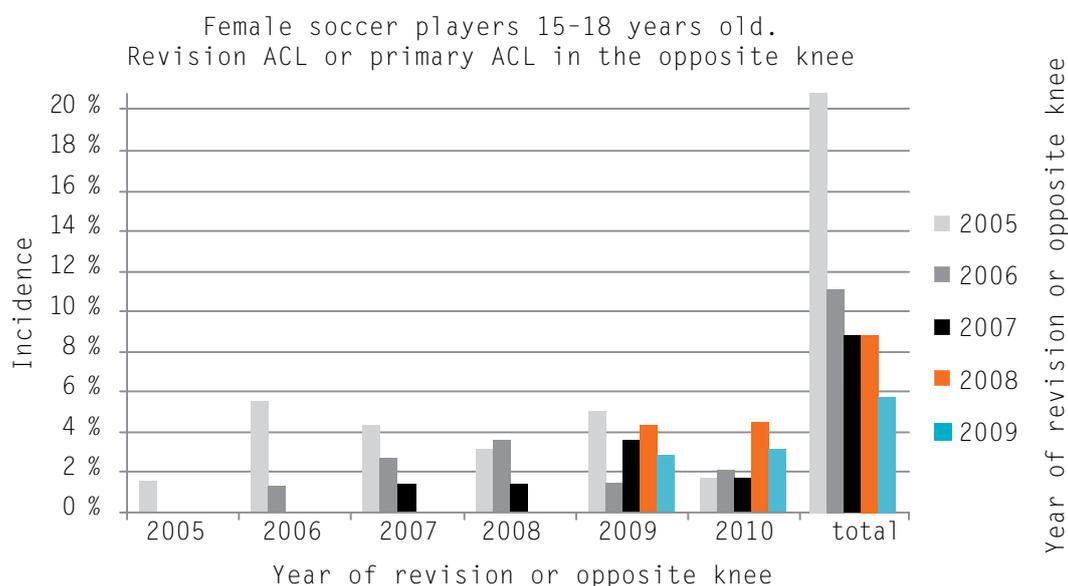
Of the patients who underwent surgery in 2005-2010, 2.1% also underwent ACL surgery on the contralateral side, although the rate is slightly higher, 3.6%, among patients under 18 years of age. The longer the time since the original operation, the higher the rate. Of those operated on in 2005, 5% have undergone surgery on the contralateral side, compared with 1.1% of those who had primary surgery in 2009.



An analysis of the group “women aged 15-18 years at primary surgery” reveals that the revision rate after six years is roughly the same (3.7%) as for men under 18 years of age (4.1%) but clearly higher than for the population as a whole (2.4%).

The rate of anterior cruciate ligament surgery on the contralateral knee for these young women after six years is 3.7% (cf. 3.5% for men), which is substantially higher than for the population as a whole (2.1%). The total risk percentage for young people below the age of 18 who underwent surgery for an ACL injury in 2005 and were operated on again during the period 2005-2010 (on the same or the contralateral knee) is 15.6%.

In the group “female soccer players aged 15-18 years”, more than 20% of those who underwent primary surgery in 2005 have had a new operation on either the same or the contralateral knee. This finding has now initiated a new study in which the number of additional patients who have suffered a new ACL injury but have opted not to have surgery is being investigated.

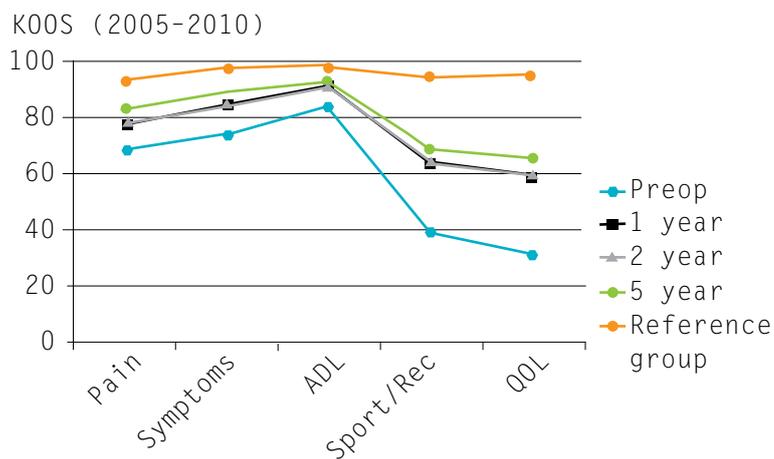


Patient-reported outcome and quality of life (PROM)

KOOS (Knee injury and Osteoarthritis Outcome Score)

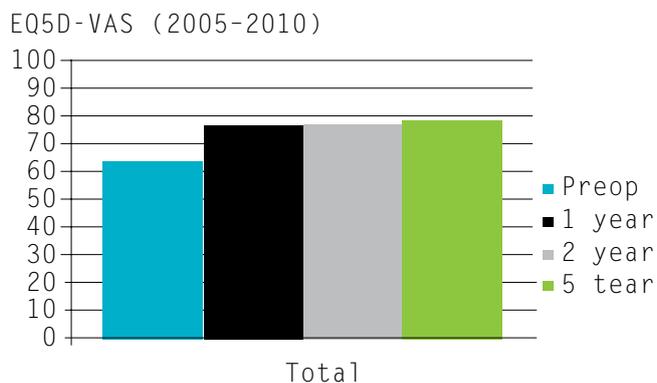
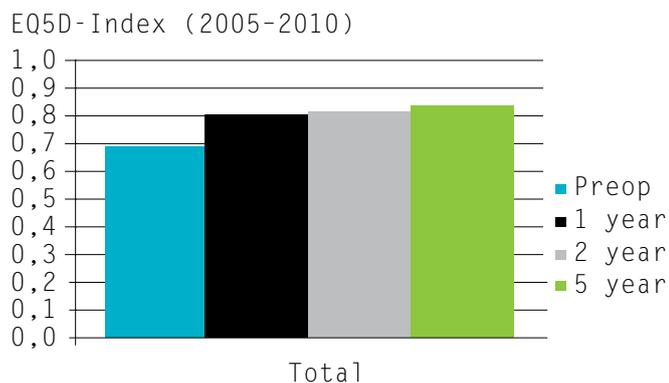
The KOOS is a knee-specific instrument for evaluating the patient's perception of his/her knees and knee-related problems. The instrument evaluates five aspects: pain, other symptoms such as swelling, joint mobility and mechanical symptoms, function in daily living, function in sport and recreation and knee-related quality of life.

Prior to surgery, the patients have an impairment in self-rated function. This impairment decreases one year after surgery and the self-rated function improves gradually over the years up to five years after surgery. In comparison with reference data ("ref") obtained from 118 football players with healthy knees (Frobell et al. 2008), it can be seen that the patients do not achieve normal function one, two or five years after surgery. The greatest differences between the patients before and after surgery and the reference group can be found in "function in sport and recreation" and "knee-related quality of life". The results for 2010 do not differ substantially from those in previous years.



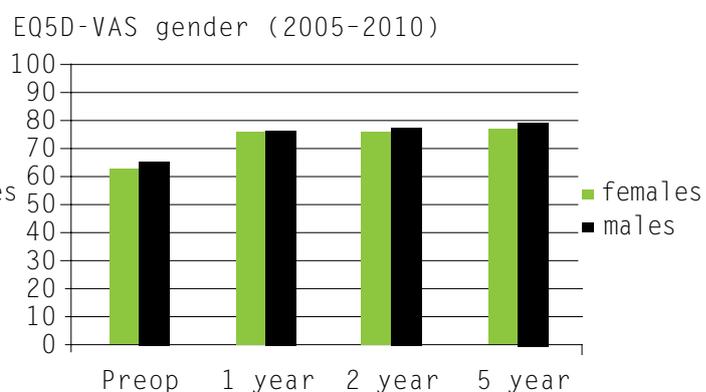
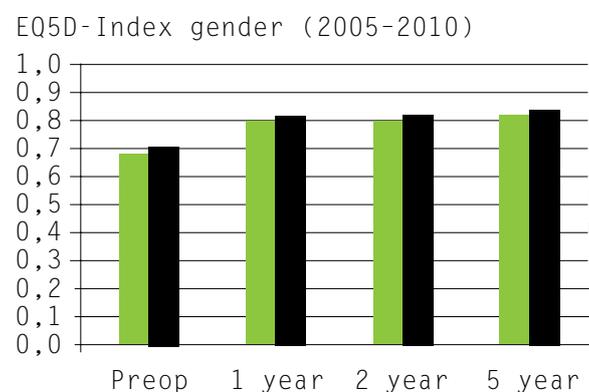
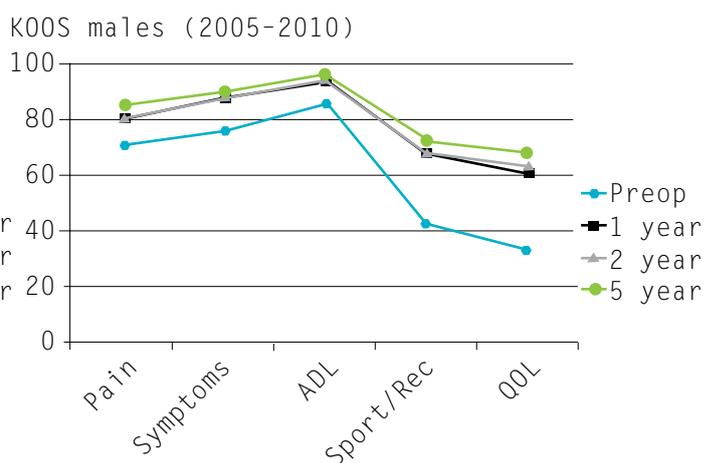
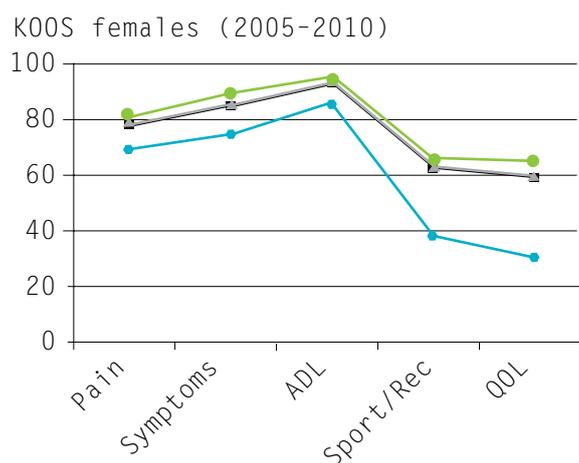
EQ-5D

Health-related quality of life is impaired in patients before and one, two and five years after ACL reconstruction ("UK EQ-5D index tariff" score 0.69-0.83) compared with a reference value from a Swedish population aged 20-40 ("UK EQ-5D index tariff" score between 0.88 and 0.89) (Buström et al. 2001) and compared with a football population ("UK EQ-5D index tariff" score 0.90, n=92) (Olsson et al. 2010). The figures below show that both the index and self-rated health improve after surgery.



Outcome and quality of life in relation to gender

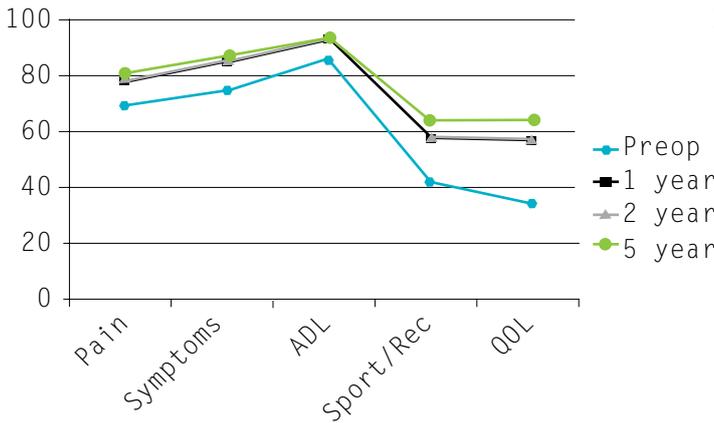
Subjective knee function and health-related quality of life are equivalent in women and men.
 The statistical processing of the results reveals statistically significant differences, but the differences are extremely small and are of little or no clinical relevance.



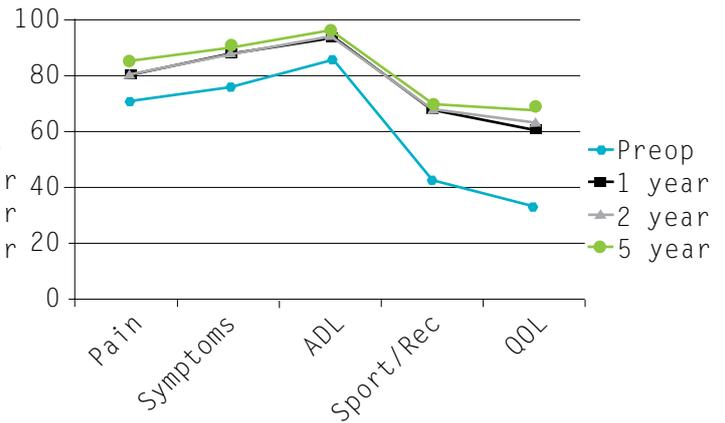
Outcome and quality of life in relation to graft

Subjective knee function and health-related quality of life are equivalent between grafts. The statistical processing of the results reveals statistically significant differences, but the differences are extremely small and are of little or no clinical relevance. In this context, it is also important to point out that the operations with patellar tendon grafts only account for 2% of all operations, which could lead to misleading comparisons.

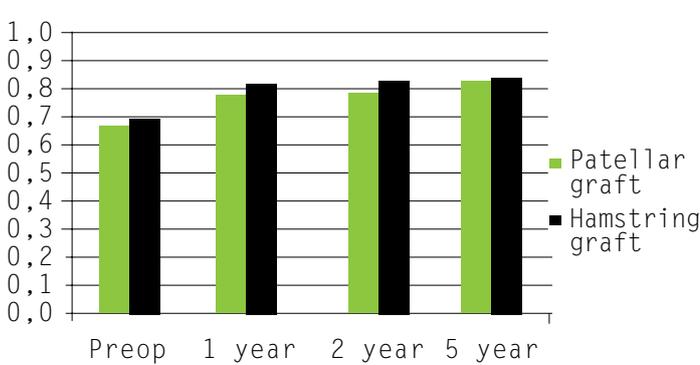
KOOS Patellar tendon grafts (2005-2010)



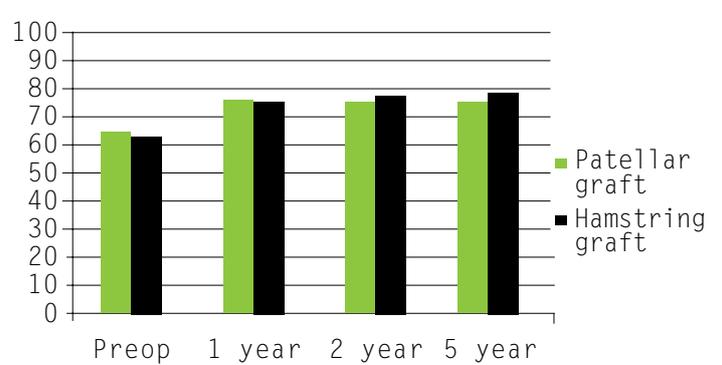
KOOS-Hamstring grafts (2005-2010)



EQ5D-Index grafts (2005-2010)



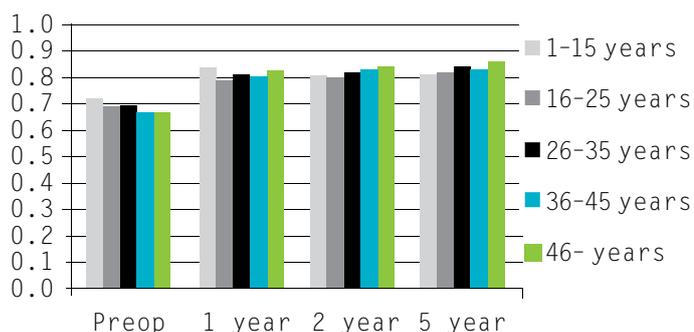
EQ5D-VAS grafts (2005-2010)



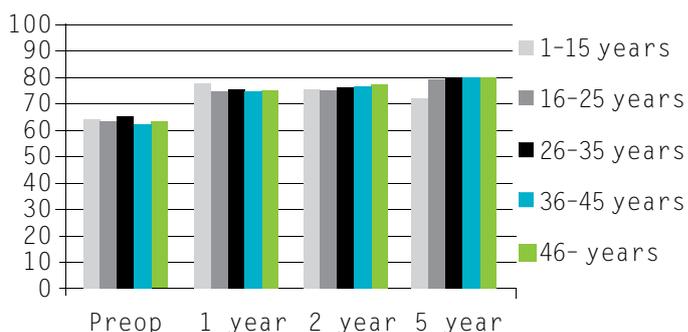
Outcome and quality of life in relation to age

The majority of the patients undergo reconstruction of the anterior cruciate ligament at the age of 16 to 35 years. Despite the uneven number of patients in each age group, neither subjective knee function nor health-related quality of life differs between the age groups. Considering the large number of patients, there are statistically significant differences between the age groups, but they are extremely small and are thus of little or no clinical relevance.

EQ5D-Index age groups(2005-2010)



EQ5D-VAS age groups (2005-2010)



Gender aspects

The results after ACL reconstruction are similar between the sexes. Since 2008, the time from injury to surgery has decreased for both men and women. The gender distribution for primary ACL reconstruction in 2009 shows a predominance for men: 58% men and 42% women. The percentages were exactly the same for revisions. The age distribution between the sexes is different. One contributory reason could be the difference in physical activity between the sexes at different ages, first and foremost because women are active in high-level sports at a younger age. Activities at the time of injury have been reported. The three activities for which the gender differences were the greatest were gymnastics (93% women), dancing (74% women) and team handball (72% women). The three male-dominated activities were ice hockey (97% men), enduro (93% men) and martial arts (80% men). In contact ball sports, the women:men ratio was 58:42 in basketball, 72:28 in team handball and 35:65 in football (soccer). In racket sports, the ratio was 24:76.

Discussion

The Swedish National ACL Register was started in 2005 and now has more than 90% coverage of all ACL operations performed in Sweden. ACL reconstruction improves both function and knee-related quality of life, but knee function is still limited even after ACL surgery and the patients do not achieve the same function as in an uninjured age-matched population. Self-reported patient-experienced quality indicators show that the patients experience reduced quality of life after the injury and that this is primarily related to lower knee-related quality of life.

A number of improvement projects are being discussed by the board and are necessary in order to improve the treatment of ACL-injured patients in Sweden. The project with the highest priority is to transform the national ACL register from a surgery register to a diagnosis register. Even now, it is possible to register non-surgically treated ACL injuries, but great efforts must be made to increase the reporting rate.

The response rate to our questionnaires has increased since the start of the register 2005. The board believes that national co-operation with web portals and the improved registration of e-mail addresses, for example, would facilitate these efforts and contribute to increased reporting and reduced costs.

The board also believes that there is a continuous need for the further training of ACL surgeons in Sweden, especially for those who perform fewer than 10 procedures annually.

Conclusions

The national ACL surgery register collaborates with other orthopaedic registers, as well as a number of other quality registers (e.g. the national Ob/Gyn surgery register). The objective is to promote simplified techniques for the collection and feedback of data. The ACL register is now participating in a project of this kind. The board of the Swedish National ACL Register would like to express its thanks for fruitful co-operation during the past year. It is clear that co-operation on the follow-up of patient-experienced health is becoming increasingly interactive, which is leading to constructive in-depth studies. The board is grateful for comments and viewpoints on the annual report and looks forward to continued good co-operation.

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