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Combined sciatic and femoral nerve block for knee arthroscopy: 4 years' experience

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Abstract Selective block of the femoral and sciatic nerves was performed on 601 patients undergoing knee arthroscopy. The results were good in 87%, adequate in 12%, and poor in 1%. The whole knee surface was covered by the nerve blockade. The duration of anesthesia was 152 ± 21 min and that of analgesia, was 336 ± 18 min. No correlation was observed between the effectiveness of the anesthesia and type of surgery performed. The technique described thus proved adequate for knee arthroscopic surgery, reproducibility was excellent, costs and hospital stays were reduced with respect to general anesthesia, and surgeon and patient satisfaction was high.

Introduction

The increasing spread of arthroscopic techniques has been accompanied by a progressive reduction in the invasiveness of knee surgery during the past decade. Anesthesia for knee surgery, on the contrary, has changed little in the same period. Narcosis, epidural or subdural spinal block, and intra-articular injections of large amounts of local anesthetic are the techniques generally used for knee arthroscopy, but each of them has intrinsic drawbacks [1–4].

To avoid these drawbacks and to identify a less invasive (compared with general and spinal anesthesia), reliable, safe, and inexpensive method of anesthesia for knee surgery, in 1988 we developed a technique of regional anesthesia based on a combined block of the sciatic and femoral nerves localized with the aid of electroneurostimulation (ENS) [5, 6]. Since 1990 we have routinely applied this technique for arthroscopic knee surgery procedures. Here we report our 4-year experience of 601 knee arthroscopies performed under regional anesthesia with overall excellent results.

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Patients and methods

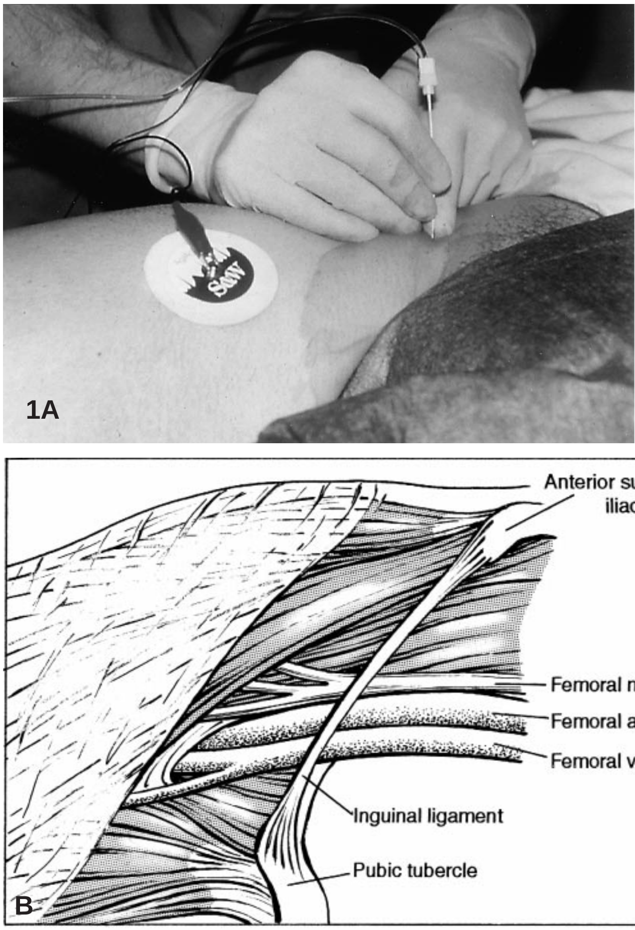
The series consisted of 601 consecutive patients (391 men, 210 women, mean age 43 ± 17 years, range 14–80 years) referred to San Raffaele Hospital, Milan, Italy, for knee arthroscopy from 1990 to 1994. Those patients who refused this type of anesthesia and those in whom, according to our opinion, it was not suitable (i.e. children, psychopaths) were excluded from the study.

Operative arthroscopy was performed with a 5.5-mm diameter arthroscope. Three standard portals (superomedial, anteromedial, and anterolateral) were usually established and, when necessary, also a posteromedial or superolateral one. An arthroscopy fluid pump was always used, with a pneumatic tourniquet at the thigh root that was inflated (300 mmHg) only if necessary. The surgical procedures included meniscectomy, partial synovectomy, removal of loose bodies, chondroplasty, drilling, and abrasion.

Peripheral block was obtained by injecting a local anesthetic solution (plain 2% mepivacaine) close to the sciatic and femoral nerves. The total dose administered was 7 mg/kg body weight, 60% of which was used for the femoral nerve block and 40% for the sciatic nerve block. In the first 2 years premedication (dehydrobenzoperidol 5 mg and atropine 0.5 mg i.m.) was given 30–40 min before surgery but not in the last 2 years as the rapid turnover of patients undergoing knee arthroscopy made it impossible to ensure safety in terms of the possible rebound effects of a major neuroleptic. We therefore administered diazepam in 5-mg boluses i.v. and repeated this if the patient manifested symptoms of anxiety or erethism.

The site where the femoral nerve was blocked was about 0.5 cm lateral to the femoral artery, and about 4 cm below the inguinal ligament where it divides into anterior and posterior branches (Fig. 1). The sciatic nerve was reached by Labat's classic posterior approach [7]; briefly, the site where it was blocked is beneath the gluteus maximus after it clears the ischial tuberosity, before descending vertically to the thigh (Fig. 2).

Selective femoral and sciatic nerve block was performed with the aid of an ENS device (ENS Medival Ecostim 910) connected to a specially designed needle, electrically insulated except at the very tip. This device allows easy localization of the nerve trunks by evoking a strong rhythmic contraction of the muscles supplied by it, and then the anesthetic can be injected safely close to the



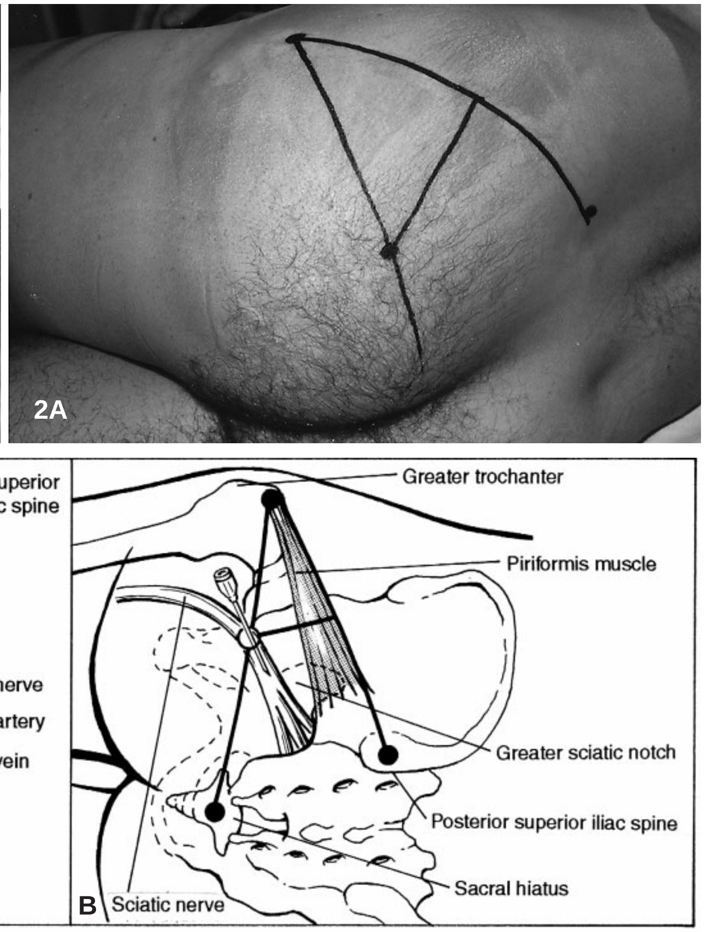


Fig. 1 Patient's position (**A**) and anatomical landmarks (**B**) for femoral nerve block

Fig. 2 Patient's position (**A**) and anatomical landmarks (**B**) for sciatic nerve block

nerve. The ENS device delivers constant current square-wave impulses of 0.3 ms each, of modulatable amplitude (0.1–10.0 mA) and frequency (1–8 Hz). It was temporarily connected to two cables to the needle and to a large surface ground electrode positioned on the patient's skin at a distance of at least 20 cm from the needle, in order to avoid deflection of the electric field. After inserting the needle, the current delivered by the ENS device was kept in the range of 0.5–1.0 mA of amplitude and 2–4 Hz of frequency, and twitching of the muscle fibers supplied by the stimulated nerve was sought.

At the point the femoral nerve leaves the inguinal canal, passing laterally to the homonymous artery, it divides into terminal branches distributed in the bellies of the quadriceps [8]. To block the femoral nerve, three branches were found and individually blocked just below the inguinal ligament. One branch supplied the vastus medialis muscle, recognized during electrical stimulation by twitching of only the medial part of the quadriceps femoris. This branch was reached with an injection perpendicular to the skin 0.5 cm laterally to the pulsation of the femoral artery and immediately under the inguinal ligament. The needle was then retracted up into the subcutaneous layer and directed laterally for 0.5 cm along a line parallel to the inguinal ligament to reach the second branch supplying the rectus femoris muscle. This branch was localized by evoking an upward shift of the patella. Lastly, the needle was directed still more laterally to localize the third branch supplying the vastus lateralis muscle, identified by twitching of the lateral part only of the quadriceps.

The sciatic nerve leaves the abdomen through the ischiatic foramen and courses vertically under the gluteal muscles. The contractions evoked by electrostimulation of the various components of the sciatic nerve are clearly evident when the patient is placed in Labat's position [8], and a 12-cm needle is inserted perpendicular to the skin between the mid- and lateral thirds of a line drawn between the upper margin of the greater trochanter and sacral hiatus. Also for the sciatic nerve block, we found and blocked three components: the tibial nerve, supplying the triceps surae, tibialis posterior, and flexor hallucis and digitorum muscles, recognized during electrical stimulation by plantar flexion of the foot and toes; the common peroneal branch supplying the anterior muscles of the leg, recognized by dorsal flexion of the foot; and the so-called nerve to the hamstrings, supplying the biceps femoris, semitendinosus, and semimembranosus, recognized by flexion of the leg.

The efficacy of the anesthesia technique was evaluated according to the following criteria.

1. Adequacy of anesthesia, defined as (a) excellent, when the surgical procedure was carried out with no need for additional pharmacological support; (b) good, when only extra sedation was necessary (diazepam up to 7.5 mg/h); (c) sufficient, when additional analgesia was required (fentanyl up to 100 mcg/h i.v.) in order to complete surgery; and (d) poor, when general anesthesia had to be given to allow the surgical operation to be completed. In 50 patients, the extent and duration of analgesia and anesthesia were measured with pin-prick and ice tests [9].

2. Degree of muscle relaxation as evaluated by the surgeon according to a 3-level scale of (a) good, when no resistance was encountered to surgical manipulation of the knee; (b) fair, when there

was a little resistance to surgical manipulation of the knee, but the outcome of the operation was not affected; and (c) poor, when pain and/or muscle contracture did not allow the surgeon to manipulate the knee as required.

3. Patient acceptability. At the follow-up examination 1 month after surgery, patients were asked to complete a questionnaire about the occurrence of late complications (neurologic disorders, paresthesia, pain at the injection site) and anesthesia acceptability.

Results

Combined femoral and sciatic nerve block allowed completion of the programmed interventions in 597 of the 601 patients considered. Only in four cases was it necessary to interrupt the operation temporarily and administer general anesthesia. Surgical treatment consisted of medial meniscectomy in 307 cases (51%), lateral meniscectomy in 109 (18%), meniscal suture in 4 (0.7%), partial synovectomy in 8 (1%), removal of loose bodies in 36 (6%), pathological synovial plicae resection in 16 (3%), chondroplasty in 108 (18%), drilling in 27 (4%), and abrasion in 41 (7%). The mean operating time was 41 ± 26 min. The pneumatic tourniquet was inflated 143 times (105 cases up to 30 min, 38 cases up to 60 min). No correlation was detected between the effectiveness of the anesthesia and type of surgery performed.

In the subgroup of 50 patients who underwent pinprick and ice tests, the whole knee surface was covered by the nerve blockade, the mean duration of anesthesia was 152 ± 21 min, and the mean duration of analgesia, 336 ± 18 min. The mean interval between administration of the anesthetic and start of its effect was 23 ± 5 min.

In 404 patients (67%), the surgical procedure was completed without any supplementary pharmacological support. Additional sedation was required in 121 cases (20%). Due to inadequate anesthesia, analgesic drugs had to be administered during surgery in 72 cases (12%). In four instances (0.7%), general anesthesia was necessary to cope with patient discomfort.

Muscle relaxation was considered good by the surgeons in 463 cases (77%), fair in 132 (22%), and poor in 6 (1%).

According to the subjective evaluation, 421 patients (70%) did not perceive manipulation of the knee whereas the sense of touch persisted in 174 (29%), who, however, did not experience pain. Disquiet caused by the operating room environment was reported by 313 patients (52%), and 168 (28%) considered the position on the table uncomfortable.

At follow-up 1 month after surgery, only 4 patients reported slight pain at the anterior site of injection, and none reported neurological disorders. A total of 433 patients (72%) would repeat this type of anesthesia.

Discussion

General anesthesia continues to be the anesthetic technique preferred by most patients even for short arthroscopic procedures on the knee joint. A recent survey reported a preference for general anesthesia in 69% of 800 patients and one for local anesthesia in 22%, to avoid the effects of general anesthesia [10]. It must be remembered that the risk of anesthesia-related mortality is generally about 1 in 10 000 [2]. A recent French study found an incidence of one major complication per 739 patients given general anesthesia [11]. There is some evidence that mortality and morbidity are lower for regional than for general anesthesia [2].

Spinal anesthesia is a less invasive anesthetic technique and as such represents progress, but in our view, some of its features make it not entirely appropriate for arthroscopic surgery of the knee. The risks of complications such as headache, infection, urinary retention, and cardiocirculatory instability are in fact still elevated and limit its use for outpatient surgery [3].

The so-called 3-in-1 block, that is, block of the femoral, obturator, and lateral femoral cutaneous nerves by a single injection of a large amount of local anesthetic through the inguinal canal has proved useful [12]. However, for the non-expert, it is a laborious technique, with an elevated number of false positives, and an assistant must always be present during performance of the block [13].

On the other hand, local anesthesia obtained with an intra-articular injection or continuous irrigation is not always efficacious, especially as regards adequate manipulation of the limb by the surgeon and the possibility of performing some surgical techniques such as abrasion arthroplasty or meniscal suture; furthermore, application of a tourniquet and pain control are problematic.

Selective femoral and sciatic nerve block has the same advantages as local anesthesia methods over general or spinal anesthesia, that is, it does not cause aspiration pneumonia, nausea, vomiting, headache, sore throat, or hoarseness [14], but it has seldom been considered for knee surgery. In fact, it was commonly believed that blockade of the femoral and sciatic nerves only was insufficient to cover the whole area of the knee and did not affect the medial aspect of the joint, which is considered to be innervated by the obturator nerve. In our series, blockade of this nerve was never found to be necessary; on the contrary, the present data indicate that deep anesthesia of the knee, including the medial aspect, may be achieved with this technique.

It is likely that the cutaneous area innervated by the obturator nerve is more proximal than usually described [15, 16]. Moreover, imbrications may exist between the femoral and obturator nerves [8]. Thus, a femoral and sciatic nerve block alone would be sufficient to cover at least part of the area of innervation of the obturator. The failure of peripheral blocks performed without the aid of ENS [17] may be due not to the presence of areas of obturator innervation but to incomplete anesthesia. In other words, for successful anesthesia, all the components of the femoral and sciatic nerves must be blocked accurately so that no areas of the knee innervated by them are left uncovered. This is probably possible only with the use of ENS.

The femoral nerve under the inguinal ligament no longer consists of a single common trunk but has already subdivided into four main branches [8]. If ENS is not used but only the classic technique of identifying the nerve by paresthesias, there is the risk of localizing and blocking one only of the nerve branches, the local anesthetic may not reach all components of the nerve trunk, and the resulting block may be incomplete. The unsatisfactory results reported by others with femoral nerve block [17] may be ascribed to the lack of use of ENS and therefore to an incomplete nerve block. By applying ENS and evoking contraction of the muscle groups innervated by the various components of the femoral nerve, it is possible to localize these components precisely, and to inject the anesthetic in their immediate vicinity.

In the case of the sciatic nerve, blocking the various components of the nerve trunk is equally important. Although the size of this nerve can facilitate its rapid identification, on the other hand, it can render the methods of blockade still more inadequate. In fact, using the technique of paresthesias, the nerve may be penetrated at its extreme periphery with the consequent risk that a local anesthetic does not "bathe" or surround the nerve completely. This can make the block partial as the sciatic nerve at the gluteal level is already subdivided into secondary and tertiary fascicles corresponding to the distal branches [18].

When ENS is used, not only is the anesthesia method appreciably more efficacious, but also its reproducibility is excellent. The relative simplicity of the technique and the possibility of continuously and precisely controlling the position of the needle with respect to the nerve trunk to be blocked markedly reduce the variability related to the operator's experience and manual ability. Blockade performed with ENS is moreover safer as the possibility of damaging the nerve trunk by injecting the anesthetic into it is greatly reduced. By modulating appropriately the intensity of the electrical impulse delivered during administration of the anesthetic, it is possible to take the needle remarkably close to the nerve trunk to be blocked; contact with it is not necessary and should be avoided [19]. The anesthetic block thus performed is also less disagreeable to the patient, who tolerates better the sensation caused by ENS than paresthesia evoked by contact of the needle with the nerve trunk.

Based on the present series, combined femoral and sciatic nerve block fulfills the anesthesiologic requirements of arthroscopic surgery.

The duration of anesthesia (mean 152 ± 21 min) allows all the usual operative arthroscopic techniques to be completed with adequate safety margins, and we believe that when long-lasting local anesthetics are used, more complex interventions such as reconstruction of the anterior cruciate ligament could also be performed. The short time required for the anesthetic effect to appear and the rapidity and simplicity of the method make it extremely versatile.

The degree of muscular relaxation obtained was considered adequate by the surgeon in most cases. In our view, this is due particularly to the sciatic nerve block, which also makes application of the pneumatic cuff tolerable. The relatively prolonged postoperative duration of analgesia enables postoperative pain to be easily controlled, and the need for pain-killing drugs is less than after general anesthesia. Like many orthopedic surgeons [20], we were used to injecting bupivacaine into the intra-articular space to control postoperative pain following knee arthroscopy under general anesthesia. We found it was no longer necessary to administer any intra-articular local anesthetics since we started employing femoral and sciatic nerve block. Moreover, the administration of NSAID (in our experience ketorolac 30–60 mg intramuscularly followed by a maintenance dose of 30 mg i.m. or 10 mg orally every 6 h after general anesthesia until discharge from the hospital) was delayed at least for the first 6 h after surgery. Femoral and sciatic nerve block does not require particular precautions or checks in the immediate postoperative period. Thus, patients can be quickly discharged from hospital, confirming how minimally invasive arthroscopic surgery is.

The acceptability of our method to patients was mainly good, although the findings in this regard were less satisfactory than for the other variables examined. This was generally due to the negative sensations generated by the operating room environment. In particular, the noise and alternation of personnel, the patient's position on the operating table, and the anxiety induced by the inability to control events were perceived as unpleasant. Such difficulties may be partly overcome by simple measures such as the constant and reassuring presence of the anesthesiologist at the patient's side, continual information on the regular progress of the intervention, and making the patient more comfortable by modifying the position on the operating table and controlling the loss of body heat by reflective blankets. In some cases we obtained good results by insulating the patient from the noise of the operating room by music heard through headphones.

Only in a small minority of patients (4) did regional anesthesia not allow completion of the programmed surgical intervention, and recourse to general anesthesia became necessary. On three occasions this was due to a technical error of evaluation of the muscular contractions during the performance of anesthesia, so that not all the femoral nerve components were identified, probably related in two instances to the learning curve of the anesthesiologist as they occurred during the first part of the study, and in the third case to the patient's excessive anxiety and consequent lack of cooperation. In the fourth case, the start of surgery was delayed as the preceding operation in the theatre proved unexpectedly long, which meant that the anesthetic effect had worn off before the surgical procedure could be completed.

Although we did not observe significant complications, our technique is not without minor ones. Pain developed at the anterior injection site in 4 of our patients, in all of whom the femoral artery was penetrated inadvertently during application of the block. The diffuse tenderness felt by the patients, which always resolved spontaneously in a few days, was attributable to the formation of a small hematoma.

The combined sciatic and femoral nerve block fulfills also the requirements of a cost-effective technique. In fact, at our institution the estimated mean cost of a combined femoral-sciatic block is $ 66 compared with $ 83 for general anesthesia (and $ 54 for spinal anesthesia).

In conclusion, our 4-year experience of combined femoral and sciatic nerve block for operative arthroscopy of the knee was generally favorable. It met the surgeon's requirements for most patients who underwent knee arthroscopy, and achieved the following goals: low invasiveness, easy reproducibility, short hospital stays, reduced costs, and surgeon and patient satisfaction.

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