Anesthesia

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Pär Nordin

Anesthesia for Groin Hernia Surgery

Not all surgical procedures are granted to have three choices of anesthesia as the open groin hernia operation. The optimal anesthetic technique has to meet several demands. It has to be simple and as safe as possible with low postoperative morbidity. It must provide good perioperative and postoperative analgesia, produce optimal operating conditions by immobility, be associated with few complications, and facilitate early patient discharge and has to be cost-effective. Finally, it is essential to remember that for an operation to be successful, the patient should be pleased with it.

Background

Groin hernia surgery is one of the most frequent operations performed in general surgery. Outcome evaluation has usually focused on recurrence rates and technical issues, but more recently there has also been a focus on chronic postherniorrhaphy pain [1]. However, the increasing demand by health-care providers for more efficient and cost-effective surgery has resulted in modifications of care to encourage more widespread adoption of day case, outpatient surgery [2]. In this context, the choice of anesthetic method for groin hernia repair plays a significant role regarding costs, morbidity, early pain relief, early discharge, and recovery. For the important question as to method of anesthesia, there is still no consensus about the best choice.

The choice of anesthesia is still controversial, and available data reflect a large variation in anesthetic practice. Only rarely nowadays is the patient totally unfit to undergo a suitably judged general or regional anesthetic. Local anesthesia for hernia repair does have particular advantages—organizational and economic as well as clinical.

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Local anesthesia is used almost exclusively in several either private hernia centers or public hospitals with a special interest in hernia surgery [3–8]. The EHS guidelines on IH treatment recommend that local anesthesia be considered for all adult patients with primary reducible unilateral His [9]. Large amounts of epidemiologic data, reflecting general surgical practice from Scotland [10], Denmark [11, 12], and Sweden [13], have shown that general anesthesia is the preferred method, for hernia repair in 60–70% of cases, regional anesthesia in 10–20%, and local infiltration anesthesia in about 10–20%. The type of anesthesia employed may depend on the preferences and skills of the surgical team rather than the feasibility of a technique in a given patient, intra- and postoperative pain control, facilitation of early recovery and monitoring requirements, postoperative morbidity, and costs.

Anesthetic Techniques

Ideally inguinal hernia repair should be performed using a simple and safe anesthetic technique that is acceptable for the patient and easily mastered in general surgical practice. The technique should carry a low morbidity risk and also be cost-effective. Postoperative side effects and prolonged hospital stay after groin hernia surgery are often related to the effects of anesthesia.

Preemptive Analgesia

Inguinal hernia repair results in pain postoperatively, and the optimal methods to treat this pain remain controversial. The concept of preemptive analgesia envisages that effective postoperative pain relief benefits the patient by providing comfort in the period after surgery [14]. It includes the use of preoperative and intraoperative local anesthetic infiltration and/or preoperative or intraoperative field block and paravertebral block and conventional NSAIDs or selective COX-2 inhibitors. The theory is that effective treatment of acute pain

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facilitates early rehabilitation and recovery, and those preemptive analgesic nerve blocks may prevent central sensitization and secondary hyperalgesia after tissue damage. It is clear that local anesthetic field blocks and subfascial and/or subcutaneous local infiltration reduce early postoperative pain scores and the need for supplemental analgesics [15–17]. Therefore, when general or regional anesthesia is used, local anesthetic field blocks and infiltration are recommended in all open groin hernia surgeries.

Paravertebral nerve blocks (PVBs) are established methods of providing analgesia to thoracic- and abdominal-surgery patients including those undergoing groin hernia repair. One systematic review [18] found a tendency to less postoperative pain in PVB patients when compared with general anesthesia and spinal anesthesia patients.

The transversus abdominis plane (TAP) block is a relatively new regional anesthetic technique developed in an attempt to reduce postoperative pain. It has evolved from a landmark technique to an ultrasound-guided one. A 2010 Cochrane Database Systematic Review found only limited evidence to suggest that the use of perioperative TAP blocks is opioid sparing or reduces pain scores after abdominal surgery [19].

A further concept in optimal management of postoperative pain relief is that of balanced analgesia [20]. This concept takes the advantage of multimodal additive and synergistic effects of a combination of analgesic drugs including nonsteroidal anti-inflammatory agents given preoperatively, incisional local anesthesia, and postoperative oral analgesics. Acting at different points on pain pathways, this approach allows low doses of individual drugs to be used thus decreasing the risk of side effects and maximizing the analgesic effect [21].

General Anesthesia

General anesthesia (GA) can provide the surgeon with optimal operating conditions in terms of patient immobility and muscular relaxation. It allows the surgeon to perform the procedure considered necessary and may have particular advantages in incarceration or suspected intestine strangulation.

Techniques

Modern GA with short-acting agents and combined with local infiltration anesthesia is safe and fully compatible with day-case surgery [22]. Inhalation anesthesia, intravenous drugs, or a combination of both may be used. In most patients optimal GA for groin hernia repair will include propofol induction supplemented with sevoflurane or desflurane inhalation for maintenance. An alternative is the total intravenous variant utilizing propofol and short-acting opioids such as remifentanil, which in most cases leads to a fast recovery.

There are disadvantages in introducing opioids such as fentanyl or alfentanil into the anesthetic sequence because of the incidence of nausea and vomiting, apnea, occasional awareness, and muscle rigidity. Benzodiazepines have proved useful for sedation; however, recovery from intravenous midazolam is not as rapid as recovery from intravenous propofol, which may be used during general anesthesia.

The disadvantages of GA are risk for airway complications, respiratory function, cardiovascular instability, nausea, vomiting, and urinary complications. Furthermore, recovery from central hypnotic effects may be prolonged, and as a consequence the method is not always suitable for day-case surgery. GA also incurs added costs since it requires specialized anesthesia staff and equipment as well as postanesthetic care facility.

Finally, the administration of a general anesthetic should not be underestimated; irrespective of technique there is incidence of side effects that may persist for up to 24 h, such as drowsiness, headache, cognitive effects, muscle pain, nausea, and vomiting.

The advantages of early ambulation to prevent thromboembolism are negated by the speed of recovery, and hence early ambulation can be achieved with modern general anesthesia.

Regional Anesthesia

Regional anesthetic (RA) techniques for groin hernia repair can be provided by either subarachnoid (spinal), epidural techniques or, more uncommon, paravertebral techniques [23].

It provides good analgesia intraoperatively and can allow the patient to be awake during the procedure if this is desired. It is quite easy to perform in the great majority of patients and avoids many of the airways and respiratory and gastrointestinal complications that may occur with GA. Its advantages include less postoperative nausea and vomiting, pain-free immediate postoperative period, and minimal drug and equipment costs.

The regional anesthetic techniques do have disadvantages, however, and are burdened with a higher (albeit low) risk of inadequate anesthesia. The bilateral motor and sympathetic block may induce a prolonged postoperative recovery due to postoperative urination difficulties. Spinal anesthesia regularly results in urine retention which results in prolonged postoperative recovery [15, 24–29]. It also carries a higher incidence of cardiovascular complications compared to general anesthesia [30]. Other disadvantages are postspinal headache and, very rarely, neurological damage

due to direct neural trauma, infection, or vascular complications. The frequency of postspinal headache (due to dural puncture) is highly dependent on the age of the patients and type of needle use [31–33]. RA requires anesthesia staff during the operation as well as in the postanesthetic care.

Techniques

In recent years improvements of the regional anesthetic techniques have been made with the use of more short-acting local anesthetic agents and small-gauge pencil-point needles. Also the use of additional spinal opioids combined with a reduction in the amount of spinal doses may reduce the postoperative side effects [31, 34]. Paravertebral block (PVB) has been used for unilateral procedures such as breast and chest wall surgery but also inguinal hernia repair.

The most common regional technique for hernia surgery is spinal anesthesia with short-acting agents, although some hernia centers use short-acting epidural anesthesia but without providing specific intraoperative and postoperative data [35]. Because of the sparse data for epidural analgesia, this technique is not discussed or recommended until further data are available. More recently, the use of a paravertebral nerve block has been investigated [23, 36], but this technique only provides analgesia equivalent to a conventional intraoperative peripheral nerve block. Two randomized trial found advantages with PVB, compared to conventional spinal anesthesia [37, 38]. In these trials all patients received intravenous infusion with propofol during surgery.

Local Anesthesia

The open treatment of primary reducible inguinal hernias in adults is nearly always possible under local anesthesia (LA) [4, 6, 39] and can be provided by a local infiltration technique [40] or by a specific blockade of the ilioinguinal and iliohypogastric nerves or a combination of the two methods (see below) [41]. Evidence strongly supports that local anesthesia has several advantages over general or regional anesthesia in elective reducible IH repairs. The administration is technically quite easy, but it requires training. LA is only successful if the surgeon handles the tissues gently, has patience, and is fully conversant with the anesthetic technique [40, 42]. Among reported advantages are simplicity, safety, extended postoperative analgesia, early mobilization without postanesthetic side effects, and low cost. The method is ideally suited for day-case surgery as the anesthetic agents used have no significant central effect, and motor block is minimal.

The clinical advantages include the prolonged analgesia provided when long-acting local anesthetic solution is employed, enhanced definition of tissue planes afforded by the hydrodynamic dissection by the local anesthetic distending the tissues, and lastly the patient cooperation possible in testing and identifying anatomic defects. The technique is more demanding for the operator: he or she must be more precise and less traumatic to tissue than in the unconscious patient. Above all, when surgery is completed, the subject may be asked to cough or strain so that any deficiencies in technique are immediately observed. The patient is saved from the anxiety of GA and the hangover effect of recovery. The time taken to infiltrate the local anesthesia sufficiently to gain satisfactory analgesia has been similar to general in comparative studies [22, 26].

The infrequent use of LA may partly be the patient's wish to sleep because of fear of pain during surgery but also explained by traditions in anesthesia practice, preferences, and skills of the surgical team. Perioperative pain sensation is reported and can sometimes be a reason for conversion to general anesthesia [43]. Many surgeons have probably also been reluctant to learn the technique as they may find the operation easier to perform with RA or GA.

Some patients may prove unsuitable for LA, notably very young patients, anxious patients, morbid obesity, and patients with suspected incarceration or strangulation. Whether scrotal hernias and obese patients are suitable depends entirely upon the surgeon's familiarity with the technique [42]. LA is rarely appropriate during laparoscopic repair of groin hernias [44].

As suggested by national hernia database analysis, hernia recurrence may be more common following operation employing local anesthesia. The Swedish Hernia Registry found that local anesthesia is associated with an increased risk of reoperation for recurrence after primary IH repair [45]. A Danish Hernia Database reported an increased reoperation rate after local anesthesia versus general or regional anesthesia after direct—but not indirect—hernia repair [46].

History

The use of local anesthesia for the repair of groin hernia has a rather exciting history. Cocaine was isolated as a pure alkaloid from the leaves of the coca plant, *Erythroxylum coca*, by Niemann in 1860. It was then exploited by the Austrian Karl Koller in 1884 when he instilled it into the eye of a rabbit. This latter discovery is attributed by some to Sigmund Freud, who had been experimenting with cocaine but who deserted his experiments, and the reporting of them, for his fiancée [47]. Freud later wrote:

> In the autumn of 1886 I began to practice medicine in Vienna and married a girl who had waited more than four years for me in a distant town. Now I realize it was my fiancée's fault I did not become famous at that time. In 1884 I was profoundly interested

> in the little known alkaloid of coca, which Merck obtained for me to study its physiological properties. During this work, the occasion presented itself of going to see my fiancée, whom l had not seen for two years. I hurriedly finished my work with cocaine, confining myself in my report to remarking it would soon be put to new use. At the same time I suggested to my friend Konigstein, the ophthalmologist that he should experiment with cocaine in some eye cases. When I came back from holiday, I found it was not to him but to another friend, Karl Koller that I had spoken about cocaine. Koller had completed the research on the eyes of animals and demonstrated the results to the ophthalmological congress in Heidelberg. Quite rightly, the discovery of local anesthesia by cocaine, of such importance in minor surgery, was thereafter attributed to Koller. But I bear my wife no grudge for what I lost!

William Stuart Halsted, in 1885, demonstrated that cocaine could block impulses through nerves and in the process became a lifelong cocaine addict himself. He underwent sanatorium treatment for his addiction before his translation to the chair of surgery at Johns Hopkins. He apparently was never truly cured of this addiction, for he continued to require daily cocaine until his death in 1922. Halsted's resident, Harvey Cushing [48], pursued the development of local anesthesia for groin hernia repair and in 1900 published the original authoritative paper on the nervous anatomy of the inguinal region and his experiences of local anesthesia in the repair of these hernias.

More recently, Glassow and Bendavid have recorded the experience from the Shouldice Clinic in Toronto with a history of over 50 years and more than 250,000 repairs, almost exclusively done in LA [5, 49]. Kark, Callesen, Barwell, Amid, and others have described similar results using local anesthesia [4, 6, 50, 51], and Kingsnorth et al. [52] described an increase in the use of local anesthesia from 78 to 91% of cases in a specialized hernia service.

The choice of anesthesia is still controversial, and available data reflect a large variation in anesthetic practice. LA is preferred at most centers with a special interest in hernia repair, whereas in general surgical practice, however, LA is only used in 5–20% of the patients [10, 11, 13].

Local Anesthetic Agents

Several safe and effective anesthetic agents currently are available. In the 1970s lignocaine (lidocaine) was the drug of choice, but since 1980 it has been superseded by more long-acting agents such as bupivacaine, levobupivacaine, and ropivacaine. However, some surgeons use a combination of agents in order to achieve the advantages of rapid onset of action and longer duration of anesthesia. Adrenaline can be used with both drugs to protract their duration of activity. Bupivacaine is available in concentrations of 0.25, 0.50, and 0.75%. Its onset of action is approximately 20 min and the half-life is 2–3 h.

The maximum safe dose of lignocaine is 3 mg/kg body weight and with adrenaline 7 mg/kg. For bupivacaine the maximum dose is 2 mg/kg body weight and 4 mg/kg with adrenaline.

Bupivacaine is more potent and longer acting than lignocaine and maintains the analgesic block for 8–10 h, which is a major advantage in day-case surgery [53]. The safety margin in the recommended maximum safe dose is wide, as illustrated by serial postoperative plasma concentrations following doses approaching the maximum recommended for lignocaine or bupivacaine. For instance, administering lignocaine with adrenaline to the maximum dose of 7 mg/kg, peak lignocaine concentration ranged from 0.23 to 0.9 mg/L, the toxicity threshold being 5 mg/L [54]. The administration of 20 mL of 0.5% plain bupivacaine resulted in peak venous plasma concentrations of 0.07–1.14 m/L, the cardiovascular toxicity occurring at plasma concentrations greater than 4 mg/L [55].

Barwell reports 2066 patients with inguinal hernias operated on under local anesthetic use 0.5% lignocaine without adrenaline. He has had no cases of anesthetic toxicity, and perhaps the worst complication is "the occasional hematoma at the site of injection for the field block" [56]. Glassow, reporting the experience of the Shouldice Clinic in Toronto, recommends 150 mL of 2% procaine without adrenaline [57], whereas Wantz recommends a mixture of lignocaine and bupivacaine with adrenaline [58].

Newer local anesthetic agents with improved safety and anesthetic equivalence have been tested in inguinal hernia surgery. In a study testing the efficacy of ropivacaine, 32 patients operated under general anesthesia were randomized to receive subcutaneous infiltration with 40 mL of ropivacaine or bupivacaine [59]. There was no difference in pain or analgesic requirements after surgery. Bay-Nielsen et al. found neither differences in intra- or postoperative pain when comparing levobupivacaine with bupivacaine [60]. In a double-blind study comparing the efficacy of levobupivacaine with bupivacaine in elective inguinal herniorrhaphy in 66 patients, Kingsnorth et al. concluded that levobupivacaine exerted similar analgesic effects in the early postoperative period compared with bupivacaine, the theoretical advantage of levobupivacaine being its increased safety margin regarding cardiotoxicity and neurotoxicity [61]. Maybe, due to the cardiotoxicity of bupivacaine, ropivacaine or levobupivacaine should be preferred in cases with extensive need of infiltration (more than 40 mL).

Prolongation of the duration of LA by the addition of agents designed to prolong absorption from the local tissues, mainly dextran, has been explored by several investigators. For the present, additional agents are of no proven advantage, and therefore it is recommended that local anesthetic agents are used plain or with adrenaline [62].

Wantz claims that the burning pain caused by the administration of LA can be eliminated by neutralizing the agent

[63]. The addition of 1 mL of 8.4% sodium bicarbonate solution to 9 mL of plain local anesthesia brings the pH to a comfortable 7.5, which also enhances the anesthesia and reduces the quantity required. The pH of local anesthetic with adrenaline is 4, and therefore 2.5 mL of the sodium bicarbonate solution is required for neutralization.

Local Anesthetic Techniques

LA can be achieved by a variety of techniques. The most common is local infiltration technique [40] or by a specific blockade of the ilioinguinal and iliohypogastric nerves (see below) or a combination of the two methods [41]. Both are preferably performed by the operating surgeon. The administration is technically quite easy, but it requires training.

The use of LA does not necessarily require an anesthesia staff during postanesthetic care [6], but in the operating theater, a nurse anesthetist should be available if supplementary sedation or analgesia is needed or anesthesia monitored care is used. An anesthetist should be available if the need arises, for instance, in case of conversion from LA to GA or when unexpected complications are met. The equipment needed for LA performance is insignificant.

The recommended local anesthetic agent is a 50:50 mixture of bupivacaine and lignocaine with the possibility to addition of adrenaline1:200,000. The benefits of this mixture are the rapid onset of action of the lignocaine solution and the prolonged duration of the bupivacaine.

Care must be taken to avoid direct intravascular injection during the infiltration, which is a very rare event since the only major vein in the region is the femoral vein, which should be far from the wandering tip of the infiltrator's needle.

Because oxygen desaturation is common in procedures carried out under sedation [64], oxygen supplementation and measurement of arterial oxygen saturation by a pulse oximeter should be mandatory. Oxygen saturation and clinical monitoring should be supplemented by devices that continuously display the heart rate, pulse volume, or arterial pressure and electrocardiogram [65]. The patient must be able to respond to commands throughout the procedure: if they are unable to do so, the seditionist has become an anesthetist. The same standards should be applied to sedative techniques (and RA), when there is depression of consciousness or cardiovascular or respiratory complications.

A small dose of intravenous midazolam (2–4 mg) reduces anxiety and makes the patient more relaxed and cooperative. However, recovery from intravenous midazolam is not as rapid as recovery from intravenous propofol. Anecdotal evidence suggests that administration of propofol reduces local anesthetic requirements [64]. In some centers propofol is used in nearly every case to make the procedure easier.

Local anesthesia should achieve the following main steps:

1. Ensure skin anesthesia in the line of incision.
2. Block the nerve supply to the aponeurotic layers, which must be dissected and manipulated.
3. Ensure anesthesia of the parietal peritoneum of the hernia and especially of the neck of the sac, which is very sensitive.

Anatomy of the Groin Area

Knowledge of the fundamental physiology and neuroanatomy of pain in the abdominal wall is essential if adequate local analgesia is to be obtained. Free nerve endings are distributed throughout the skin; stretch and pain receptors occur in each of the aponeurotic layers and in the parietal peritoneum. The skin and subcutaneous tissue are sensitive to all noxious stimuli. Pinprick, pressure, and chemical stimuli (e.g., hypertonic solutions) cause pain in these tissues. The parietal peritoneum is also sensitive to pinprick, stretching, and chemical stimuli. In contrast, the visceral peritoneum and hollow organs are insensitive to touch, to clamp, to knife, and to cautery, but the visceral arteries to these organs are sensitive. There is no pain when viscera are handled under local anesthesia, until a clamp is placed on the vascular pedicle.

The inguinal area is mainly supplied by three nerves which all come from the lumbar plexus. The iliohypogastric nerve (L1) runs between the transverses and internal oblique muscles and supplies the skin above the inguinal ligament. The ilioinguinal nerve (L1) runs parallel to but below the iliohypogastric nerve and on top of the cord through the external ring and gives supply to the adjacent skin and to the scrotum. The genitofemoral nerve (L1 and L2) via its genital branch supplies the cord structures and anterior scrotum and via its femoral branch the skin and subcutaneous tissue in the femoral triangle. All the nerves of the anterior abdominal wall communicate with each other, and thus their cutaneous distribution overlaps (Fig. 6.1). Autonomic nerve fibers accompany the cord to the testis.

Inguinal Block Technique

Inguinal and femoral hernias lie in the borderland between the regular anatomy of the abdominal wall and the complex anatomy of the lower limb. However, the same technical sequence ensures adequate regional anesthesia:

1. An injection is made between the internal oblique and transversus muscles about 1 cm superior to the anterior superior spine in an endeavor to block the ilioinguinal and

iliohypogastric nerves. To do this the needle is pushed in vertically; the "give" as the needle penetrates the aponeurosis of the external oblique allows easy estimate of the depth of the injection. Twenty milliliters of local anesthetic is injected at this site (Fig. 6.2).

2. A local weal is raised in the line of the incision. This weal starts 2 cm above and medial to the anterior superior iliac spine. Long spinal needles may be used to deliver this 20 mL infiltration (Fig. 6.3).

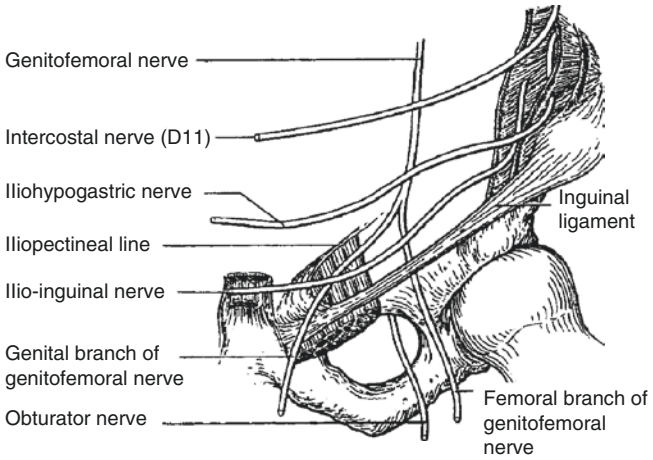

Fig. 6.1 Sensory nerve supply of the inguinal, femoral, and obturator regions

3. The medial end of the oblique subcutaneous weal is now "topped up" with 2 mL of local solution, taking care to carry the injection down to the pubic tubercle and the origin of the rectus muscle from the pubis.
4. The final 20 mL syringe of local anesthetic mixture is infiltrated along the direction of the spermatic cord and through the skin, subcutaneous fat, and external oblique adjacent peritoneal sac, beginning at the deep ring. To aponeurosis (the "give" is felt as the needle penetrates; to achieve this, the tip of the infiltration needle is inserted into the aponeurosis), the syringe is aspirated to ensure that the skin at the surface marking of the deep ring, traversed pampiniform plexus has not been penetrated, and the content of the syringe is then gently injected obliquely along the direction of the spermatic cord toward and including the pubic tubercle. This solution will anesthetize the deeper structures including the sac and the genital branch of the genitofemoral nerve (Fig. 6.4).
5. This anesthetic block can conveniently be applied by the surgeon or anesthetist under strict aseptic conditions but before scrubbing up and gowning. In the 5 or 10 min between application of the block, scrubbing, gowning, and preparing the skin and draping the patient, the infiltration will have become completely effective.
6. Patients should be informed that the slightest discomfort will be supplemented with additional local anesthetic solution. This event is the patient's greatest anxiety, and the nature of previous anesthetic experience is the prime determinant of any anxiety preoperatively [66].

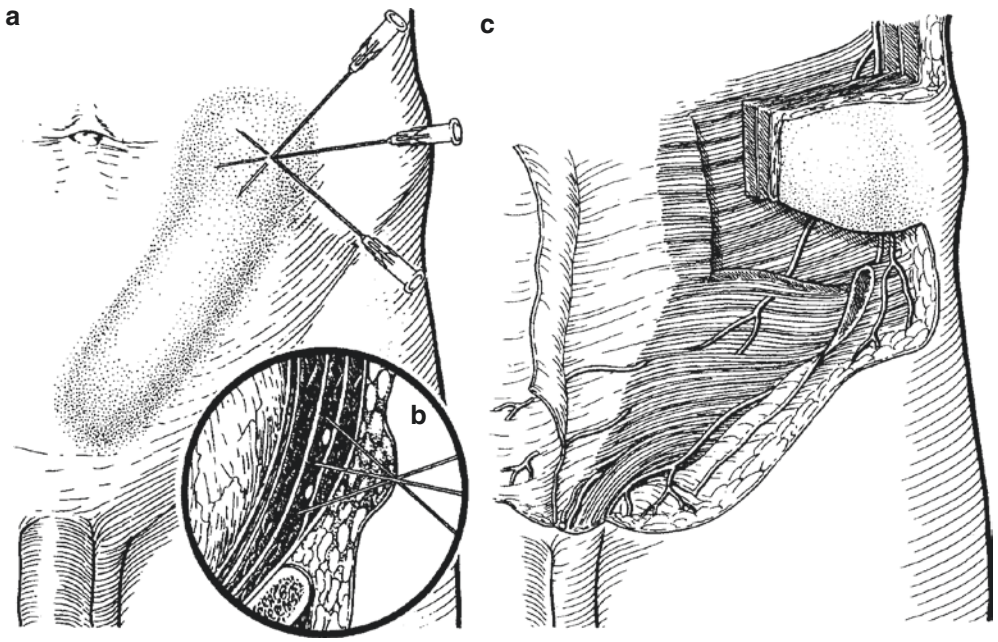

Fig. 6.2 (**a**, **b**) At the *upper* end of the previous weal, at a point approximately 1 cm above and medial to the anterior superior iliac spine, some 3 mL of the anesthetic solution is injected deep to the aponeurosis of the external oblique. The needle is pushed in until the external oblique aponeurosis is felt as a firm resistant structure. (**c**) The needle is pushed through the aponeurosis and the anesthetic solution distributed to block the ilioinguinal and iliohypogastric nerves which run between the external and internal oblique muscles at this point

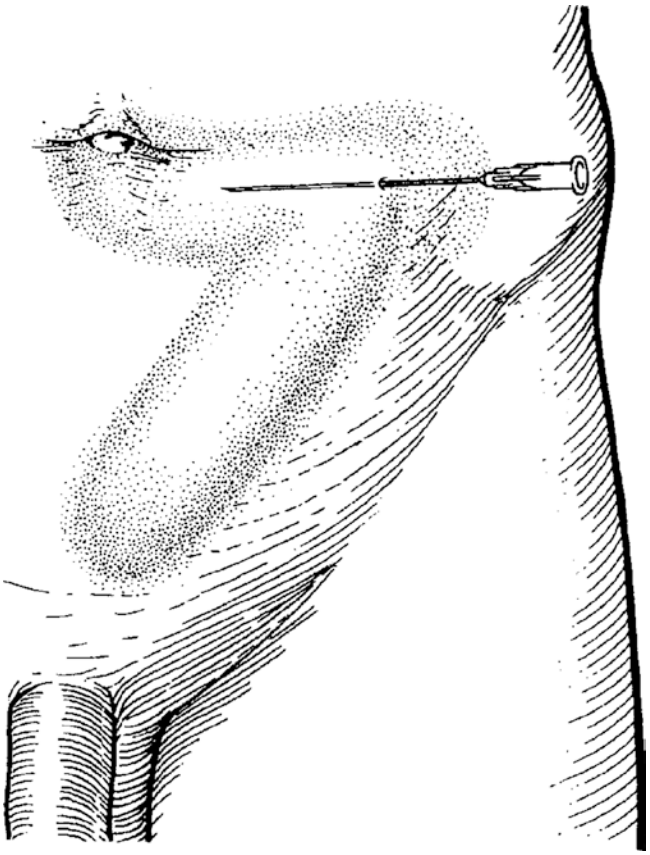

Fig. 6.3 Local anesthesia for an inguinal hernioplasty: using a long spinal needle, a weal of local anesthetic solution is made in the line of the groin incision

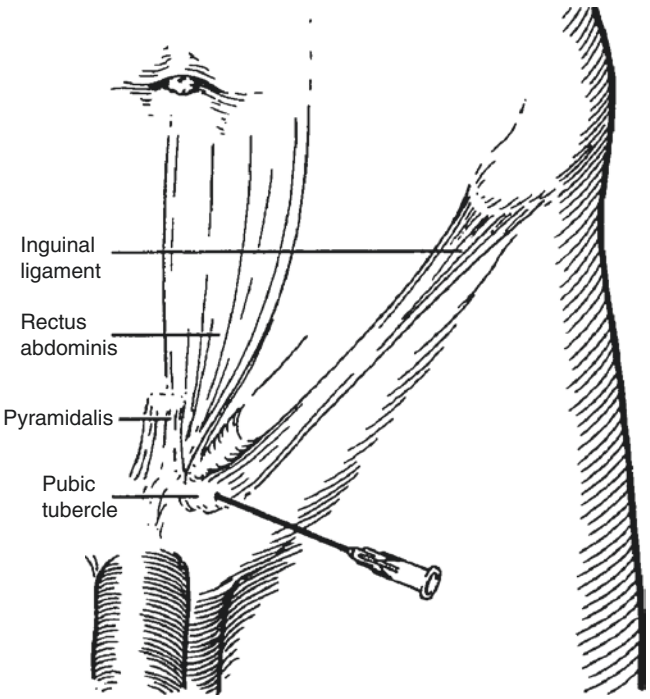

Fig. 6.4 The medial end of the oblique groin (incision) weal is topped up down to the pubic tubercle and origin of the rectus

Local Infiltration Technique

This method is based on preventing pain by infiltration before the incision and, as always when LA is applied, the use of a gentle and atraumatic surgical technique. Forty milliliters of the 50:50 mixture of a short- and a long-acting agent is usually sufficient for a unilateral hernia operation. It is a simple step-by-step infiltration procedure well described by Amid et al. [40] and contains no field blocks at all, only local infiltration. The method should contain the following steps:

1. *Subdermal infiltration*: 10 mL along the line of the incision.
2. *Deep subcutaneous infiltration*: 10 mL deep into the adipose tissue by vertical insertions 2 cm apart. It's often possible to feel the external aponeurosis with the top of the needle.
3. These first steps should be performed 5 or 10 min before the start of the operation (before scrubbing, gowning, and preparing the skin and draping the patient). Then the infiltration will have become completely effective.
4. *Subfascial infiltration*: 10 mL immediately underneath the aponeurosis through a window created in the adipose tissue at the lateral corner of the incision.
5. While the rest of the subcutaneous tissue is incised, the injection floods the enclosed inguinal canal and anesthetizes all three major nerves in the inguinal region. This injection also separates the external oblique aponeurosis from the underlying ilioinguinal nerve when the aponeurosis is incised.
6. *Pubic tubercle infiltration*: A few milliliters are infiltrated as early as possible in the soft tissue over the tubercle, which is a sensitive area.
7. Now the cord can be released and infiltrated around its proximal section.
8. *Hernia sac infiltration*: This is the final step of the infiltration. A few milliliters are placed around the neck of the hernia sac.

Laparoscopic Hernia Repair

Hernia surgery requiring intra-abdominal manipulation is rarely advisable under local anesthetic, and the technique is rarely appropriate during laparoscopic repair of inguinal hernias [44]. However, there are some who are attempting to pursue laparoscopic hernia repair under local anesthetic approaches combined with sedation. It is technically much more difficult to perform and requires extensive experience. In general surgical practice, GA should be the preferable choice when laparoscopic repair is to be adopted.

Complications of Local Anesthetics

The possible major complications are allergic reactions, CNS toxicity, cardiac arrhythmias, and cardiovascular collapse due to inadvertent intravascular injection of the local anesthetic. However, all is rare with the local infiltration technique and has never described in large hernia series (Callesen, Amid, Kark, Bendavid). A possible minor complication is a transient femoral nerve blockade, due to a deep injection or spread between fascia planes [67]. Apart from this, the technique is considered extremely safe. Patients undergoing local anesthesia should be questioned about previous side effects from local anesthetics.

Complications of local anesthetics are systemic and local.

Systemic:

(a) Excitation of the nervous system, nervousness, nausea, and convulsions—these are very rare; increased patient excitability and garrulousness, a rising pulse rate, and an increasing blood pressure are the early signs of CNS intoxication.
(b) Depression of the cardiovascular system with hypotension and arrhythmias.
(c) Hypersensitivity reactions are very rare with lignocaine and bupivacaine.

Local:

(a) Ecchymoses and bruising.
(b) Local ischemia and tissue necrosis if too much adrenaline is injected at one site.
(c) These local complications can compromise wound healing.

Local Anesthesia for Other Small Abdominal Wall Hernias

The same concept of local anesthesia—a combination of regional block and field infiltration—can be employed for small incisional, umbilical, and epigastric hernias. Important points are to adequately infiltrate the subcutaneous layer, especially cranial to the proposed incision, and then to adequately anesthetize the intercostal nerves, which run deep to the internal, oblique/rectus sheath aponeurosis to within 2 cm of the midline.

The intercostal nerves run from their intercostal space forward between the internal oblique and transversus muscles to the lateral margin of the rectus sheath. They enter the sheath on its posterior aspect, supply the rectus muscle, pierce the anterior sheath, and then ramify in the subcutaneous tissue and supply the adjacent skin. Each of these nerves gives a lateral cutaneous branch, which pierces the flat muscles and becomes subcutaneous in the midaxillary line. Once subcutaneous, this lateral cutaneous branch gives anterior and posterior branches to supply the skin and subcutaneous tissue.

The anterior portions of the six lower intercostal nerves are continued forward from their respective spaces onto the anterior abdominal wall and are accompanied by the last thoracic (subcostal) nerve.

For local anesthesia nerve block to be successful, the intercostal nerve must be blocked before the lateral cutaneous branch is given off. The site of election for the local anesthetic injection is in the posterior axillary line. If the intercostal nerve is blocked too far anteriorly, the anterior division of the lateral cutaneous branch will remain sensitive (Fig. 6.5).

It should be remembered that the intercostal nerve is tucked under the lower border of the rib in its posterior third and in the center of the intercostal space more anteriorly (Fig. 6.6).

When the hernia is exposed, it is important to infiltrate the neck of the hernial sac (parietal peritoneum) to ensure adequate anesthesia, while the sac is dissected, incised, emptied, and closed (if this is the done rather than mere reduction into the preperitoneal space).

Hernia surgery requiring extensive dissection, major intra-abdominal manipulation, fluid shifts, or blood transfu-

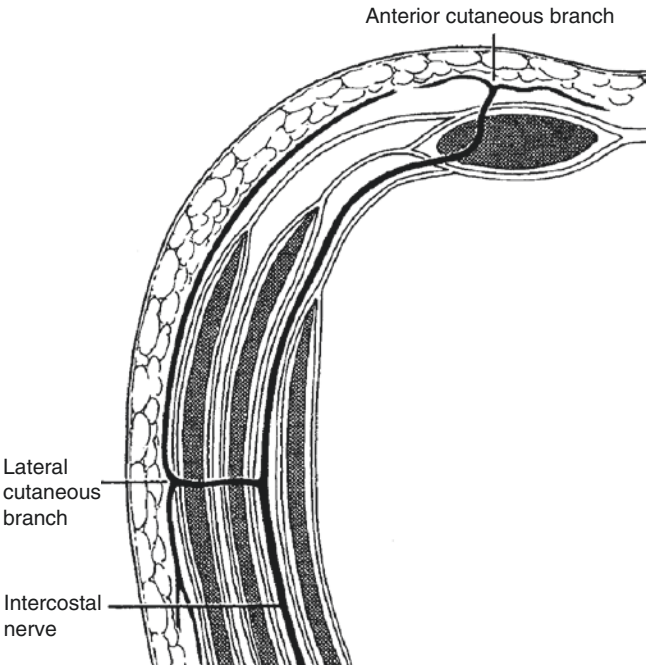

Fig. 6.5 Transverse section through the abdominal wall. The lateral cutaneous branch of an intercostal nerve gives an anterior and posterior division; the anterior division must be blocked for effective abdominal wall anesthesia

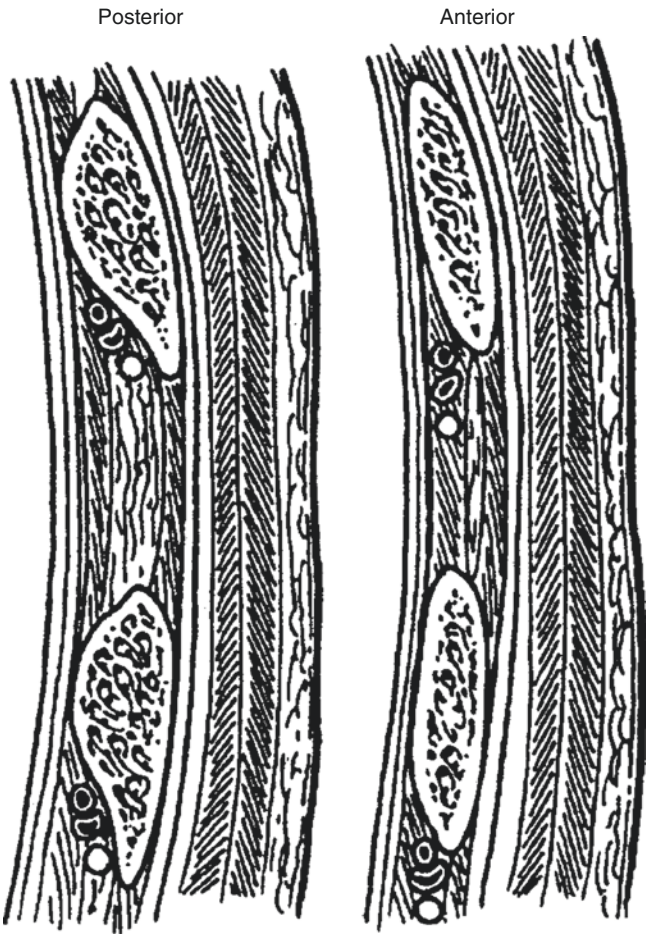

Fig. 6.6 The relative positions of the ribs and the intercostal nerves vary. Posterior to the midaxillary line, the intercostal nerves and vessels are tucked under the rib next above; anteriorly they lie midway between the ribs in the mid-intercostal space

sion is rarely advisable under local anesthetic, and the technique is rarely appropriate during laparoscopic repair of inguinal hernias [44].

Postoperative Outcome of the Anesthetic Techniques

Postoperative Pain

Effective postoperative pain relief benefits the patient by providing comfort in the period after surgery as well as modifying the autonomic and somatic reflexes to pain which delay recovery. Treatment of pain facilitates early rehabilitation and recovery [14]. Maximum pain is found on postoperative day 1, and often significant problems are present until the end of the first week [68].

Early postoperative pain is reduced when the operation is performed under LA with the use of a long-acting local anesthetic (bupivacaine, levobupivacaine, ropivacaine) that lasts 4–8 h. This is longer than that for RA or GA, as documented in large, randomized trials comparing the three anesthetic techniques [22, 26]. In earlier reports regarding postoperative pain, one study found no difference [69] between anesthetic methods, and five studies observed less pain with LA [6, 26, 70–73]. An exception is the randomized controlled trial of Teasdale et al. [43], where patients with LA required more postoperative analgesics than those in the GA group. Perhaps their use of a short-action agent may be held responsible.

When general anesthesia is used, the addition of local anesthetic field blocks of the ilioinguinal and iliohypogastric nerves and/or subfascial and subcutaneous infiltration reduces early postoperative pain scores and the need for other analgesics [15–17, 74]. Omission of this step should be considered suboptimal care [75, 76]. Patients given GA do not differ in pain scores or analgesic consumption whether given inguinal field block before the surgical incision or after wound closure [77, 78].

In addition to the preoperative and intraoperative pain prevention and treatment methods above, non-opioid and nonsteroidal anti-inflammatory medications, NSAIDs and selective COX-2 inhibitors, can be used for postoperative pain management [15, 79–81]. However, these drugs should be used with caution in patients with previous gastrointestinal ulceration, asthma, renal failure, heart failure, or bleeding diatheses.

Paracetamol has insufficient effect as single-agent therapy for moderate to severe pain. However, the combination of paracetamol and a nonsteroidal anti-inflammatory drug, given in a timely manner, seems to be optimal and provides sufficient analgesic during the early recovery phase provided that there is no contraindication [82].

Opioids are frequently necessary and used routinely in some areas of the world.

Early Complications

The reported risk of urinary retention is usually around 3% [25]. Spinal anesthesia regularly results in urine retention which results in prolonged postoperative recovery [15, 24–29].

In large epidemiologic and consecutive series and several randomized clinical studies, the lowest risk of urinary retention has been obtained with local infiltration anesthesia amounting to 0–1% [4, 6, 15, 25–28] and without an increase in local surgical complications.

The risk of hematoma, infection, and other complications in relation to the anesthetic technique has not been accurately elucidated but is probably inconsiderable owing to the otherwise low morbidity rate associated with elective groin hernia repair.

Recovery

Postoperative side effects after groin hernia surgery such as nausea and vomiting, time to first meal, and daily activities are often related to anesthesia. Of 13 randomized studies comparing LA with GA and/or RA [7, 22, 26, 28, 43, 71–73, 83–88], 12 bear witness of faster discharge and faster short-term recovery with local. This held true for the length of postoperative hospital stay as well as for the number of unplanned overnight admissions. The main reason was greater postoperative pain, requiring opioid analgesics after RA and GA, and the large number of patients, especially in the RA group, with pronounced micturition difficulties necessitating catheterization. One study did not reveal any difference [88], but interpretation was hindered because of the use of large doses of sedatives and intraoperative and early postoperative potent, long-acting opioids, which often leads to unnecessary nausea, sedation, and discomfort. The few data available from other reports concerning postoperative recovery also reported advantages for LA [6, 15, 69].

Recurrence

Although complication rates are low and hernia recurrence rates lower in many reported series using LA, it is difficult to suggest that the anesthetic has a direct effect on the recurrence rate, which is governed so much by surgical and technical factors. The long-term outcome of hernia repair is generally assumed not to be affected by method of anesthesia used. However, the evidence on which this assumption is based is far from convincing. The few studies on the topic have rendered conflicting results [39, 89–92]. Moreover, information from most randomized trials is limited since follow-up periods are relatively short.

In a register study from Sweden where 59,823 hernia repairs were recorded [45], LA was found to be associated with a somewhat higher reoperation rate in primary hernia repair. No similar association was found after operations for recurrence. In a study on the effect of smoking, Sorensen et al. [93] accidentally found LA to carry a higher risk of recurrence than GA and RA combined. The Danish Hernia Database reported an increased reoperation rate after local anesthesia versus general or regional anesthesia after direct—but not indirect—hernia repair [46]. Kingsnorth et al. [91] found that the surgeon's personal experience was the factor that most strongly influenced recurrence.

This leads us to stress the importance of proper training before adopting the local anesthetic technique, which is quite easy to learn, but only successful if the surgeon handles the tissues gently and has patience. Since skill and experience seem to be of such great importance in LA, substandard results are likely to occur if surgeons use the technique without appropriate training.

Patient Satisfaction

Most reviews and case series as well as randomized trials indicate that LA has the edge on its rivals GA and RA. But for an operation to be entirely successful, the patients should be satisfied with all aspects of management and are hardly likely to be so if they consider themselves to have been exposed to more pain than was absolutely necessary. Data from randomized studies comparing the three anesthetic techniques have shown similar patient satisfaction. The total satisfaction rate of patients operated under LA varies between 80 and 96% [4, 6, 22, 43, 69, 70, 94–96]. The main reason for dissatisfaction with local seemed to be intraoperative pain and discomfort [6, 96]. A great majority of patients from all three groups was satisfied or very satisfied with their anesthesia, and the proportion of patients who would prefer the same kind of anesthesia in the future was similar among the three groups [22, 28, 85, 95, 96].

However, in a dedicated ambulatory unit undertaking inguinal hernia repair under unmonitored local anesthesia, 1000 patients were sent a questionnaire after the surgical intervention [6]. The questionnaire was returned by 940 patients of whom 124 expressed dissatisfaction with the local anesthesia, the day-case setup, or both. The primary reason for complaint by the patients was intraoperative pain (7.8%). This is a relatively high rate of dissatisfaction and suggests that the local anesthetic care pathway still has room for improvement in the intraoperative phase.

Patient preference in the choice of anesthetic cannot be discounted, and LA is only successful if the surgeon handles the tissues gently, has patience, and is fully conversant with the technique [42]. When these conditions are fulfilled, surgeons should be able to offer the patient painless surgery, which no doubt is crucial for patient acceptance. Insufficient local infiltration technique may be accompanied by the risk of insufficient analgesia and unacceptable anxiety, emphasizing the need for optional supplementary sedation or analgesia [6]. Halsted and Cushing noted over a 100 years ago that pain during surgery under LA depends entirely upon the surgeon's familiarity with the technique, an experience that is presumably still valid today [48]. However, the learning curve required to provide effective local anesthesia is short.

Costs

Ideally inguinal hernia repair should be performed using a simple and safe technique that is acceptable for the patient and easily mastered by the surgeon. The technique should carry a low morbidity risk and also be cost-effective. The latter aspect, cost-effectiveness, has so far attracted only slight attention, but scrutiny to ensure that limited healthcare resources are used rationally is of the utmost importance.

Cost comparisons for the anesthetic alternatives have given similar results. LA provides cost advantage over both RA and GA, regarding both total intraoperative and postoperative costs [22, 97–100]. Of three randomized controlled trials [22, 88, 100], two found local to be cheaper than both GA and RA [22, 100], while one observed no major difference between LA and GA [88]. The probable explanation is that in the latter trial (O'Dwyer), all operations were performed on an in-patient basis with a mean hospital stay of 3 days. In day-case surgery, prolonged hospital stay after groin hernia surgery is often due to the effects of anesthesia. It follows that for cost-saving purposes, the avoidance of such side effects is of crucial importance. Shorter total theater time, earlier discharge, and to some extent, anesthetic equipment requirements were the main factors for the great difference in total costs.

Conclusions

Either general, regional, or local anesthesia is suitable for open groin hernia repair. The available scientific data support the use of local anesthesia. A great majority of randomized studies comparing the anesthetic techniques bear witness to advantage for local anesthetic such as less postoperative pain, less anesthesia-related complaints, less micturition difficulties, faster discharge, faster short-term recovery, and fewer costs. However, when surgeons inexperienced in its use administer local anesthesia, more hernia recurrences might result.

The knowledge of the benefits of LA has not been translated into general practice. There seems to be a discrepancy between existing scientific data and clinical practice. This may be due, in part, to patient preferences to undergo GA rather than either RA or LA.

The development of new short-acting intravenous general anesthetics (propofol, remifentanil) may be a valid alternative to local infiltration anesthesia alone, as the former can be combined with intraoperative local infiltration anesthesia for early postoperative pain relief.

Regional anesthesia especially when using high dose and/or long-acting agents seems to have no documented benefits in open inguinal hernia repair and increases the risk of urinary retention, prolonged recovery, and delayed discharge.

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