



Regional anaesthesia and analgesia in fast track knee arthroplasty

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Summary

Total knee arthroplasty is a surgery that provokes intense postoperative pain and requires special care. An effective analgesia with minimal side effects is vital in elderly patients, who often have significant comorbid diseases.

Delays in postoperative mobilisation induce tissue retraction, adhesions and atrophy. They also can lead to different complications such as thromboembolism, increase morbidity and decline in cognitive function.

Fast track surgery is defined as the synergetic effect on convalescence achieved by adding multi-modal evidence-based care principles and combining these with optimal logistics. The yield is quicker functional recovery, reduced need of hospitalisation, rapid resumption of normal activities of daily life and high levels of patient satisfaction. At the same time there are large economic benefits as a result of shorter hospitalisations.

Effective postoperative pain relief is a prerequisite for successful early mobilisation and intensive physiotherapy rehabilitation.

Compared with general anaesthesia and/or systemic analgesia regional anaesthesia reduces opioid consumption and opioid-related side effects. The use of epidural anaesthesia cannot be suggested due to the risk of bleeding, hypotension and other side effects.

Ultrasound guided placed catheters for continuous peripheral nerve blocks on femoral and sciatic nerve are proved to be of advantage to other techniques.

Different studies also suggest that the addition of an obturator nerve block to femoral and sciatic blockade improves postoperative analgesia following total knee replacement especially on the day of the surgery.

Femoral and sciatic nerve block is well documented option for post-operative analgesia, but a prolonged motor block, which may occur, can prevent early mobilisation and increase the length of hospitalisation.

In order to prevent quadriceps weakness a new technique of an adductor canal block has been developed. The saphenous nerve and in part the obturator nerve are traversing the adductor canal of the thigh. Repeated administration of local anaesthetic into this aponeurotic space could be a useful option for postoperative analgesia after knee replacement surgery. The preliminary results are very encouraging, but need to be confirmed in randomized control trials.

The anaesthesiology challenge to provide sufficient analgesia with preserve muscle function and minimal side effects still remains.

Fast Track

"Fast track concept" or "Enhanced rapid recovery programme" is the concept of improving perioperative efficiency with accelerated and improved recovery. It is increasingly being applied in different types of surgeries and is of significant importance for the patient in particular and wider economic and social spheres in general.

This concept represents an evidence based multi disciplinary synergetic work of different medical departments and is combined with optimised logistics. All procedures are strictly standardised. The aim is earliest possible functional recovery of the patient, decrease of postoperative complications, early discharge from hospital treatment with rapid resumption of normal daily activities. A complementary result is also the reduction of hospital costs which is important in the current economic climate (1).

Fast Track concept for total knee arthroplasty requires early patient management and begins at the time of preoperative consultation. The patients are examined and informed by the anaesthetist, orthopaedic surgeon and a specialist for physical medicine.

In this way the patient already knows the detailed plan of exercises in the physical therapy and the scheduled day of discharge. This results with reduction of anxiety and more motivation particularly if the exercises are carried out in groups.

The implantation of knee arthroplasty is a very common surgical intervention. In USA, the number of joint replacements in 2011 was fourfold in comparison with 1999 and by 2015 is expected to reach 1.5 million.

It is also well known that the operation has a high pain factor and therefore it is very important to have an effective postoperative pain relief that ensures VAS that does not exceed 4 including mobilisation phase. Early and intensive mobilisation is the fundamental precondition for fast recovery and short hospital treatment (3). It is generally accepted that the mobilisation should start latest the morning after the operation. In this context, the role of the anaesthetists is very complex as adequate analgesia needs to be provided and earliest possible mobility enabled while at the same time ensuring good hemodynamic stability, avoiding nausea, vomiting and dizziness (2). It is well known that for the cognitive function improvement of older patients, active mobilisation is of utmost importance.

Different methods of postoperative pain therapy

Due to very intense postoperative pain, systemic analgesia is most commonly carried out with opioids applied through a PCA pump. This therapy is only sufficient with high doses and is inevitably associated with side effects such as nausea, vomiting, sedation and often a respiratory depression.

On the other hand, regional anaesthesia ensures good postoperative therapy (14), reduces the consumption of

opioids (22), decreases the incidence of PONV and provides more success in rehabilitation (16, 17) In comparison with general anaesthesia, regional anaesthesia has shown a far smaller risk of postoperative thrombosis (4).

Injecting the local anaesthetic through the epidural catheter with or without opioids results in good analgesia (19), but has side effects such as hypotension (5), reduced capability of mobilisation and urinary retention. The major issue is the risk of epidural bleeding due to which lumbar epidural anaesthesia and analgesia are no longer recommended.

Psoas compartment block is technically more complex in comparison with other peripheral blocks. From the analgesia point of view it is comparable to femoral nerve block with the advantage that the obturator nerve is also blocked (6, 7). The disadvantage is that this block requires more local anaesthetics and that concerning anticoagulation therapy, the same rules have to be applied as for the epidural block.

Many studies have shown that the peripheral blocks such as femoral and sciatic nerve blocks as well as combination of the two result in excellent analgesia (8, 9, 10, 11). In comparison with epidural blocks, these blocks have significant advantages, they block one extremity and there minor side effects compared with epidural blocks. If applied under US monitoring, these blocks can be use in anticoagulated patients (apart from anterior approach to sciatic nerve where deep blood vessels necessitate caution).

It is well known that ultrasound guided nerve blocks have multiple advantages in comparison with nerve stimulation such as risk reduction of puncturing blood vessels, nerve injuries and decrease of local anaesthetic volume by at least 40–50% (31).

Peripheral nerve catheters

The use of peripheral nerve catheters has the advantage over single shot techniques and is considered as the technique of choice for postoperative analgesia after total knee replacement surgery. It enables prolongation of block duration and analgesia. The method of local anaesthetic administration can be continuous or bolus injections (15, 18, 20).

Major neurologic and infectious adverse events are rare (35).

Most studies show that continuous application of local anaesthetic improves patients' recovery and enables earlier discharge, there are some studies with opposite results, but at the time of these studies patients were laying in bed for longer period of time and early mobilisation was not an issue (21).

The necessity of sciatic nerve catheter

Application of femoral nerve catheters and single shot sciatic nerve blocks has been a long established practice.

In the mean time numerous studies have shown that application of local anaesthetic through a catheter on sciatic nerve combined with a catheter on femoral nerve have

resulted in lower VAS score and an 80% reduction in application of opioids in the first 36 postoperative hours. Continuous application of local anaesthetic on the sciatic nerve and lumbar plexus catheter gives similar results (24).

A study comparing a combination of catheters on femoral and sciatic nerves versus an isolated femoral nerve catheter and isolated psoas block, has also shown a 3-fold reduction of opioids needs in the group using combined catheters (25).

Another study of continuous local anaesthetic application through a femoral catheter and a dummy sciatic nerve catheter has shown that 85% of patients requested an additional local anaesthetic due to pain in the region innervated by sciatic nerve (26).

From these studies it can be concluded that for optimal postoperative analgesia both catheters are necessary as it is also recommended by the German S3 Guideline for treatment of acute perioperative and posttraumatic pains class evidence A.

Obturator nerve block

It is well known that the posterior branch of obturator nerve partially innervates the medial side of the knee and that the innervation is highly individual. The anatomic path variations and the anterior and posterior divisions of the obturator nerve are numerous. This division occurs in 23% of cases intrapelvic, 52% in the obturator canal and 25% in the thigh, meaning that the application of the posterior nerve block can be difficult despite the use of US (36).

Study where obturator nerve block was added to femoral and sciatic nerve blocks has shown that the time span when patients requested an analgesic was 1/3 longer compared to patients without the obturator nerve block (27).

Another study shows significantly lower adductor muscle contraction (78% +/-22%) and reduced analgesic requirement particularly in the first 20–40 hours after the operation as the effects of the obturator nerve block (28).

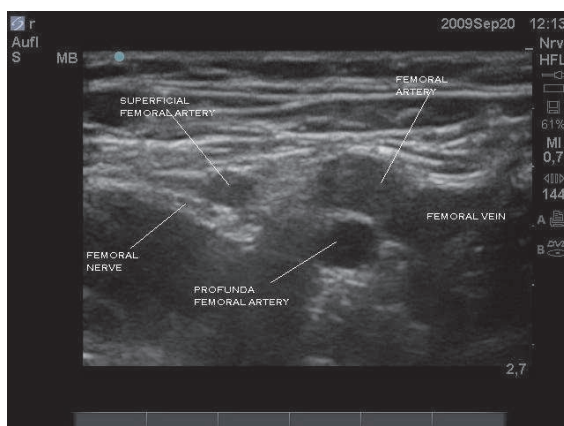


Figure 1. Femoral nerve in inguinal area.

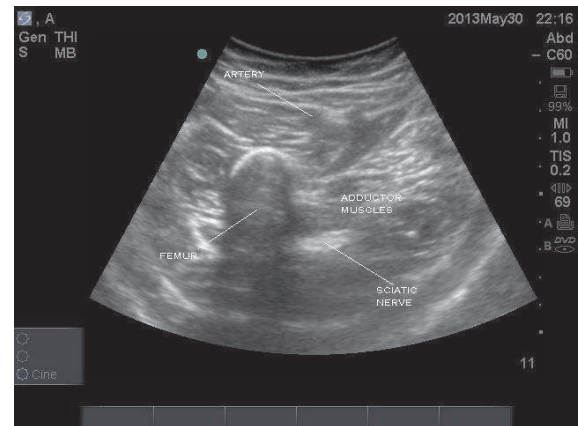


Figure 2. Anterior transversal scan of sciatic nerve.

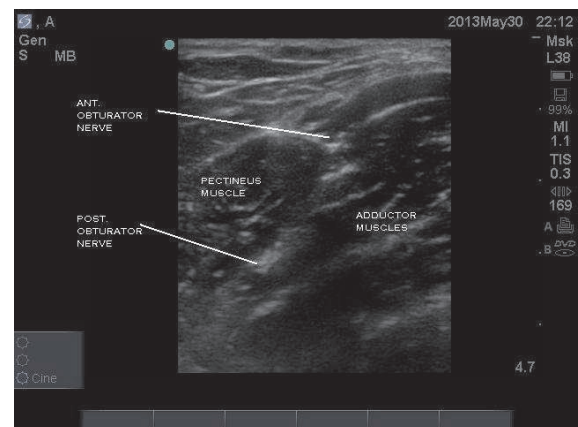


Figure 3. Obturator nerve - anterior and posterior branch.

It is important to bear in mind that the cutaneous innervation by the obturator nerve is to be found in only 40% of the cases. Therefore the sensory evaluation of the block is not reliable (29).

Research on optimisation of the postoperative analgesia without the reduction of quadriceps muscle contraction

Early patient mobilisation is the most important precondition for fast recovery and early discharge for home treatment.

The concept of majority of fast track procedures in knee arthroplasty includes active mobilisation morning after the operation. This represents a big challenge for the anaesthetist because the patient should not have pain and at the same time he should have a good muscle strength in order to participate in active physical therapy. A precise control of muscle contraction intensity is imperative by periphery nerve blocks of lower extremities in order to avoid falls and injuries (37, 39).

Femoral nerve block, which is the block of the front thigh muscles such as quadriceps, pectineus, iliopsoas

and sartorius muscle in this time period must not be motoric so as not to make the mobilisation of the patient impossible. This also applies for the sciatic nerve block.

Different studies have been conducted with the aim of achieving good analgesia and avoiding motor impairment.

A study which tested the decreased concentration of local anaesthetic by comparing the results after application of different ropivacaine concentrations: 0.025%, 0.05% and 0.1% has shown that application of concentration below 0.1% does not result in a satisfactory analgesia (30).

Studies were also carried out about the effects of lowered concentration of the local anaesthetic and increased volume and vice versa, applied continuously through a catheter. The results show that the concentration of the anaesthetic and the volume do not change the block characteristics. The total dose or mass of the anaesthetic determines the block characteristics (32).

Based on these results further examination of applying different local anaesthetic concentration and volume by constant mass were made on patients with bilateral knee arthroplasty. The patients received ropivacain 0.1% @ 12 ml/h or 0.4% @ 3ml/h with a possibility of 4 mg additional bolus. The different concentration levels did not have any effect on reduction of quadriceps muscle contraction and it was concluded that the muscle contraction weakness can only be avoided by reduction of the total anaesthetic mass (33).

Further studies examined the effects of applying the local anaesthetic in form of bolus versus continuously, with the aim of reducing the motor while preserving the sensor block. Volunteers received a bilateral perineural femoral block. Ropivacain 0.1% was continuously applied at the rate of 5 ml/h or as a bolus of 5ml every hour for six hours. Results show that the block was identical in both cases (34).

The effect of distribution of motor and sensory fibres in the nerve and even the catheter position (anterior or posterior) may also influence the type of the block. Research into these issues is currently in progress.

Adductor canal block

In recent times there is an on going research of the adductor canal block with the aim of solving the problem of weakened quadriceps contraction after the femoral block.

The sensory knee innervation is highly complex and variable (41, 42, 43, 44).

Saphenous nerve, as the terminal branch of the femoral nerve, and partly obturator nerve pass through the adductor canal. Branches of vastus medial muscle and cutaneous nerve are also to be found there. It is assumed that this block could be effective in postoperative period by reducing the pain in mobilisation i.e. flexing of the knee as well as in the idle state. Parallel with this, the quantity of systemic opioids could be reduced so as to avoid the opioid associated side effects.

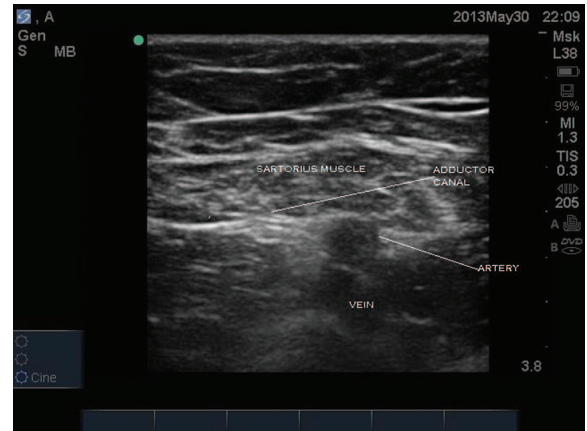


Figure 4. Adductor canal.

A study dealing with existing postoperative pain looked at the effect of injecting 30 ml of 0.75% ropivacain in the adductor canal space and noted that the local anaesthetic spread was in the region 7cm above patella to 8-10 cm distal from the femoral triangle. This block reduced the pain caused by knee flexion. Following that, through a placed catheter 15ml of 0.75% ropivacain was injected every 6 hours for up to 48 hours after the operation. The results on postoperative analgesia were similar to results achieved by femoral nerve catheter (38).

Second study used healthy volunteers. On one leg they had an adductor canal or femoral nerve block and on the other leg a placebo catheters. Maximal quadriceps and adductor muscle contraction was measured. In the group with the adductor canal block there was a far fewer incidence of quadriceps muscle weakness (8%) compared to the femoral nerve block (49%)(40).

Local infiltration analgesia

According to the regional anaesthesia hypothesis "The more peripheral – the better" in recent times and particularly in Scandinavian countries local infiltration analgesia has become increasingly popular. Analgesia is carried out with a large volume of local anaesthetic and has proved to be successful in the first couple of hours after the operation. The method is recommended because of its simplicity (45).

However due to high dose there is a danger of intoxication and damage to the chondrocytes and by repeated application through intra articular catheter even possibility of infection.

The method is still evolving and these studies are trying to resolve open issues:

The optimal placement of local anaesthetic application is still not defined and it is still not clear whether it should be infra capsular or intra articular (46).

Essving compared the effectiveness of local infiltration to intratecal analgesia with morphine in the postoperative period. The conclusion was that analgesia with local infiltration is better and enables earlier discharge

which is understandable when morphine side effects are taken into account (47).

As it is not well defined what concentration and volume should be used for wound infiltration a study comparing the application of high volume and low concentration (20ml, 0.5% LA) to low volume and high concentration (10ml, 0.1% LA) was performed. It has shown that the analgesic effect is identical when the local anaesthetic is applied through intra capsular catheter (48). This corresponds to the current state of the art knowledge that the total mass of the local anaesthetic is of primary importance.

Application of the local analgesia through a catheter by a surgeon is delegating of competence for postoperative pain therapy, which may have positive as well as negative effect on the patient.

Overview of knee arthroplasty experience at Herz Jesu Hospital in Vienna

Perioperative placing of catheter on femoral and sciatic nerves with the help of US is practiced in Herz Jesu Hospital since 2005. The annual number of operation with this application has steadily risen from 400 to 700 in 2012.

Fast track procedure was introduced in March 2010 and includes:

- The patient is examined by the anaesthetist, orthopaedic surgeon and physical medicine staff approximately 7 to 15 days before the operation and is informed about the complete process, physiotherapy and planned discharge date.

- Preoperative placing of catheters on femoral and sciatic nerves and bolus administration via catheters of 0.5% ropivacain and a single shot block of obturator nerve with 0.5% ropivacain. Due to tight schedule, the catheters can be placed after the operation and injected with 0.2% ropivacain.

From 2005 until 2008 the local anaesthetic was applied continuously but since then the application was in the form of bolus. The advantage of this method is that the total quantity is significantly smaller and there is no accumulation risk.

- Patients receive the second bolus with 0.2% ropivacain, depending on the time of the operation, between 7 and 9 pm, third in evening of the first postoperative day and the fourth also in the evening of the second postoperative day.

Apart from this type of analgesia the patients also receive analgesics according to the schedule WHO I with individual adjustment.

- VAS score, level of motor response and sensitivity are measured in the innervations region daily 4x by ward staff and 2x by the anaesthetist.

First mobilisation of the patient is in the morning of the first postoperative day and second around 1pm. Pa-

tients perform physical therapy in groups thus mutually boosting motivation.

In case the patient cannot be mobilised and take part in physical therapy, this is documented by the physical therapy team and the anaesthetist is informed.

A sample of the latest 102 patients has retrospectively shown the following results:

- Patients average age 71.7 years
- BMI 31 +/- 4.5
- 98 patients received femoral and sciatic nerve catheters
- 34 patients received the obturator block
- Placing of sciatic nerve catheter on 4 patients was not successful
- Time span before catheter removal 3.5 +/- 0.6 days
- 91 patients were discharged after the 6th postoperative day
- Average maximal pain level (VAS) was 4 in the first 12 hours of the first postoperative day and decreasing thereafter

An interesting fact is that the patients have lower pain levels after the afternoon more intensive physical therapy as compared to morning exercises. This correlates with a study which describes positive effects of mobilisation on analgesia (49).

Morning mobilisation was not possible in 7% of cases due to muscle weakness caused by prolonged effects of the block. Prolonged effects were equally frequent on femoral and sciatic nerves but not simultaneously in all patients. Only 2% of patients could not take part in the afternoon therapy due to muscle weakness. In 4% of the cases mobilisation was not possible due to dizziness and general weakness.

These facts are of great importance for us and we are taking measures to improve the early morning mobilisation. Data collection which is going to be online is being created. In this way the data will be easily accessible to all involved and a better evaluation of the pain therapy will be possible.

In planning is a study that will compare analgesia values of combined adductor canal and sciatic nerve blocks with combined femoral and sciatic blocks in order to totally eliminate muscle weakness and enable earliest possible mobilisation of all patients.

Our striving to discharge patients 6 days after the operation is also due to the fact that in Austria hospitalisation time is limited for each operation. This economic consideration plays a certain role although primary focus is on the patients who are only discharged when independently mobile.

CONCLUSIONS

Fast track procedure is a multi modal, multi disciplinary, strictly standardised and evidence based concept with the aim of faster patient convalescence and discharge from clinical therapy while at the same time hav-

ing positive economic effects. This procedure should be applied in knee replacement surgery.

The role of the anaesthetist is to ensure an optimal pain therapy, where possible without side effects, and at the same time to preserve the muscle function so that the patient can participate in the early physical therapy which is of exceptional importance for fast recovery.

Placing of the femoral and sciatic nerve catheters and applying local anaesthetic through them has evolved as the method of choice. Applying additional obturatorius nerve block is also beneficial.

As possible prolonged local anaesthetic effects through these two catheters can lead to weaker muscle contraction and consequently delayed patient mobilisation, research of analgesia effects of the adductor canal block, is being carried out. Initial results are encouraging but still need to be supported by further research.

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