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A Concept for Treatment of Sports Related Knee Injuries

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Stockholm 2004

Artro Clinic's logotypes from 1992, 1998 and 2004

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Days of satisfaction don't rank first.
The greatest days, they are the days of thirst.

Our journey might turn out to be in vain,
But it's the path itself that's worth the pain.

A single goal in life is not the best.
The best of goals is just a night-long rest.

In places where you only spend one night,
you sleep secure and wake up with delight.

Get up! It's time to leave your cozy bed.
Another grand adventure lies ahead.

Karin Boye, In motion, 1927

Den mätta dagen, den är aldrig störst.
Den bästa dagen är en dag av törst.

Nog finns det mål och mening i vår färd,
men det är vägen, som är mödan värd.

Det bästa målet är en nattlång rast,
där elden tänds och brödet bryts i hast.

På ställen, där man sover blott en gång,
blir sömnen trygg och drömmen full av sång.

Bryt upp, bryt upp! Den nya dagen gryr.
Oändligt är vårt stora äventyr.

Karin Boye, I rörelse, 1927

CONTENTS

ABSTRACT

The aim of the present thesis was, to evaluate local anesthesia as an anesthetic technique when performing knee arthroscopies, from a clinical and economical point of view, and to describe the total costs for surgery of knee injuries caused by sport activities in Stockholm.
In a retrospective study of 6519 arthroscopies, we tried to estimate the failure rate for knee arthroscopy in local anesthesia compared to the same procedure in general anesthesia. Failure was defined as a rearthroscopy within 180 days due to persisting clinical symptoms. Encouraged by the comparable results between local and general anesthesia in this study a prospective, randomized study including 400 patients was designed. Two hundred patients were randomized to local anesthesia, 100 patients to general anesthesia and 100 to spinal anesthesia. Ninety percent of the patients who had local anesthesia were satisfied with the procedure. From the surgeon's point of view, technical problems were experienced in 5% of the procedures in local anesthesia. Arthroscopy in local anesthesia should be avoided if the patient has excessive synovitis. The results of the study led to the conclusion that elective knee arthroscopy can be performed under local anesthesia in the majority of the patients. Furthermore the cost saving for an arthroscopy in local anesthesia was SEK 1 011 per procedure compared to an arthroscopy in general or spinal anesthesia with our described setup. The total hospital stay for patients was significantly lower for patients with local anesthesia compared to both general and spinal anesthesia. To determine health care costs for sports related knee surgery, we used data from three different databases – an insurance company database including all players in the studied sports (football, floor ball, European team handball and ice hockey), the hospital patient record database and data from a county database containing information about all surgical procedures performed in Stockholm. The average knee surgery cost for all studied players in the population was SEK 108 in 1997.
In conclusion, arthroscopy with local anesthesia was an anesthetic technique with clinical results comparable to other methods like general or spinal anesthesia. Furthermore local anesthesia was more cost and time effective. The total health costs for the community was low for players in football, floor ball, European team handball and ice hockey when their knee injuries were surgically treated.

Keywords: local anesthesia, arthroscopy, health care cost, knee injuries, efficacy, insurance, knee surgery cost, rearthroscopy, football, soccer, handball, ice hockey, floor ball
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LIST OF ORIGINAL PAPERS

This thesis is based on the following papers, which will be referred to in the text by their Roman numbers (Paper I-IV).

I

Forssblad M, Weidenhielm L. Knee arthroscopy in local versus general anesthesia. The incidence of rearthroscopy. Knee Surgery Sports Traumatology Arthroscopy 1999;7:323-326.

II

Jacobson E, Forssblad M, Rosenberg J, Westman L, Weidenhielm L. Can local anesthesia be recommended for routine use in elective knee surgery? A comparison between local, spinal and general anesthesia. Arthroscopy 2000;2:183-190.

III

Forssblad M, Jacobson E, Weidenhielm L. Knee arthroscopy with different anesthesia methods. A comparison of efficacy and cost. Accepted for publication in Knee Surgery Sports Traumatology Arthroscopy.

IV

Forssblad M, Weidenhielm L, Werner S. Knee surgery costs in football, floor ball, European team handball and ice hockey. Accepted for publication in Scandinavian Journal of Medicine & Science in Sports.

ABBREVIATIONS

ACL	Anterior Cruciate Ligament
ASA	American Society of Anesthesiologists
CPI	Consumer Price Index
DKK	Danish crowns
DRG	Diagnosis Related Group
EA	Epidural Anesthesia
EURO	Euro currency
FFR	French francs
GA	General Anesthesia
IKDC	International Knee Documentation Committee
IT	Information Technology
KOOS	Knee injury and Osteoarthritis Outcome Score
LA	Local Anesthesia
NRN	National Registration Number
NSAID	Non Steroid Anti Inflammatory Drugs
SA	Spinal Anesthesia
SEK	Swedish crowns
SD	Standard Deviation
SMS	Short Message System (cellular phones)
USD	US dollar
VAS	Visual Analogue Scale

INTRODUCTION

Knee arthroscopy was introduced in Sweden during the 70's and it is now routine surgery in all hospitals. The first arthroscopy was described by professor Kenji Takagi in 1919, when he performed a knee arthroscopy with a cystoscope. Dr Masaki Watanabe reported the first partial meniscectomy in 1962 (Mc Ginty 1996). In Sweden arthroscopy was introduced by Ejnar Eriksson and Jan Gillqvist. Today there are more than 30 000 arthroscopies performed each year in Sweden.

Stockholm County changed the economic steering system from budget financed health care to the DRG (Diagnosis Related Groups) system in 1992. This led to the possibility to produce more health care in the hospital and receive an individual compensation for each patient visit and for each surgical procedure.

Together with my colleagues Leif Hansson and Anders Valentin, I was given the opportunity to start an independent unit focused on arthroscopy and sports injuries at St Görans hospital, Stockholm in 1992. The mandate was given by the former hospital manager Sture Sjölund and the former head of the orthopaedic department Nils Rydell. The new unit was given the name Artro Clinic and is now an independent company owned by St Görans hospital and the Capio group.

We got a free mandate to organize the Artro Clinic in the way we wanted and we were encouraged to try new concepts. We formed a business strategy with six main areas: high efficacy, latest technology, best information to patients, best computer systems (IT), research and education and best possible environment for the staff.

One of the corner stones in our daily work was to further develop the use of local anesthesia (LA) when performing arthroscopies. This method was introduced in Sweden by Ejnar Eriksson in the early 70's as a cost and time effective method. The compensation from the DRG system was not related to the type of anesthesia used at surgery, and if we could perform arthroscopies to a lower cost, we could use the money for other things such as developing IT systems and performing research. By using LA in a new setup in our outpatient unit, we could also perform more surgery in our operating department with full anesthesia service. This was our way to try to

eliminate the long waiting lists that existed in Stockholm before 1992. Patients had to wait between six to twelve months for an arthroscopy, often receiving economic sick leave compensation from the employer and the community.

The hypothesis of the present thesis was that LA for arthroscopy is a method with at least equal clinical results compared to general anesthesia / spinal anesthesia and that the LA method is more cost and time effective than other types of anesthesia. Furthermore, the aim was to try to mirror the total health costs for knee surgery in sports.

AIMS OF THE THESIS

- To identify those arthroscopies that could not successfully be completed because of inadequate local anesthesia
- To investigate if local anesthesia was associated with an increased number of rearthroscopies compared to general anesthesia
- To compare local anesthesia with general and spinal anesthesia for elective knee arthroscopy
- To compare costs and time consuming between three well documented anesthesia methods (local anesthesia compared to general and spinal anesthesia)
- To determine the health care costs for knee surgery directly related to participation in the following sports: football, floor ball, European team handball and ice hockey
- To determine the number of operated anterior cruciate ligament (ACL) injuries that were reported to the insurance company by the patient in order to claim compensation for the injury.

A REVIEW OF THE LITERATURE AND BACKGROUND

A large number of papers has been published about arthroscopy and out patient surgery during the last decades (Fruensgaard and Johannsen 1990, Kinnard and Lirette 1991). Using the keyword “Arthroscopy” when searching on Medline returns almost 10 000 publications. The majority of the studies deal with research about outcome, comparison of different anesthetic techniques, methods for pain relief and costs for different methods (Carroll et al. 1995, Chung 1995, Milankov et al. 2000, Pellaci et al. 1996). There are, however, some prospective, randomized studies – most of them trying to focus on different methods for anesthesia or pain relief (Casati et al. 2002, Heidwall et al. 2000, Martikainen et al. 2001, Ries et al. 1999).

Anesthetic techniques

Many studies have been published comparing different anesthetic techniques (Bonicalzi and Gallino 1995, Dahl et al. 1997, Dolk et al 2002, Göransson et al. 1997).

Studies II and III of the present thesis are based on a prospective, randomized investigation using three different anesthetic techniques – local (LA), general (GA) and spinal anesthesia (SA). To our knowledge the only published randomized study that compares LA to GA or SA is a study published by Williams and Thomas (1997). The duration of the operation was longer in the LA group (P = 0.05). A 0 to 10 scoring system indicated that patients preferred LA while the surgeon preferred to operate in GA (P = 0.05). Those having LA required less physiotherapy (P = 0.025) and a higher number of them returned earlier to work and sports (P = 0.05).

In 1997 Dahl et al published a randomized study comparing GA, SA and epidural (EA). Their study comprised 91 patients and they found that GA resulted in the shortest stay in the operation theatre but a higher degree of postoperative pain and a higher cost of drugs and disposables.

Mulroy et al (2000) also compared GA, SA and EA in a randomized study of 48 patients. They found that EA and GA provided equal recovery times and patients’ satisfaction, whereas SA might prolong recovery and had increased side effects.

Fairclough et al (1990) compared LA to GA and presented a study, where 50 patients in the LA group had a technically successful arthroscopy, 12 a partially successful and four a totally unsatisfactory.
Lintner et al (1996) published data from two studies – one retrospective with 256 patients with LA, GA or SA/EA and one prospective study with 100 patients with LA. No patient from the LA group required conversion to GA.
Shapiro et al (1995) presented a retrospective study comparing LA, GA and SA/EA. Two percent of the patients in LA required conversion to GA.
Lorentsen et al (1997) described their experiences from 403 arthroscopies in LA, where they could not perform six successfully.
Ramanathan (1998) reported five interrupted arthroscopies out of total 95 patients in LA.
Westphal and Krogsgaard (2001) found in a retrospective study that 11 patients out of 371 in LA could not fulfil the arthroscopy.
Fruensgaard and Johannsen (1990) found that the failure rate using LA was 0.9%.
Tsai and Wredmark (1993) reported about 356 consecutive arthroscopies in LA, where 228 patients had some intra articular pathology. Surgery had to be terminated prematurely in 18 of these 228 cases (8%).
Yacobucci et al (1990) reported that three out of 500 patients in LA required conversion to GA.
Munck and Pedersen (1994) pointed out that 15% in a serie of 100 consecutive patients in LA required a second arthroscopy in GA.

Cost and time analyze studies

The majority of publications have focused on the cost for given drugs. However, some authors have tried to calculate the total cost difference between different anesthetic techniques. Lintner et al (1997) found that the cost saving of arthroscopies in LA was at least USD 400 compared to other techniques. Munck and Pedersen (1994) found that the cost for arthroscopy in LA was DKK 2 055 including the costs for rearthroscopy in GA (15% of the patients). The cost for GA was estimated to DKK 2 458. Trieshman (1996) found an average cost reduction of USD 600 in 53 patients in LA compared to GA.

Ries et al (1999) compared sevoflurane and isoflurane in a randomized study. They found a fourfold sevoflurane-to-isoflurane cost difference. On the other hand Heidvall et al (2000) found that sevoflurane was more cost effective compared to propofol. In a randomized study on 60 patients Martikainen et al (2001) reported that the drug costs were higher for the GA group than for the SA group. The total recovery time was nearly equal for the both groups. Casati et al (2002) found no differences regarding cost, when comparing femoral block anesthesia with GA using a randomized study design in 40 patients. The time for the patients in the recovery room was shorter with femoral block.

Epidemiology and health costs

Sport attracts millions of participants worldwide. In Sweden football, floor ball, European team handball and ice hockey are the most common team sports, when it comes to the number of participants (Folksam 1994). These sports are characterised by i.e. quick turns and repeated acceleration and deceleration movements, which might predispose for traumatic injuries, particularly knee injuries. Sport in general, and football in particular, is often associated with an increased risk for injury and subsequent increased health care costs. In fact, football has been suggested to be a knee disease rather than a sport stated by Lindahl in 1970 - “Football is no sport but rather a knee disease”. A sports injury is the result of a complex interaction of various risk factors in the course of time (Taimela et al. 1990, Van Mechelen et al. 1992, Inklaar 1994). Each sport, due to its unique demands, will predispose individuals to a given pattern of injury (Meeuwisse 1991, Van Mechelen et al. 1992, Kujala et al. 1995).

According to the National Athletic Injury Registration System (NAIRS) in the US and the Council of Europe a sports injury has been defined as an injury occurring during participation in sports, and that limits sports participation for at least one day after onset (Lysens et al. 1991). The classification of the severity of an injury varies in different investigations and is usually based on time of absence from athletic participation. One of the most frequently used classifications is the one described by Ekstrand, that classifies injuries into minor (absence less than one week), moderate

(absence from one week to one month) and major (absence more than one month) (Ekstrand 1982).

Many reports in the scientific literature have focused on sports injuries and their mechanisms. In a traumatic injury this involves an accidental or external force (Taimela et al. 1990). However, there are only a few publications the last years, focusing on the cost of sports injuries for the community (de Loes et al. 2000, Rockborn et al. 2000, de Loes and Jansson 2002). There have been studies published regarding insurance data but only including cases reported to the insurance company (Roos et al. 1985, Berger-Vachon et al. 1986, Sandelin et al 1985, Sandelin 1988). Roos et al (1986) reported a prevalence of 344 ACL injuries among 188 152 football players, which corresponds to 18 injuries / 10 000 players. Approximately, 50% of these were treated with surgical interventions.

There are several studies published about knee injuries in different sports but to the best of our knowledge no study has used different patient databases to estimate the costs of knee surgery in sport.

Highly specialized surgeons

There have been some reports about cost reductions when comparing highly specialized surgeons with less experienced surgeons. For example, Farnworth et al. (2001) compared orthopaedic faculty and residents with regard to operative time and costs. Based on increased operative times, operating room costs, on average, were $661.85 higher for residents. They conclude that the significant differences demonstrated between residents and faculty suggest the need to develop strategies and technical training facilities in order to improve orthopaedic resident's surgical skills and efficiency outside of the expensive operating room.
O'Neill et al. (2002) stated "These results indicate that, in the opinion of physicians involved in the education of residents and fellows, it may take a substantial number of repetitions to become proficient in arthroscopy. Physicians who perform little or no arthroscopy themselves may underestimate its difficulty. Interestingly, there was a

substantial variability in the number of repetitions estimated to achieve proficiency in all procedures".

The DRG system

DRG is an abbreviation for "Diagnosis Related Group". DRG's are numeric codes ranging from 0 to about 500. These codes represent patient classifications on the basis of diagnosis, procedure, age, gender and discharge disposition. These groups were constructed to control length of stay, which in turn correlates to resource consumption and severity of illness.
The original DRG's were invented at Yale University's Health Systems Management Group in the late 1970s (Fetter et al. 1980, Fetter 1984). The DRG values have descriptions, weights and length of stay outlier trim.
DRG's are good for providing a context in which to analyze hospital stays. DRG's were designed to allow hospitals to operate on a more industrial basis, with resource allocation and cost center analysis, all of which were very popular in the late 1970s when DRG's were created. To summarize, DRG's predict likely resource consumption for any given hospital stay, allowing one to compare different hospitals regarding hospital stay and cost effectiveness.
The actual DRG group is decided by a combination of the patient's diagnosis and performed surgery.
The DRG system was implemented in Stockholm county 1992 and all hospitals changed from a budget controlled system to a DRG system. One of the positive effects with DRG is that the hospitals get paid for their actual production, but a negative effect is the difficulty to control the total health care costs for the community.

Artro Clinic

The Artro Clinic was founded in 1992 as a highly specialized unit for arthroscopy and arthroscopic surgery like ligament surgery in knees, shoulders, ankles, elbows and hips. It also includes a physiotherapy unit for pre- and postoperative evaluation and treatment of the patients. The business strategy for Artro Clinic has been defined as follows:

Efficiency and highly specialized staff

The Artro Clinic performs about 70% of all arthroscopies in LA. Ninety percent of the patients are treated as outpatients.

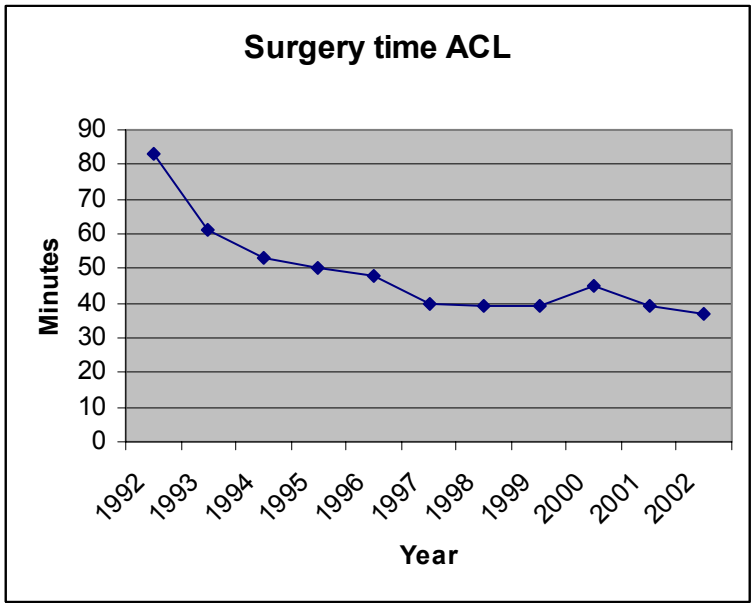


Figure 1. Surgery time for ACL reconstruction.

In figure 1 there is an example of surgery times for ACL reconstructions over the years for one surgeon in the Artro Clinic. In a few years the surgery time decreased with 50%. This will certainly give a lot of good side effects like increased productivity and will probably lower the infection rate. Well skilled surgeons probably also produce better end results. There has also been a discussion in Sweden about how much a surgeon should perform – for example, should an orthopaedic surgeon be able to perform hip and knee replacements, back surgery, shoulders, fractures as well as ligament surgery, or is it better with sub specialized surgeons? The Artro Clinic's standpoint here is clear – it is favourable for efficiency and for the patients with highly specialized orthopaedic surgeons.

By tradition the operating wards have operating nurses rotating between different specialities. Since some years Artro Clinic has employed our own nurses just for our specialized type of surgery, which has proven to be a great advantage. These nurses are well educated in this specific field, and the surgery time has been shorten by

letting the nurses take active part in the surgery, preparing the grafts in ACL reconstruction, for instance. This is also an important part of our cost effectiveness.

Technology

At the Artro Clinic we always try to use the latest technology and develop new methods/standards for surgery. In a reimbursement system, like the system in Stockholm, it is difficult to develop new methods and evaluate them in a proper way if the new methods include additional costs. One way to solve this problem is to allocate extra resources for example “evaluation of cartilage culture transplantation” and give the mandate to specialized units (like Artro Clinic) to evaluate these new methods. The result could then be “guidelines” for future surgery. It is also important to evaluate surgery from a cost effective point of view and try to assess other health costs effect for the community (for example, sick leave costs, cost for infections, cost for new surgery when removing implants, screws).

Service to the patients

The importance of a well informed patient has increased over the years. We use Internet, E-mail and cellular phone messages (SMS) to provide that. We also have our own newspaper for information. Cancellation of surgery due to inadequate patient preparation is unacceptable in a cost effective environment. Furthermore, Swedish media has increased their interest in medical matters during the last years. These facts indicate a demand for more information to the patient regarding choice of methods and grafts.

IT system

The Artro Clinic has developed their own IT system with modules for patient records, appointments, digital imaging, surgery planning, questionnaires, follow up database and statistics. It is important to have supportive IT systems for follow up and research. Our digital imaging system allows us to save images and videos from all

surgery, which can be used for comparison over time and for an objective evaluation of surgical results. All data about surgery and follow up are stored in our online database and can be accessed by all surgeons and researchers. For ACL reconstructions we store information about graft choice, fixation, surgery time and various epidemiological data. At follow up we register laxity (KT-1000), muscle torques (Biodex dynamometer) and different scores (Lysholm, Tegner, KOOS and IKDC). This database now includes data for 4 000 ACL reconstructions between 1992 and 2004 and can be used in our daily work. For questionnaires we have developed an IT system, where we can send questionnaires to the patients by E-mail, Internet or regular paper to be scanned into the database. This system makes the data collection very easy.

Research and development

The Artro Clinic is connected to the section of sport medicine (department of surgical sciences) Karolinska Institutet for research and shares a professorship with the university. It is of great importance for the Artro Clinic to produce research and this is also an important part of our business strategy. Artro Clinic has a very close cooperation with both external supporters like Svenska Spel AB (Swedish National Lottery Company) and with different sport federations in Sweden (Swedish Olympic Committee, Swedish Football Association and Swedish Sports Federation – RF).

Staff environment

There are currently 35 employees in the Artro Clinic (2004). The turnover for 2003 was SEK 65 000 000. There is a focus on high motivated and well skilled staff. All the staff is involved in a bonus programme, which can increase the annual salary with up to 15%. By Swedish tradition all doctors are employed by the Artro Clinic and create a unit performing clinical work, research and administration. It is very important to have this “clinic feeling”, where the doctors can spend time on projects, which do not directly give revenues to the clinic. This is a long term work intended to bring us to a future frontline position. Artro Clinic also has a rehabilitation unit with 7-8

physiotherapists on full time basis. This unit is an essential part of the concept and allows us to develop treatment plans, follow ups and evaluate surgical as well as rehabilitative methods.

Setup for local anesthesia

The LA arthroscopies are performed in our outpatient ward without anesthesia service. The unit consists of four parts – a dressing room, a room for preparation, an operating room and a recovery room with a convenient chair. There are no beds for recovery. However, the patients have the possibility to recover, sitting in a chair and are offered light refreshments (i.e. sandwich and coffee). The patients receive oral and written information that also can be found at our website (www.artroclinic.se). One important part is also that during the arthroscopy the surgeon can inform the patient about the findings and help the patient to better understanding of his/her injury. If a conversion to GA is considered necessary the patient is rescheduled for another arthroscopy two to three weeks later. The equipment for arthroscopy is exactly the same as the GA and SA setup including pump and shaver.

Figure 2 & 3. Dressing and preparation room in the local anesthesia setup in Artro Clinics outpatient ward.

Figure 4 & 5. Operating and recovery room in the local anesthesia setup.

Setup for general and spinal anesthesia

The SA and LA arthroscopies are performed in our central operating ward with full anesthesia service. The ward consists of 13 operating theatres, a full recovery unit with approximately 20 beds and an intensive care unit.

MATERIALS

- INCLUSION CRITERIAE AND RANDOMIZATION PROCEDURES

Study I

In this retrospective study, all primary knee arthroscopies performed at St Görans hospital's Artro Clinic, during a 3.5 year period, between January 1993 and July 1996, were reviewed and the incidence of rearthroscopy, which occurred within 180 days, was assessed. The study included 6519 arthroscopies (4101 in the LA group and 2418 in the GA group). The mean age of the patients was 40.9 +/- 13.1 for LA and 35.3 +/- 13.6 for GA. A database including information about all surgical procedures performed in Stockholm was also reviewed in order to assess the number of rearthroscopies performed in any other hospital, than the primary arthroscopy.

Study II and Study III

In this prospective study, 400 patients, aged 18 years or older, scheduled for primary arthroscopy were randomized into three groups (LA (200), GA (100) and SA (100)). Inclusion criteriae wee:

1. Patients scheduled for primary knee arthroscopy,
2. Patients with ASA (American Society of Anesthesiologists) physical status I and II,
3. Patients with knee range of motion more than 90 degree of knee flexion.

Exclusion criteriae were:

1. Patients with neurological/neuromuscular disease,
2. Patients with local infection at planned injection site,
3. Patients with allergy to amide LA or non steroidal anti inflammatory drugs (NSAIDS).

In this study 1062 patients were asked to participate, 516 did not want to participate and 146 were excluded due to inclusion or exclusion criteriae (Figure 7). The arthroscopies were performed between 1996 and 1997. The average age for the LA

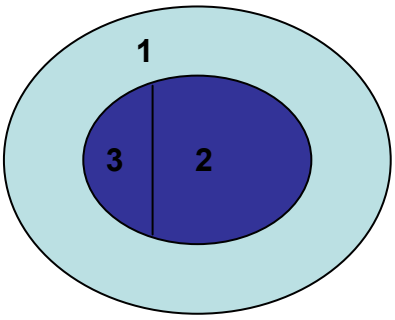
group was 44 years (20-78), for the GA group 39.5 years (20-74) and for the SA group 46 years (20-73).

Study IV

In this study we included all players 15 years or older from the Stockholm region that played either football, floor ball, European team handball or ice hockey. The data were obtained from the insurance company Folksam. It is mandatory for each player to have this insurance, if they participate in competition level. To find out if the player had surgery during the studied period, data was obtained from St Görans hospital database combined with data from Stockholm County. Data were collected for year 1997.

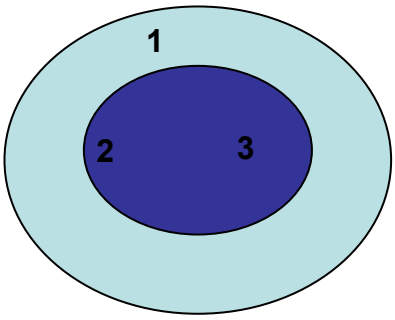
Study designs

Study I



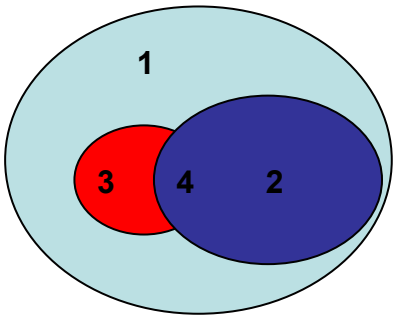
1. All surgery in Artro Clinic
2. Arthroscopies in LA n=4101
3. Arthroscopies in GA n=2418

Study II & III



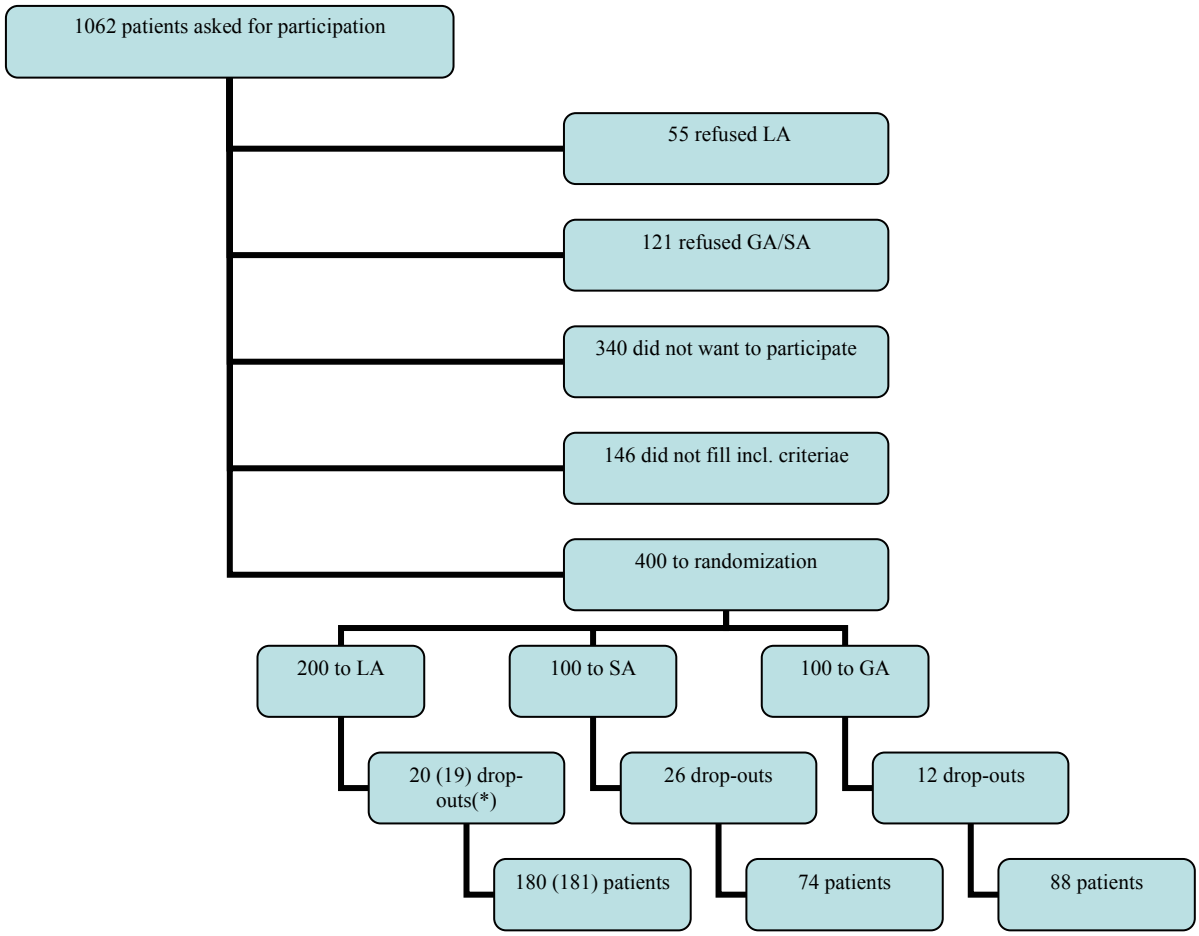
1. All patients in Artro Clinic
2. Asked for participation n=1062
3. Randomized n=400 LA n=200, GA n=100, SA n=100

Study IV



1. All inhabitants in Stockholm
2. All players in studied sports n=40229
3. All knee surgery in Stockholm n=6859
4. Studied knee surgery n=762

Figure 6. Study designs.



(*) In study III there was one less drop out in the LA group

Figure 7. Randomization in study II and III.

ETHICAL CONSIDERATIONS

Study I

This was a retrospective study and when it was performed there was no need for ethical assessment by an ethical committee.

Study II & III

These studies were approved by the ethical committee at the Karolinska Hospital – diary number 96-074.

Study IV

For comparison of the databases permission was given by the Swedish Data Inspection Board - diary number 5174-1997, by the insurance company (Folksam), by the Stockholm County and by the four involved national sport federations.

METHODS

Study I

Information about each arthroscopy was stored in our hospital database. The database contained information about diagnosis, operated side, type of anesthesia used, name of surgeon who performed the operation and type of surgical procedure. Three patient groups were formed and analyzed. In group I, a second arthroscopy was performed within 180 days due to a new indication, such as a new trauma or a scheduled second arthroscopy in patients treated with cartilage transplantation or meniscus suture. In group II, the primary arthroscopy was interrupted because of intolerable pain and/or the fact that the surgeon regarded the procedure as incomplete and a second arthroscopy was immediately scheduled. In group III, a primary arthroscopy was performed without technical problems, however, a second arthroscopy was performed within 180 days because of persisting symptoms, i.e. a true rearthroscopy.

Study II

The patients were randomized into three groups, LA group, GA group and SA group,

LA group: In the LA group 10 ml of 0.5% prilocaine with adrenaline (Citanest 0,5% 5 mg/ml plus adrenaline 4 ug/ml ®; Astra, Södertälje, Sweden) was infiltrated at each of three portal sites (Figure 8), and 20 ml was infiltrated into the joint (total 40 to 70 ml). Surgery was started approximately 30 minutes after administration of the anesthetic solution. Paracetamol 1 g rectally and 20 mg ketorolac intravenously were administered immediately preoperatively. No other drugs were allowed intraoperatively.

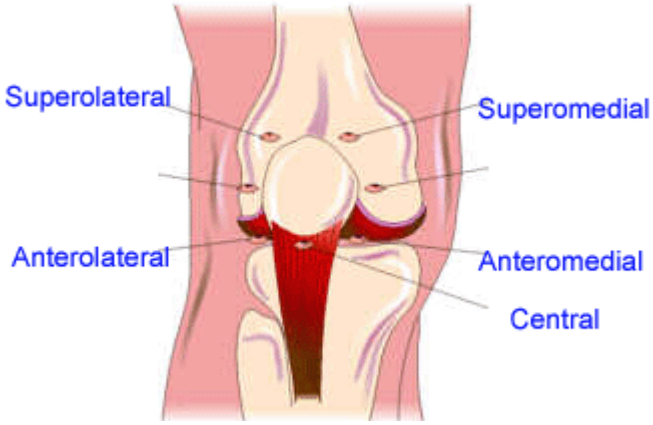


Figure 8. Common portals in knee arthroscopy.

GA group: Premedication included 10 mg oral diazepam and 1 g of rectal paracetamol were administered 1 hour before the start of anesthesia. Propofol (induction and maintenance) and alfentanil were used according to hospital routine. The patients were breathing spontaneously during surgery, supplied with additional oxygen. Ketorolac (20 mg) was administered intravenously immediately before surgery. The surgeon injected 10 ml of prilocaine 0.5% with adrenaline at each of three portals at the beginning of the surgery. At the end of the arthroscopy, 20 ml of prilocaine with 0.5% adrenaline was administered into the joint.

SA group: Premedication was the same as for the GA patients. The intrathecal block was performed according to hospital routine. Hyperbaric lidocaine (Xylocain heavy 5% ®; Astra) 60 to 90 mg was used. Occasional hypotension was treated with ephedrine, 5 to 10 mg. Just before the start of the surgical procedure, ketorolac (20 mg) was administered intravenously. The surgeon injected 10 ml of prilocaine 0.5% with adrenaline at each of three portals at the beginning of the surgery. At the end of the arthroscopy, 20 ml of prilocaine with 0.5% adrenaline was administered into the joint.

In order to standardize the postoperative analgesic consumption, each patient in the study was supplied with a set of 30 paracetamol (500 mg) tablets (Alvedon®, Astra)

All patients pain and nausea were assessed 1, 6 and 12 hours after surgery. The following two postoperative days, the patients made a self assessment evaluation once a day (at 8 AM). A visual analogue scale (VAS) was used to assess pain and nausea. The scales consisted of two 100 mm horizontal lines with the following anchor words: no pain (0 mm) and most intensive pain ever (100 mm), and no nausea (0 mm) and most intensive nausea ever (100 mm). Pain ratings were performed at rest and during active knee flexion from 0º to 90º. The postoperative analgesic consumption, the patient's opinion of the anesthetic technique used, and postoperative sick leave were reported two days after surgery.

The surgeon was asked to grade the technical difficulty of the arthroscopic procedure on a VAS scale. The anchor words were: not complicated (0 mm) and very complicated (100 mm). The surgeons were also asked if the allocated anesthetic technique was optimal and, if not, which technique they would have preferred. Any adverse events during the procedure were also reported.

Study III

A protocol was used for collection of time stamps and a separate protocol was designed to register all drugs given to each patient. To compare the costs between the two setups, the distinctions regarding the cost pattern were assessed. Costs for patient administration (i.e. booking, patient records, computer systems), material for surgery, surgeons cost and sterilization was considered equal for the two setups and therefore excluded in the comparison. On the other hand costs for anesthesia staff and operating nurses were analyzed in the hospitals "Activity Based Costing" system used (Baker and Boyd 1997, Hansson and Nilsson 1994, Brimson 1991). Activity Based Costing is an advanced cost calculation technique, that allocates resource costs to products, based on activity consumption. For cost data for the setup in LA, the actual figures were used.

Study IV

Three different databases were used in this study. To identify the patients the national registration number (NRN) was used (Lunde et al. 1980). The NRN is a unique personal identifier assigned to all Swedish residents, which allows linkage between different registers and databases. For comparison of the databases permission was given by the Swedish Data Inspection Board, by the insurance company (Folksam), by the Stockholm County and by the four involved national sport federations. The following three databases were used.

1. *Folksam Insurance Company – all players with "sports" insurance in 1997*
   All players in Swedish football, floor ball, European team handball and ice hockey teams are required to have insurance in the same company and it is mandatory for the players to be insured when participating in sporting competitions. We have included all players 15 years or older from the Stockholm region that played either football, floor ball, European team handball or ice hockey. Information about the NRN for each individual and specific sport could be obtained from the database, but no information about the standard of play was stored.

2. *St Görans Hospital Patient Record Database*
   Information about all surgical procedures performed at one of Stockholm's major hospitals specialized in sports medicine was stored in this database. The database contained information about the date of the surgery, diagnosis, operative procedure, operated side (i.e., left or right) and the patient's NRN. All knee surgery in 1997 was analyzed. To calculate the cost for surgery, the DRG system was used. In Stockholm the total cost 1997 for an arthroscopy was approximately SEK 4 000 and for an ACL reconstruction approximately SEK12 000.

3. *The Stockholm Health County database*
   This database contained information about the majority of surgical procedures performed in Stockholm. The exception was surgery provided by some minor

private institutions, which maybe included some arthroscopies but no major surgery, such as ACL reconstructions. It was used for calculating the total health care cost for knee surgery in Stockholm.

All surgical procedures related to DRG code 221 (Knee surgery with complications), 222 (Knee surgery without complications), 222B (ACL reconstructions) and 232 (Diagnostic arthroscopy) were included in this study. Total knee replacements with DRG code 209 or 209B were excluded.

To confirm whether there existed a direct relationship between participation in sport and injury mechanism a questionnaire was sent to all patients, who had undergone knee surgery in 1997 at St Görans hospital. The main issue was if the specific injury occurred during participation in the patient's principal sport. For those patients who did not answer the questionnaire the patient record were studied to find out if there was a direct relationship. Any injury with no obvious relation, for example a ski injury in a football player was excluded. However, injuries with possible relations, for example long term knee pain in a football player were included.

STATISTICAL METHODS

Study I

Differences between the analyzed groups were calculated using Chi-square tests. A P value < 0.05 was considered statistically significant.

Study II

Median values, mean values, and standard deviations (SD) were calculated. The Kruskal-Wallis and Wilcoxon rank sum tests were used to test the results of the VAS measurements, and the Chi-square test was used to test the other non parametric variables.

Study III

Arithmetic mean values and standard deviations (SD) were calculated. Since the time measurements were parametric on a ratio scale we used an analysis of variance (Anova) and Students T-test with Boneferronic correction as posthoc tests to assess differences in time measurements between LA, GA and SA.

RESULTS

Study I

The total number of rearthroscopies performed within 180 days from the primary arthroscopy was 214. One hundred forty six were performed due to a new indication. Thirty eight (0.9%) were performed because of an inadequate examination in a primary arthroscopy performed in local anesthesia (LA). Thirty arthroscopies were performed because of clinical persisting symptoms. Of the 4101 primary arthroscopies in LA there were 19 (0.46%) in this group and of the 2418 arthroscopies in general anesthesia (GA) there were 11 (0.45%) in this group.
The frequency of rearthroscopies was 1.2% for the experienced surgeons, defined as surgeons who had performed more than 500 knee arthroscopies, compared to 2.5% for less experienced surgeons ($p < 0.018$).

Study II

The surgeons assessed technical difficulties on the VAS to be more intense during surgery in the LA group (median 10 mm; mean 17.0 mm; range 0 to 93 mm) as compared with GA group (median 4 mm; mean 12.8 mm; range 0 to 88 mm) and the spinal anesthesia (SA) group (median 4 mm; mean 12.2 mm; range 0 to 71 mm) ($p < 0.05$).
The performing surgeon comprehended the patient's pain as more intense during surgery in the LA group (median 8 mm; mean 15.9) compared with the GA group (median 1 mm; mean 2.2) and the SA group (median 0 mm; mean 1.3) ($p < .0001$).
In 29 patients, LA was not considered by the surgeon to be the optimal anesthetic technique. The median VAS pain score for these 29 patients during surgery was 34 mm (mean 37.8 mm; SD 31.8; range 0 to 100 mm). In 10 of these cases the patient could not relax. There were technical difficulties in nine patients: the most commonly given reasons were a narrow joint capsule and/or extensive surgery. In five patients, the surgeon felt excess synovitis made LA less optimal. In another five patients, vasovagal reactions occurred that created problems both preoperatively and intraoperatively. In 18 GA patients and 21 SA patients, the anesthetic technique used was not optimal because the procedure was short in duration and easy to perform

according to the surgeon. LA would have been more optimal. No technical problems were reported in the GA or SA groups.

The patients were assessed concerning the intraoperative pain at discharge from the hospital at the day of surgery. The median VAS score for the LA patients was 6 mm (mean 17.8 mm; SD 23.2; range 0 to 100 mm) and for the SA patients 0 mm (mean 1.1 mm; SD 6.0; range 0 to 52 mm). The GA patients experienced no pain. The difference between the LA group and the GA and SA groups was significant.

The VAS scores for pain intensity at rest and at movement did not differ in the three different groups during the postoperative course.

In the LA group, 47% of the patients did not use analgesics postoperatively compared with 56% in the GA group and 26% in the SA group, a significant difference. More patients in the SA group used analgesics compared with the LA group ($p < 0.01$) and the GA group ($p < 0.0001$). Furthermore there was no difference in VAS scores for postoperative pain at movement and nausea between the groups.

In the LA group, 21 patients would have preferred another form of anesthesia. Thirteen of these patients would have preferred GA, five patients SA, and three patients any anesthesia other than LA. Seven of these 21 LA patients would not like to have the same anesthetic procedure again. If these patients were to need another arthroscopic procedure, five patients would prefer GA and two patients would prefer SA. In eight of these 21 LA patients, the surgeon also felt that the anesthetic technique used was not optimal (two women, six men). In five of these eight patients, the surgeon indicated that excess synovitis was the problem. Of the eight LA patients where the patient and surgeon agreed the anesthesia was not optimal, only one patient would not have the same anesthetic technique again.

The median postoperative VAS score for pain in these 21 patients was 16 mm (mean 27.3 mm; SD 27.4; range 0 to 100 mm). There were seven patients with VAS scores above 30 mm. Six of these patients were in the group where both patient and surgeon considered anesthesia to be less than optimal. In cases where both patient and surgeon were satisfied with LA, 27 patients (20%) had VAS scores above 30 mm.

Study III

Mean total stay time for the LA group was 130 minutes (SD 35.1; range 63-383) compared to the GA group 280 minutes (SD 79.3; range 155-589) and to the SA

group 350 minutes (SD 65.4; range 198-502). The LA group had a shorter hospital stay than the SA group ($p<0.001$). The LA group had a shorter hospital stay than the GA group ($p<0.001$). The GA group had a shorter hospital stay than the SA group ($p<0.001$).

For the LA group the time from start of anesthesia to start of surgery was 39 minutes (SD 13.1; range 17-87), GA group 18 minutes (SD 4.6; range 9-44) and the SA group 20 minutes (SD 4.9; range 11-35). The difference between the LA and GA respectively LA and SA was significant ($p < 0.001$). There was no statistical difference between the GA and SA group.

The surgery time was similar in the three groups. The time for LA was 13 minutes (SD 8.5; range 3-75), for GA 14 minutes (SD 7.3; range 4-41) and for SA 15 minutes (SD 6.1; range 3-28). These differences were not significant.

The recovery time (end of surgery to discharge) was for the LA group 34 minutes (SD 9.4; range 13-66), for GA 139 minutes (SD 48.9; range 55-385) and for SA 230 minutes (SD 50.4; 101-355). Statistic significance was $p < 0.001$ when comparing LA against SA, LA against GA and GA against SA.

The cost per patient for drugs was for the LA group SEK 61, for the GA group SEK 278 and for the SA group SEK 166 (1 USD dollar is approximately SEK 7.5, 1 Euro is approximately SEK 9, December 2003). For the GA and SA groups together the drug cost was SEK 227 per patient.

The cost saving for arthroscopy in LA was SEK 1 011 for each procedure.

Study IV

In the Stockholm county database 6781 surgical procedures related to the knee (DRG 221, 222, 222B and 232) were performed to a cost of SEK 39 026 657 in 1997 When linking the Stockholm county database with the insurance database (patients ≥ 15 years old) it was found that 762 knee surgical procedures (in 657 patients) were performed on players (football, floor ball, European team handball, ice hockey) in Stockholm 1997.

Out of these, 319 surgical procedures (in 288 patients) were performed at St Görans hospital. In 293 (92%) of these procedures performed at St Görans hospital, the knee injury was reported to be directly related to participation in the athlete's specific sport.

The total DRG cost for these surgical procedures in all players in Stockholm was SEK 4 884 076. For surgery directly related to participation in the specific sports the cost is estimated to be SEK 4 493 350 and the number to 701. Overall, the average cost per player was estimated to be SEK 108. The average cost was for football SEK 115, floor ball SEK 87, European team handball SEK 220 and ice hockey SEK 72.

All patients with ACL injuries recorded in the insurance database were retrieved. The total number of ACL reconstructions was 151 and out of these 79 were performed at St Görans hospital. Two of these did not occur as a result of participating in the specific sport. Out of the remaining 77 ACL reconstructions, 57 (74%) were reported to the insurance company.

DISCUSSION

Since arthroscopy was introduced in the beginning of the 70's in Sweden there has been a rapid development both regarding the number of procedures performed per year and the operative technique. The procedure has been improved over the years by for example better camera equipment, improved arthroscopic instruments, new methods, new inventions and digital imaging systems. Although local anesthesia (LA) was introduced early, as a cost and time effective method, the technique has never been widely accepted in neither Sweden or internationally. The reason for this is not known but one can speculate in factors such as lack of economical interest amongst surgeons, lack of stimulus for cost effective health care and that surgeons are more confident with general anesthesia (GA) / spinal anesthesia (SA). There is also most probably a learning curve when using LA, which can be negative both for the patient and the surgeon.

The purpose of this thesis was to share our knowledge about the use of LA and to compare with different types of anesthesia, but also to describe our way to make surgery more cost effective. Furthermore, the aim was to try to reflect the total health costs for knee surgery in sports.

Rearthroscopies and interrupted arthroscopies due to pain

The results of the first study demonstrate no difference in the number of rearthroscopies after knee arthroscopy using LA versus GA. The follow up period for defining a rearthroscopy was set to 180 days. At this time, most patients are fully rehabilitated, according to our clinical experience. With a longer follow up period, there might have been a higher number of rearthroscopies. On the other hand, factors other than that of the initial pathologic condition could have influenced the decision to perform a secondary arthroscopy. Furthermore, the aim of the current study was not to assess the total number of rearthroscopies, but to determine whether there was a difference between LA and GA in this respect.

We reviewed 4101 primary arthroscopies performed in LA. Only 0.9% of these had to be prematurely interrupted due to problems directly related to the anesthesia.

Compared to other reports, this number is low. For example, Munk and Pedersen (1994) reported a corresponding figure of 15%, whereas Shapiro et al. (1995) reported that 2% of the patients in their study required conversion to GA. Furthermore, Fairclough et al. (1990) reported that with LA, the operative procedure used in their study was "successful" in 50 patients, "partially successful" in 12 patients and "totally unsatisfactory" in four patients. It is, therefore, hardly surprising that there has been some concern about performing operative arthroscopic procedures successfully in LA (Fruensgaard and Johannsen 1990).

In 75% of the patients reviewed in this study, a variety of operative procedures were performed. Our findings revealed that the type of anesthesia used (i.e. LA or GA) did not significantly influence the number of rearthroscopies, that had to be performed because the patient's symptoms were not relieved by the primary procedure. Subsequently, it can be concluded that these rearthroscopies were not related to the anesthetic technique.

A retrospective review is often associated with certain drawbacks. For example, in the present study there was no information concerning how the patients were selected for LA or GA, and there was an uneven diagnostic distribution, with a higher number of medial meniscus lesions in the LA group and a higher number of ligament lesions in the GA group. In this study, the type of anesthesia was decided by the surgeon in agreement and after discussion with the patient, and therefore a certain selection bias might have been possible. It is, however, not possible to determine whether these facts had any effect on the overall results. Furthermore, there was an uneven distribution of gender. No reports could be found in the literature, which described gender differences for arthroscopies performed with different types of anesthesia. Therefore, it is not known if the uneven gender distribution did affect the results of this study.

A potential source of error in the material presented in study I is those patients who underwent a primary arthroscopy at Artro Clinic and a rearthroscopy at another hospital. We therefore reviewed a regional database containing information about all arthroscopic procedures that were performed in Stockholm during a part of the study period. Unfortunately, this database does not contain information about which joint or

on which side of the body that the arthroscopic procedure was performed. Nevertheless, the review was done to assess the number of patients who underwent a rearthroscopy at another hospital in Stockholm within 180 days after the primary arthroscopy at Artro Clinic.

Complications with GA are uncommon, especially in young healthy patients undergoing elective surgery. Serious complications, however, such as aspiration, malignant hyperthermia and death have been reported. The risks associated with LA are minimal. Anaphylactic reactions and systemic effects are extremely rare (Shapiro et al. 1995). Therefore, we feel that it is an advantage to use LA in arthroscopic surgery, especially if the surgical results and patient satisfaction are equal. We recommend LA for the majority of patients undergoing arthroscopy. This recommendation is in agreement with other reports (Eriksson et al. 1986, Shapiro et al. 1995). We were, however in this study, unable to identify those patients for whom LA was not sufficient.

The randomized study

The results of the second study show that in the majority of the patients scheduled for knee arthroscopy, both diagnostic and operative can be performed under LA.

Local anesthesia

Some patients declined to have their surgical procedure performed in LA. Careful selection of suitable patients and better information with respect to the potential advantages of LA might further reduce the number of patient's declining of LA. Another issue is the difficulty for the surgeon in addressing all types of intra articular pathology, in LA compared to GA or SA. The preoperative evaluation is essential to avoid scheduling patients for LA, when they might have intra articular pathology requiring GA or SA. In those cases, where the surgeon and the patient did agree that LA was not an optimal anesthesia form, hypertrophic synovitis (presented as capsular swelling and diagnosed at clinical examination) was the prevalent problem. This indicates that LA is not sufficient when extensive synovitis is present. The total

synovial area is enlarged when it is inflamed, and the standardized dose may not have been sufficient to produce adequate anesthesia in these patients.

Furthermore, intra articular injection of LA containing adrenaline can be painful for patients due to the low pH of the solution. The patients can also feel discomfort caused by the rate of injection and the volume of fluid injected. To limit this pain you can inject the solution slowly, to allow the stretch receptors to accommodate (Auletta and Grekin 1991).

In the LA group, 14 patients experienced hypotension, which shows that careful monitoring and preoperative preparation are vital for performing a successful LA arthroscopy. Hypotension was more frequent in the LA patients than in the other groups, clearly demonstrating that the risk for an awake patient having a vasovagal reaction. These reactions occur because of pain and/or discomfort and can not be neglected. No serious adverse event occurred. Nonetheless, surgery had to be postponed in two cases.

The overall mean surgery time was short probably due to highly specialized surgeons. This fact might contribute to our good results.

General anesthesia

All patients randomized to GA accepted this form of anesthesia and there were only a few complications with this technique. This high level of acceptance of GA by the patients is also reported in several other studies, and many surgeons seem to favour GA (Shevde and Panagopoulos 1991). This is probably because there is no concern about pain and discomfort perioperatively, and there are relatively few technical problems (Cardosa et al. 1994). An adequate SA offers the same advantages intraoperatively, but the patient is awake. The fact that the patient is asleep under GA seems to be favoured by many patients and surgeons, although GA does carry inherent risks, such as aspiration.

Spinal anesthesia

There was a relatively high number of patients in the SA group who did not accept SA when randomized to this group, even though acceptance of SA is relatively high in Sweden (Holmström et al. 1997). The present study reflects well known drawbacks of this type of anesthesia. Some patients are generally reluctant to SA, technical errors and complications can occur, and sometimes the anesthesia is incomplete which might require additional GA. As expected, a few patients had hypotension during SA. Pain intraoperatively was negligible and the procedure was well tolerated. It is also interesting that a higher number of SA patients needed more postoperative analgesics compared to the LA and GA patients.

Intraoperative pain

Perioperative pain and discomfort are the major drawbacks with LA. The majority of the LA patients though reported no or mild intraoperative pain which is in agreement with other reports (Eriksson et al. 1986, Tsai and Wredmark 1993). One patient was excluded because of intolerable pain, which is in accordance with the retrospective analysis of 4 100 arthroscopies performed in LA. It is interesting that in 20% of the patients who found LA optimal, VAS pain scores were above 30 mm. A pain score of more than 30 mm is generally not considered acceptable postoperatively (Collins et al 1997, Kelly 2001). This finding indicates that pain and nausea are not the only variables involved in assessing patient satisfaction.

As expected, no pain was experienced in the patients having either GA or SA, and the most important future ambition must be to try to eliminate pain when using LA. An additional light sedation might be advantageous with LA. In this study, this was not given in order to avoid amnesia and to enhance early discharge.

Postoperative pain

There were only small differences between the groups with respect to postoperative pain. However, a significantly higher number of patients in the LA and GA groups did not use analgesics postoperatively compared with patients in the SA group. This is surprising because the type of postoperative pain management and the type of surgical procedures performed were similar in all three groups. Both LA and SA have the advantage of a prolonged pain free postoperative period compared with GA. A program of postoperative pain management consisting of non steroidal anti inflammatory drugs, paracetamol and LA injected at the incision sites has produced such a good pain relief that the differences in postoperative pain for the three forms of anesthesia are minimal.

No difference with respect to nausea between the groups was noted, indicating small differences in pain between the groups and minor influence of the type of anesthesia used. Postoperative pain management might also be further improved by administration of LA into the joint at least 20 to 40 minutes prior to surgery under SA or GA, allowing LA to anesthetic the tissues well.

Cost effective care

We are aware of the difficulties to compare costs between different centers because of national traditions, reimbursing systems and culture. Nevertheless, we find it important to study health care from an economical point of view and to share experiences in order to produce as cost effective health care as possible.
In earlier publications we have shown that arthroscopy in LA is a safe procedure with similar clinical outcome compared to arthroscopies in GA/SA (Forssblad and Weidenhielm 1999, Jacobson et al. 2000, Jacobson et al. 2002). Results of study III confirms that arthroscopy in LA was both more cost and time effective than arthroscopy in GA/SA in our setup. Several authors have in different countries and setups reported about cost savings for arthroscopies in LA (Lintner et al. 1996, Munk and Pedersen 1994, Trieshman 1996, Williams and Thomas 1997). Other authors

have solely reported about differences in costs when using different drugs (Casati et al. 2002, Heidvall et al. 2000, Martikainen et al. 2001, Ries et al. 1999).

In this study the setup for arthroscopy in LA was different from the GA or SA setup, because LA arthroscopy was performed outside the operating ward in a separate theatre, which reduced the costs for the LA setup. Some authors (Cardosa et al.1994, Lintner et al. 1996, Munk and Pedersen 1994, Shapiro et al.1995) have compared different anesthetic techniques in the same environment, which probably explains the difference in cost and time effects compared to our results. In Sweden, we have long waiting lists and problems to provide adequate capacity for surgery in operation wards. Our model might allow us to perform a higher number of arthroscopies outside the existing operating ward. That could increase the capacity to do more extensive surgery, such as ligament surgery, in operating ward with full anesthesia service.

The short hospital stay for arthroscopies in LA was appreciated by the patients (Jacobson et al. 2000, Jacobson et al. 2002) and our impression was that arthroscopy in LA outside the operating department was well tolerated by the patients. There were only 55 patients out of 1064, who chose not to participate in the study before randomization, because they were negative to the LA procedure, compared to 121 patients who did not like the SA/GA procedure. In a six month follow up of our patients there was no difference in the satisfaction rate between the three anesthesia groups (Jacobson et al. 2002).

The long preoperative delay for LA was intentional as we wanted to be sure that the LA had full effect. In our setup we inject LA to the patient just before we start the surgery on another previously anesthetised patient. The time from injection of the LA to the start of the operation, is depending on the time for surgery of the previous patient together with the time for cleaning the theatre. In our experience it is very important to wait at least 20-40 minutes after administrating LA (Hultin 1992).

The fact that we avoid sedative drugs and the shorter recovery time in the LA patients compared to the GA and SA patients reduces their need for recovery beds

and postoperative care. The SA group had a significantly longer recovery time and hospital stay time compared to the GA group.

The cost saving for arthroscopy in LA was SEK 1 011 for each procedure in 1997. If we adjust the cost to the Swedish consumer price index (CPI), the cost for 2003 would be SEK 1 095 (Consumer Price Index 1980=100, 1997=254.6, 2003=276) [Sweden Statistical Databases].

In 1997, the reimbursement payment was SEK 4 383 for an out patient arthroscopy. This was supposed to cover all costs including the surgeon's fee. The payment was independent of the type of anesthesia and therefore we could increase our profit with approximately 25% when using LA. The cost saving expressed in SEK seems to be relatively low, but not in relation to the total reimbursement. If a hospital performs many arthroscopies the total savings can be significant.

In other studies (Munk and Pedersen 1994) they have corrected the estimated cost saving for LA by adding the cost for all rearthroscopies in GA, when the primary arthroscopy in LA was interrupted due to pain, for instance. In the present studies there were very few interrupted in the LA group. This could of course still affect the cost savings, but in our reimbursement system we were also paid for the rearthroscopies.

In 2001 there were at least 29 838 knee arthroscopies performed in Sweden [The national board of health and welfare, Sweden] and the total potential for cost savings in Sweden would be approximately SEK 30 000 000 by using the LA technique.
In conclusion, we found that arthroscopy in LA could be performed with a shorter hospital stay and to a lower cost than arthroscopy in SA and GA.

Knee surgery costs in different team sports

There are a number of different ways to evaluate the costs of sports related injuries. The methods used in these types of studies have both specific advantages as well as disadvantages. Hitherto, there are solely a few publications about cost evaluation.

However, to the best of our knowledge no study has used an epidemiologic approach to estimate the costs of sports related knee surgery. Approximately, one third of all sports related knee surgical procedures in Stockholm are performed at Artro Clinic. Sweden is probably unique when it comes to the use of different databases and NRN, which makes this type of investigations possible.

In study IV we studied a population of players in different sports. There is a risk that not all individuals are registered in the different databases. There might also be some patients who had undergone surgical procedures outside the Stockholm region. We have considered that risk, but we do not consider that this could have any major influence on the results.

All studied DRG groups, except for DRG 232, involve knee surgery exclusively. In the DRG group 232 there can also be some diagnostic arthroscopies of the ankle and shoulder. The database containing all surgeries in Stockholm was not complete regarding the surgery code for the DRG group 232, which means that we might have included some diagnostic arthroscopies of other joints in this study. Among the surgeries performed at St Görans hospital (37% of the total) there were six arthroscopies out of 61 from the DRG group 232, which were not related to the knee joint. We therefore estimate that there might be an error of 10% of the 204 arthroscopies in the DRG group 232. In this case, the overestimation of the costs could be approximately SEK 80 000 compared to the total cost of SEK 4 884 076. This difference, however, did not influence the findings of this study.

In studies where data from insurance companies are reviewed, there is always a risk that a number of injuries are not reported to the insurance company. The reason for this may be, for example a low level of compensation or lack of awareness of having the insurance. Only 74% of all ACL injuries resulting in surgical treatment were reported to the insurance company.

Roos et al. (1985) reported a prevalence of 344 ACL injuries among 188 152 football players, which means 18 injuries/10 000 players (males 16 injuries/10 000 players, females 29 injuries/10 000 players). Approximately, 50% of these were treated with surgical intervention. In our study we found 40 ACL injuries / 10 000 players (males

33 injuries / 10 000 players, females 70 injuries / 10 000 players) operated in 1997, which subsequently is considerably higher than the findings of Roos. This might to some extent be explained by possible underreporting in the study by Roos. However, it should also be pointed out that ACL surgery has increased over the years, and so has the number of participants in football. In our material of football players in Stockholm 18.6% were female players compared to 19.5% in Sweden as a whole in the material of Roos 1986. Another explanation is of course a higher incidence of ACL injuries over the years, Folksam reported 24 injuries / 1 000 players in 1986, 34 injuries / 1 000 players in 1990 and 28 injuries / 1 000 players in 1997 amongst football player (Folksam 1994, personal communication).
Other explanations to the increased ACL surgery over the years might be better diagnostics, better operative results and higher demands from the patients.

The findings with regard to the ratio of day surgery and length of hospital stay following ACL reconstructions, when comparing different hospitals in the Stockholm region, reflects how different hospitals in the same city undertake health care (Table 1). For example, an arthroscopy with meniscus resection, the DRG reimbursement is SEK 4 383 for a patient in day surgery and SEK 24 181 for a patient with one night stay in the hospital. This difference is not reflecting the extra cost for the hospital and is an unacceptable drawback for cost effective care.

Hospital	Total number of surgical procedures in day surgery (n)	Total number of surgical procedures (n)	Day surgery ratio (%)	Hospital stay for ACL surgery (days)
1	2177	2532	86	1.03
2	559	754	74	3.70
3	0	22	0	NA
4	739	739	100	NA
5	340	340	100	NA
6	446	546	82	1.26
7	658	787	84	1.62
8	338	450	75	2.18
9	212	293	72	NA
10	143	163	88	4.00
11	232	232	100	NA
All	5845	6859	85	1.60

Table 1. Distribution of knee surgery (DRG 221, 222, 222B and 232) in Stockholm hospitals 1997 in patients ≥ 15 years old.

There are several publications regarding health costs, for example for traffic accidents, smoking, alcohol consumption and treatment of different diseases (Stockholm Health County 2000, Fenoglio et al. 2003). It is, however, difficult to make comparisons with those results, since the materials and methods differ between studies. Nevertheless, the total cost for all health care in Stockholm was SEK 18 000 000 000 in 1999. For orthopaedic related health care the cost was SEK 400 000 000, heart diseases SEK 884 000 000 and for mental health care SEK 625 000 000. This should be compared to our costs of approximately SEK 5 000 000 for sport related injuries. Fenoglio et al. (2003) reported that the cost per capita for alcohol consumption in France during 1997 was FFR 1 966 (French Francs), for smoking FFR 1 520 and for drugs FFR 227.

Our data describe only the surgery cost for knee injuries in different sports. This type of data can be useful when discussing new types of insurances for athletes. In Sweden, a public discussion about priority in health has recently started and some politicians argue for excluding sports injuries from the national health care system. This stresses the importance of reducing the costs for sports injuries, in particular serious knee injuries such as ACL injuries, since these are the most expensive sport injuries today. By early diagnosis, treatment and rehabilitation we can also probably prevent subsequent knee injuries in these patients, reducing health care expenses further on.

Sports related health care costs should, however, be considered in relation to total health costs. Furthermore, all positive effects attained from sport participation should be taken into account. These include not only medical ones such as i.e. prevention of heart diseases, osteoporosis and diseases due to alcohol, but also aspects regarding the positive social and psychological influence that sport often has on many young individuals. Furthermore, today there are an increasing number of athletes, especially in football, that makes their living on the sport. Many of these individuals have no other education. Therefore, a serious injury also means a considerable economical disadvantage for these athletes.

Based on the study IV it is concluded, that health care costs for sports related knee surgery are low compared to health care costs for other diseases, such as heart diseases and osteoporosis for instance, which at least to some extent are related to physical inactivity.

Final discussion

My opinion is that Artro Clinic is a successful concept with focus on patients, employees and owners and that this concept can be used in many parts of the health care system. Finally I want to discuss some general questions related to our concept.

The fact that highly specialized surgeons shorten the surgery time is supported by an earlier report (Farnsworth 2001). In our first study it was concluded that experienced surgeons have a lower rate of rearthroscopy compared to less experienced. However, generally there is a lack of evidence that well trained surgeons have better clinical outcome than less experienced surgeons. An explanation for this may be that surgeons in general have good skills and that they do not finish a surgical procedure until they are happy with the result. In a unit, like Artro Clinic, all surgeons can always have backup support from their colleagues, who can advise and help them during the surgical intervention.

One explanation to our favourable results comparing to earlier studies, when operating in LA, is of course only that experienced surgeons have performed the arthroscopies. When a surgeon starts to do arthroscopies in LA there is for certain a learning curve with a threshold to pass. This is also on the other side a strong argument for highly specialized units as well as that a surgeon needs to perform a certain numbers of procedures every year. Furthermore it is important that these highly specialized units can offer training and education for surgeons from other hospitals. In Sweden there is a good climate for education and training probably due to openness and cooperation between different hospital clinics and doctors.

In Sweden there has been a notable drop in productivity per doctor over the last years. In 1975 each doctor in Sweden treated 2 024 patients per year compared to 909 patients in 2000 (Swedish Federation of County Councils). The surgeons are performing less surgery in favour of other duties for example administration, patient contacts and documentation (Figure 9). It is therefore important to develop supporting, user friendly IT systems to minimize the time for time consuming activities such as administration and instead to try to increase the time for surgery.

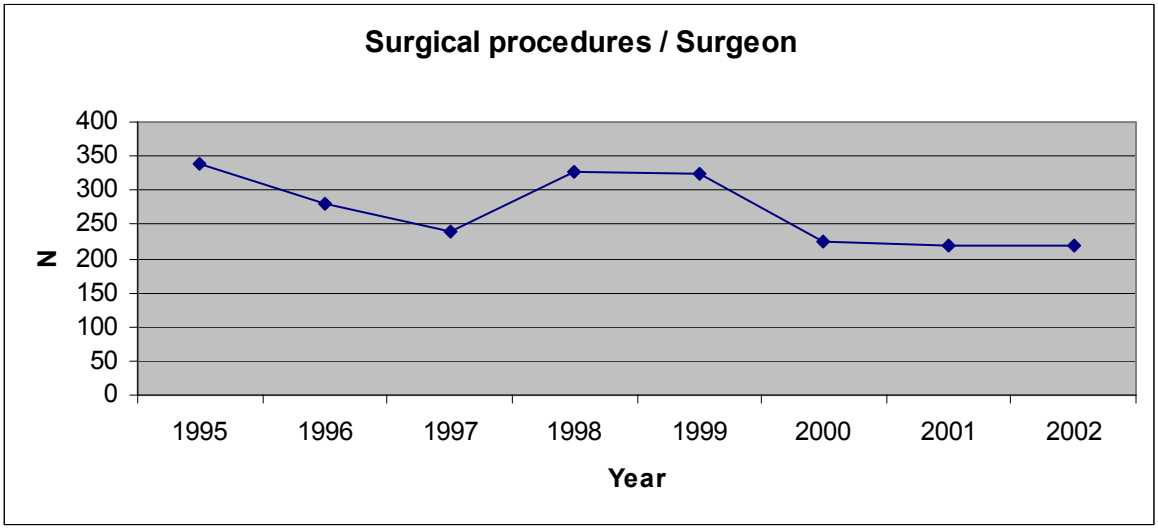


Figure 9. Number of surgical procedures / surgeons in Artro Clinic 1995 – 2002.

Cost savings and efficiency are crucial for future health care development, but there is definitely a risk of pushing things to hard. One interesting issue is the possible number of surgical procedures each surgeon is able to perform in one day, and still keeping up a reasonable level of quality. There have been suggestions that a surgeon should perform about 20 arthroscopies, or eight total hip replacements in one day, using two linked operating theatres. Mathematically, by just adding up the operating time for a certain number of procedures, it is possible, but is it safe and sound? For the surgeons it is a delicate balance where increasing experience, maintaining surgical skills, efficiency and production, concentration ability and risk for exhaustion play important roles. However this is a field for further research: How to organize the daily work for a surgeon? How many i.e. ACL reconstructions are needed yearly to maintain experience and knowledge for a surgeon? Surgeons are human beings, not robots!

Another issue is the rapidly growing health care costs in Sweden presented in table 2. (The National Board of Health and Welfare, Yearbook of Health and Medical Care 2002).

Year	Total health cost in SEK	Per Capita (inhabitants) in SEK
1993	119 058 000 000	13 656
1994	120 617 000 000	13 737
1995	128 087 000 000	14 511
1996	134 892 000 000	15 268
1997	136 173 000 000	15 394
1998	144 207 000 000	16 293
1999	153 591 000 000	17 339
2000	163 068 000 000	18 380
2001	172 469 000 000	19 387

Table 2. Total health cost in Sweden 1993 – 2001.

There have been many attempts to lower the health care costs. In my opinion the administrators and the politicians tries to either cut costs, for example by general cost saving programs, prolonging the waiting time for health care or as just recently introduce “priority lists”, where some specific diagnosis are excluded from the health care system.

Some countys in Sweden, like Stockholm, still use the DRG system. This system has many advantages but can not really control the total health care costs unless it is combined with limitations in for example number of hospitals, surgeons and visits. The DRG system contains unmotivated high differences in reimbursements when comparing day surgery with over night stays in the hospital, which can give the hospitals higher revenues in a short term perspective. There has also, to my opinion, been a lack of stimulus in Stockholm to provide cost effective care.

The costs for sick leave in Sweden are paid by the state and the employers, but not by the countys. As an example a study in Gothenburg showed that the sick leave costs for 159 patients on the waiting list for spinal-, shoulder- and knee surgery was SEK 89 000 000 (Hansson et al. 2003). Another study 2003 pointed out that 36 % of all patients waiting for meniscus surgery were on paid sick leave (Swedish Federation of County Councils 2003). Subsequently, it is important to take care of patients that are waiting for surgery and that are on paid sick leave. To sum up, a systematic error in the politicians way of coordinating the total public health care

economy, some times unfortunately delays treatment for some patients. It increases the total cost, and is medically and socially unsuitable, at the tax payers' expense.

My final recommendation is therefore to start an evaluation of different treatment methods from a more total economical point of view including not only costs for sick leave – costs for additional surgery (i.e. removal of screws) and costs for insurance companies (Table 3). Our current system focus only on DRG costs for one specific operation (# 3 in table 3) but the total potential of cost saving is high.

#	Type of cost	Payer in Sweden
1	Preoperative management (i.e. visits, MRI)	County
2	Sick leave cost before surgery according to long waiting lists	State, Employer
3	DRG cost for the surgery	County
4	Cost for different methods i.e. comparing ACL reconstruction using patella tendon graft with semitendinosus graft	Hospital
5	Sick leave cost after surgery - i.e. is there a difference between patients operated with patella tendon graft and semitendinosus graft?	State, Employer
6	Cost for visits after surgery	County
7	Reoperation on short term basis - cost for removal of screws or i.e. higher incidence of septic arthritis	County
8	Rehabilitation cost i.e. physiotherapy, travel expenses	County, Insurance company, Private, Employer
9	Cost for insurance company - i.e. is there a different compensation for patients operated with semitendinosus graft compared with patella tendon graft?	Insurance company
10	Patient experience (i.e. pain, suffering)	Patient
11	Reoperation on long term basis – is one method better than the other?	All

Table 3. Model for comparing different methods.

This is also a field for future research and it is important for us, who are working inside the health care system, to take a greater responsibility for this type of questions. We have to decide the future direction in health care and convince the administrators and the politicians to make the right decisions for the future! It is necessary for us to take that and even more responsibility.

CONCLUSIONS

- There was no significant difference in the frequency of rearthroscopy between LA and GA when reviewing 6519 arthroscopies if the initial arthroscopy was carried out properly.
- Out of 4101 arthroscopies performed in LA, 38 (0.9%) was interrupted due to pain or technical problems and rescheduled for a second arthroscopy.
- The frequency of rearthroscopies for well trained surgeons (1.2%) was lower compared to the frequency among less experienced surgeons (2.5%, $p = 0.018$).
- Elective knee arthroscopy can be performed under LA in the majority of the patients.
- Ninety percent of the patients with LA were satisfied with their procedure.
- From the surgeons' point of view, technical problems are to be expected in 5% of the procedures in LA.
- Arthroscopy in LA should be avoided if the patient has excessive synovitis.
- Patients who undergo an arthroscopy in LA have significantly shorter hospital stay compared to patients with GA and SA.
- Cost saving for arthroscopies in LA is about SEK 1011 for each procedure compared to GA and SA.
- Average health cost for knee surgery (excluding total knee replacements) for players in different sports (football, floor ball, European team handball and ice hockey) was SEK 108 during 1997. The average cost was for football SEK 115, floor ball SEK 87, European team handball SEK 220 and ice hockey SEK 72.Seventy four percent of the patients operated with ACL reconstruction in 1997 reported the injury to their insurance company.

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