LOCAL ANAESTHETIC TECHNIQUES FOR PREVENTION OF POSTOPERATIVE PAIN

E. N. ARMITAGE

HISTORY

The potential benefits of local anaesthetic techniques in the postoperative period have long been recognized. In a review of early work, Simpson and Parkhouse (1961) pointed out that, in 1935, Capelle irrigated abdominal wounds with local anaesthetic injected through large, curved, hollow needles. These were inserted at the end of the operation and left in place in a manner similar to deep tension sutures. The method was apparently effective, but was not adopted widely because of fear of wound infection and delayed healing. Gerwig, Thompson and Blades (1951) used the same principle when they inserted polyethylene tubes deep to the anterior rectus sheath for wound irrigation, and they noted that patients so treated required only a quarter of the usual amount of morphine.

Gius (1940) described the use of paravertebral block with procaine for the treatment of post-operative atelectasis, and Cleland (1949) used "continuous" caudal and extradural analgesia for over 100 abdominal and ano—rectal cases. He claimed that this resulted in normal postoperative respiration and early, painless ambulation. Bonica (1953) used intermittent injections through an indwelling extradural catheter to produce segmental analgesia, and found that this gave complete pain relief and allowed effective ventilation and coughing. Dawkins (1956) preferred to give extradural lignocaine as an infusion. He found that this technique was capable of providing truly continuous analgesia, and pointed out that the use of the word "continuous" is a misnomer when applied to intermittent injections or top-ups of local anaesthetic.

These pioneer workers had demonstrated that local anaesthetics produce excellent postoperative analgesia, but they had also encountered the drawbacks. Infusion systems were open to the criticism that the extent of block might be difficult to control and that any sudden, unsuspected hypotension could be dangerous to a patient in the sitting position (Bonica, 1957). Regarding intermittent top-ups, Simpson and colleagues (1961) summarized the situation as follows: "The exacting nature of the technique, the necessity for scrupulous asepsis, and the large numbers of injections required, make continuous postoperative analgesia by means of intermittent, mid-thoracic extradural block unsuitable for routine use except where the special facilities of an intensive therapy unit are available."

These early observations provide guidelines for the "ideal" local anaesthetic technique for use in the postoperative period. It should be effective over the whole of the painful area, but its extent should not be difficult to control. It should not readily produce toxic effects and should not be unduly labour-intensive. Side effects should be minimal.

EXTRADURAL BLOCK

This is particularly useful because it can provide analgesia after surgery of the thorax, abdomen, pelvis and lower limb.

Factors affecting the catheter

Position. The catheter must be placed so that local anaesthetic solution injected through it produces analgesia at the site of operation. The mode of spread of solution depends on the method of administration. Injected solution emerges from the catheter under pressure and spreads equally up and down the extradural space. The catheter tip should therefore lie at the segment innervating the middle of the required area of analgesia. For upper abdominal operations, this should be between T6 and T8. An infused solution enters the extradural space under minimal pressure and its spread is...
Insertion. When an extradural block is used only for the duration of surgery, it is customary to insert a short length of catheter (2–3 cm) to the extradural space. Looping and knotting cannot occur and the risk of venous and dural puncture is minimized. Although this is satisfactory during and immediately after the operation, the catheter tends to become extruded as the patient mobilizes and as infusions are continued or repeated injections given. At least 5 cm of catheter should therefore be inserted to the extradural space if long-term analgesia is planned.

Duration. The pain of major surgery is at its most severe and debilitating in the first 2 or 3 days and extradural analgesia is of most benefit during this time. Thereafter, the intensity of pain diminishes and it can usually be controlled adequately with i.m. opioids or oral preparations. Infection is unlikely to occur when catheters are removed after 2 days and patients have been reported in whom they have been left in place for between 7 and 25 days (Dawkins, 1966; Lloyd and Rucklidge, 1969; Spoerel, Thomas and Gerula, 1970). However, skin infection was noted after 3 days at the entry site of the catheter in one instance. Infection of the extradural space is very rare (Baker et al., 1975), but it is serious when it occurs (Saady, 1976) and injections and infusions should be delivered through a system which includes a bacterial filter. Indwelling catheters can migrate and the tip can enter a blood vessel or puncture the dura. The length of time for which a catheter is left in place represents a compromise between these possible hazards and the benefits resulting from the analgesia. Two to three days would seem to be the optimal time.

Choice of drug

It is important that a local anaesthetic, given by intermittent bolus injection or by infusion, should not produce systemic toxicity. Reynolds (1971) found bupivacaine to have a wider safety margin than lignocaine or mepivacaine when given by intermittent injection during surgery. Tucker and Mather (1975) used a computer model to predict the pattern of drug concentrations in the extradural and plasma compartments, and concluded that longer-acting agents such as etidocaine accumulate rapidly in the extradural space, but slowly in the plasma (fig. 2). Systemic toxicity and tachyphylaxis were observed when lignocaine was administered as a continuous extradural infusion (Sjogren and Wright, 1972). Bromage (1975) found that, in low concentration, bupivacaine produced less motor block, for any given degree of sensory block, than did etidocaine, amethocaine and lignocaine. The evidence suggests that bupivacaine is the agent of choice for postoperative use.

It may be thought that the addition of adrenaline to the local anaesthetic could be beneficial on the grounds that the risk of systemic toxicity would be reduced, but in fact plasma concentrations are not significantly decreased (Wahba, Don and Craig, 1975). Hypotension is more marked when the local anaesthetic solution

![Diagram of analgesia area T6-T12](https://academic.oup.com/bja/article-abstract/58/7/790/279351)
contains adrenaline (Kennedy, 1966) and in view of the possibility that the prolonged infusion of adrenaline might cause ischaemic nerve damage, its use should be avoided.

**Anticoagulation**

The extradural space is vascular and since the insertion of a catheter is a "blind" procedure, occasional damage to blood vessels is inevitable. Haemorrhage from such damage cannot be controlled directly and although this is of little clinical consequence in the presence of normal clotting mechanisms, it does have implications for patients receiving anticoagulants. Some will be receiving oral anticoagulants for pre-existing cardiovascular disease. Others may require heparinization during arterial procedures, and the administration of low-dose heparin for prophylaxis against deep vein thrombosis after major surgery is now widely practised.

There has been understandable reluctance to insert extradural catheters to patients in any of these categories, but there is evidence that the procedure may be safe in certain circumstances. Rao and El-Etr (1981) reported 3164 patients who received continuous extradural anaesthesia before the administration of heparin during operation. The activated clotting time was approximately twice the preoperative value, but the authors found no evidence of extradural haematoma. Odoom and Sih (1983) reported 950 patients who received intraoperative heparin after insertion of the catheter, but these patients had also received oral anticoagulants before operation and their clotting mechanisms were abnormal at the time of catheter insertion (mean thrombotest: 19%; normal range: 70–130%). None developed neurological complications.

Although these studies appear to demonstrate the relative safety of heparinization after insertion of an extradural catheter, the authors stress the importance of controlling the degree of heparinization through the activated clotting time, and they regard thrombocytopenia, prior heparinization, long-term aspirin therapy and a thrombotest below 10% as contraindications. The management of the individual case depends on the balance between factors contributing to the thrombosis risk and the benefits likely to be conferred by the extradural. For major abdominal operations, the present author inserts the catheter before surgery and does not institute low-dose heparin therapy until 6–8 h after operation.

**Bolus Injection**

Intermittent injection, or topping-up, is the traditional method of prolonging analgesia into the postoperative period. It is satisfactory if the increments are given on a regular, timed basis with the objective of preventing pain. It is much less satisfactory if given on demand, since this implies that the presence of pain is the indication for a top-up. If the top-ups are to be given by nursing or medical staff, the patient nursed in an intensive therapy unit or a high dependency area stands a better chance of receiving prompt attention, and the method is therefore inappropriate for the majority of patients who return to a general...
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surgical ward. Early attempts were made to overcome this difficulty by the use of a mechanical injection device which delivered a predetermined dose of lignocaine or mepivacaine at regular intervals (Cox and Spoerel, 1964). More recently, Scott, Schweitzer and Thorn (1982) used a specially designed roller pump to deliver 6–10-ml doses of 0.5% bupivacaine 2 hourly. They found this provided good analgesia over 24 h. In the same study, another group of patients received 0.5% bupivacaine 4–5 ml given every 1–2 h by nurses. It was not possible to continue this regimen overnight and, even over the 8 h for which data were available, good analgesia was obtained in less than half the patients, because the nurses could not give the injections frequently enough. Schweitzer (personal communication) subsequently found that when 2-ml doses of 0.5% bupivacaine were delivered hourly through the pump, good analgesia was obtained.

Continuous Infusion

It was soon appreciated that it should be possible to maintain a constant state of analgesia by administering local anaesthetic by infusion. The method has the advantage that syringe drivers and variable rate infusion pumps are standard equipment and readily available, and the maintenance and monitoring is not labour-intensive.

Low volume/high concentration. Early workers (Spoerel, Thomas and Gerula, 1970) used standard concentrations of drug, 1 or 2% lignocaine or mepivacaine, at a rate of 5–12 ml h⁻¹ after thoracic and abdominal surgery. They continued the infusion for an average of 3 days and claimed good results in 77% of cases. Pfug and colleagues (1974) achieved excellent analgesia after upper abdominal surgery, infusing 0.5% bupivacaine at a rate of 3–5 ml h⁻¹. They reduced the concentration to 0.25% on the 3rd day, but kept the rate constant. It would seem that further reduction of the rate results in variable blocks. This is because an infused solution, unlike a bolus injection, has minimal injection pressure to propel it away from the catheter tip, and an increase in drug concentration is insufficient to compensate for this lack of physical spread. Renck and colleagues (1976) gave 1% bupivacaine at a rate of 0.75 ml h⁻¹ after thoracic surgery and failed to achieve reliable analgesia.

High volume/low concentration. In the author’s opinion, this is the method of choice. It involves the infusion of 0.1–0.125% bupivacaine 16–24 ml h⁻¹. Assuming that the catheter tip is appropriately placed, there is rarely any difficulty in achieving adequate spread of analgesia, motor block is less intense and drowsiness, a systemic side effect of bupivacaine, is less common than with the 0.25% solution (Griffiths, Diamond and Cameron, 1975). The accidental administration of excessive volume is likely to result in less severe toxic effects if a solution of low concentration is used. Hypotension is less common with an infusion than with a bolus technique (Scott, Schweitzer and Thorn, 1982), and infusions have been used safely on general surgical wards after abdominal and thoracic surgery (Ross, Clarke and Armitage, 1980). Unfortunately, local anaesthetics are not yet commercially available in low concentration and large volume, and suitable solutions have therefore to be specially prepared.

Practical aspects of management

Filters. Extradural filters are designed to prevent the passage of bacteria and are capable of excluding particles as small as 0.22 μm. When fluid is infused at a rate of, for example, 20 ml h⁻¹, particles accumulate rapidly on the filter and its resistance increases. The resulting increase in pressure between the filter and the pump may cause separation of the infusion line at a junction point. This problem can be overcome by changing the filter every 12 h, but it is the author’s practice to insert a blood filter between the pack of local anaesthetic solution and the administration set. This removes the larger particles, and the bacterial filter usually lasts for the duration of the infusion.

The pump. Resistance in an infusion line is high, since fluid has to pass not only through the filter, but also along the narrow 90-cm long extradural catheter. The pump must therefore be powerful. It should also be quiet and accurate and give warning when solution is flowing faster or slower than the selected rate. Nursing staff should have easy access to an illustrated chart showing the common causes of, and remedies for, pump malfunction.

Bolus during an infusion. Although an infusion of 0.1% bupivacaine 20 ml h⁻¹ will often give satisfactory analgesia for 2–3 days without the need for adjustment, the block will sometimes regress. Setting the pump at a higher rate will not correct a regressing block unless a bolus is first
given to re-establish the required area of analgesia. A "bolus" can be given without breaching the infusion line by running the pump at 90 drops min\(^{-1}\). A standard administration set delivers 4.5 ml during 1 min at this rate, and volumes of 4.5–9 ml are usually required. Griffiths, Diamond and Cameron (1975) infused 0.125% or 0.25% bupivacaine at 15 ml h\(^{-1}\) after thoracic surgery and achieved satisfactory analgesia in five of seven patients. However, in spite of this generous rate, a mean of five bolus doses (5–8 ml of 0.25% bupivacaine) was required during the 48-h period studied.

A regressing block may not be the only reason for a bolus being required. Gjessing and Tomlin (1979) have suggested that the intensity of postoperative pain is not constant, but cyclical. They identified four peaks (occurring at 4, 10, 14 and 18 h) during an 18-h period in women undergoing total hip replacement, and two peaks (at 6–8 and 12–16 h) in men having the same operation. They also suggested that patterns of pain may be different after different types of surgery.

Motor block. Weakness or paralysis of the lower limb muscles is not usually produced when nerves are subjected to intermittent bolus injections of local anaesthetic, but it is quite common, even with dilute solutions, during the course of an infusion. This is presumably because the large, resistant motor fibres eventually become affected after they have been bathed constantly for several hours. The patient should be warned of this possibility at the preoperative visit and assured that recovery of function occurs within 2 or 3 h after reduction of the infusion rate. Similarly, surgeons should be aware that symptoms do not necessarily betoken a neurological or vascular disaster.

Additional sedation. Since postoperative extradural block is performed to provide better pain control at the operation site than conventional opioid analgesia, it is sometimes felt that any discomfort indicates a failure of the block and that no opioid should be necessary. This attitude fails to take into account the fact that there are some sources of discomfort which the extradural is intrinsically incapable of relieving, or which lie outside its range. These include anxiety about the recent operation, sleeplessness as a result of noise and the need for frequent postoperative observations, and shoulder tip pain which is thought to result from pneumoperitoneum. The administration of occasional, small doses of opioid under these circumstances, far from devaluing the block, greatly enhances it and gives excellent overall results.

Plasma concentrations. The extradural infusion of a local anaesthetic drug over a long period may lead to potentially toxic plasma concentrations. Ross, Clarke and Armitage (1980) followed intraoperative boluses of 0.25% bupivacaine with the postoperative infusion of 0.125%, and measured venous plasma concentrations at 4-h intervals for 44 h. The infusion rate was adjusted so that patients were pain-free and side effects were minimal, and it varied between 12 and 36 ml h\(^{-1}\) with an average of 20 ml h\(^{-1}\). This regimen produced mean venous bupivacaine concentrations of 3 \(\mu\)g ml\(^{-1}\) (range 1.3–4.9 \(\mu\)g ml\(^{-1}\)) after 44 h (fig. 3). Patients were assessed clinically when the blood samples were taken and no signs of cerebral toxicity were detected, although one patient became euphoric. Reynolds (1971) has stated that even mild toxic symptoms are unlikely to appear at plasma concentrations less than 1.6 \(\mu\)g ml\(^{-1}\). Unfortunately, this figure has sometimes subsequently been taken to represent "the toxic level" for bupivacaine and this is
clearly an incorrect interpretation of the original statement.

The appearance of toxic symptoms depends on factors other than the plasma concentration. Scott (1975) administered i.v. bupivacaine at different rates to conscious volunteers and found that symptoms appeared at low plasma concentrations when the infusion rate was high. The rate of increase in concentration tends to be very slow when dilute bupivacaine is given by extradural infusion (fig. 3) and this may explain why no toxic effects were observed in Ross’s patients. A further explanation may lie in the fact that α-globulin, the protein to which bupivacaine binds, increases after surgery and may match the increase in plasma bupivacaine concentration. The unbound fraction of the drug may remain virtually constant under these circumstances.

Although venous plasma concentrations are often measured, it is the arterial concentration which is more closely related to the development of toxic symptoms. Griffiths, Diamond and Cameron (1975) followed intraoperative injections of 0.5% bupivacaine (with adrenaline) 6-8 ml with a postoperative infusion of 0.125% bupivacaine at a mean rate of 13 ml h⁻¹ and they supplemented this, as required, with boluses of 0.25% bupivacaine 5-8 ml. They took arterial samples and found a mean value of 2 µg ml⁻¹ (range 0.93-3.76 µg ml⁻¹).

Effects on the cardiovascular system

Some degree of hypotension almost invariably accompanies extradural block and it is fear of its consequences and, perhaps, uncertainty about its significance which deters many from prolonging the block after operation.

_The normal patient._ The sympathetic denervation caused by extradural block results in peripheral arterial and venous dilatation. The latter gives rise to decreased venous return and, if the affected veins are below the level of the right atrium, cardiac output may be reduced. Mean arterial pressure decreases in proportion to the decrease in cardiac output and peripheral vascular resistance.

As a consequence, coronary blood flow is reduced, but fortunately this is accompanied by a similar reduction in the myocardial oxygen requirement.

Sympathetic block below T4 results in dilatation of the splanchnic, pelvic and lower limb vessels, and various mechanisms come into play to compensate for this. Vasoconstriction above the level of the block occurs, mediated by unblocked sympathetic vasoconstrictor fibres (T1-4), and release of catecholamines may be mediated by any unblocked fibres to the adrenal medulla. Unblocked cardiac sympathetic fibres mediate an increase in myocardial contractility and heart rate. In addition, vascular tone below the level of the block may return because of autoregulation of flow by precapillary sphincters (Granger and Guyton, 1969) and it has been suggested that low plasma concentrations of local anaesthetic drug cause cardiovascular stimulation (Bonica, Berges and Morikawa, 1970).

_Sympathetic block above T4 reduces or abolishes compensatory vasoconstriction in the head, neck and upper limb as well as the ability of the cardiac sympathetic fibres to stimulate the heart. It is therefore surprising that the cardiovascular changes noted with upper thoracic blocks have been relatively modest. McLean and colleagues (1967) found a 15-20% reduction in cardiac output and an increase in central venous pressure (CVP). Bonica and colleagues (1971, 1972) also demonstrated an increase in CVP and found that mean arterial pressure and peripheral resistance decreased by about 20%, but they observed no change in cardiac output or heart rate.

_Relation of sympathetic to sensory block._ There is disagreement as to whether or not a sympathetic block extends higher or lower than a somatic block. Bonica, Berges and Morikawa (1970) were unable to demonstrate any sympathetic block in two of eight patients, even though all had skin hypoalgesia. On the other hand, Horner’s syndrome is occasionally seen following an extradural where the analgesia is confined to the lower thoracic segments. Wugmeister and Hehre (1967) concluded that sympathetic and somatic block extended to the same level because loss of pin prick and cold sensation affected the same area. The above evidence suggests that there is wide variation between patients. The practical consequence is that the incidence and severity of hypotension are also likely to vary.

_Patients in pain._ The effect of extradural block on the cardiovascular system of the postoperative patient was studied by Sjogren and Wright (1972). They maintained analgesia with 0.4% lignocaine infused overnight at a rate of 30-45 ml h⁻¹ and took cardiovascular measurements before discontinuing the infusion. The measurements were repeated when the block had worn off and the
patients were in pain, and again when the infusion had been re-commenced and the patients were pain free. The measurements taken when patients were in pain showed an increase in cardiac output, heart rate and mean arterial pressure and a decrease in stroke volume and skin blood flow—changes which indicated a strong sympathetic stimulation of the circulation. Re-establishment of analgesia was followed by a return to the values obtained before pain had been allowed to occur. Holmdahl and colleagues (1972) gave continuous extradural analgesia after cholecystectomy and found that hypotension was less of a problem when the catheter was placed in the thoracic rather than the lumbar region.

**Effects on the respiratory system**

Patients who have undergone major thoracic and abdominal surgery are prone to respiratory infection because pain prevents them from breathing deeply and coughing effectively. The abolition of pain by continuous extradural block might be expected to improve pulmonary function, and various aspects of the subject have been investigated.

*The normal patient.* Extradural block has very little effect on respiratory parameters in the normal patient. A block to the level of T4 had no significant effect on functional residual capacity (FRC), expiratory reserve volume (ERV) or inspiratory capacity. However, a block extending higher than T4 caused a decrease in ERV of 12–36% (Freund et al., 1967; Sjogren and Wright, 1972; Takasaki and Takahashi, 1980). Arterial blood-gas tensions showed little change (Ward et al., 1965). Extradural block should theoretically allow unopposed vagal tone to cause bronchoconstriction, but no such change was found, even in the presence of high blocks, in three separate studies (Sjogren and Wright, 1972; Wahba et al., 1972; Takasaki and Takahashi, 1980) and Bromage (1978) quoted patients in whom extradural block has actually proved therapeutic in status asthmaticus.

The ability to cough effectively requires co-ordinated, powerful contraction of the diaphragm and muscles of the abdominal wall. Motor block to the latter occurs during upper thoracic spinal anaesthesia (Egbert, Tamersoy and Deas, 1961), but extradural block has minimal effect, perhaps because motor block cannot be shown to extend as high as sensory block (Freund et al., 1967).

*Patients in pain.* The effects of extradural block are not as dramatic as might be expected. There is sometimes improvement in lung volume measurements such as FRC and vital capacity (VC), but results are inconsistent and improvement is limited to reduction of deterioration rather than restoration of preoperative values (Simpson et al., 1961; Wahba, Don and Craig, 1975). However, the greatest benefit is seen in patients with chronic obstructive airways disease after upper abdominal surgery. Extradural block improved the VC from 37% of the preoperative value to 90% in these patients (Simpson et al., 1961). The effect on arterial blood-gas tensions is even less impressive. Patients are relatively hypoxaemic on the 1st day after upper abdominal surgery, whether they have received extradural anaesthesia or not (Muneyuki et al., 1968; Spence, Smith and Harris, 1968; Sjogren and Wright, 1972; Pfug et al., 1974; Spence and Logan, 1975), and when pain is relieved by extradural block, no improvement in $P_{aO_2}$ is seen (Muneyuki et al., 1968; Drummond and Littlewood, 1977).

There is, however, a marked improvement in the ability to cough. Sjogren and Wright (1972) studied patients receiving thoracic and lumbar extradural analgesia after gall bladder surgery and found that the peak expiratory flow rate increased by 64% and 90%, although these improved values were still only approximately one-half those obtained before operation.

It is not easy to find clear-cut evidence that extradural block causes significant improvement in respiratory function or reduces the incidence of postoperative chest infection in normal patients. However, since extradural analgesia improves the ability to cough, and increases VC to a greater extent in patients with chronic obstructive airways disease, it probably conveys most benefit to this group of patients, who most need it.

*Other effects*

**Lower limb blood flow.** Extradural block increases blood flow to the lower limb (Bonica, Berges and Morikawa, 1970), the skin receiving most of the increase (Cousins and Wright, 1971). Therefore flow must increase through the long and short saphenous veins, which drain the skin, and also through the femoral and iliac veins. Since thrombi in the latter vessels are most likely to result in pulmonary embolism (PE) (Modig et al., 1983), extradural block may be expected to play an
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important part in the prevention of deep vein thrombosis (DVT) and PE.

Total hip replacement carries a high incidence of DVT, and PE is the commonest cause of immediate postoperative death after this procedure. Modig and colleagues (1983) studied patients in two groups, one of which received extradural anaesthesia for the operation and extradural analgesia after operation, and the other in which general anaesthesia was followed by postoperative opioid analgesia. The incidence of DVT was reduced significantly in the extradural patients. Lung scans were used to detect PE, which was found in 33% of the general anaesthesia/opioid group, but in only 10% of the extradural group.

Gastric emptying and intestinal motility. Opioids delay gastric emptying and reduce intestinal motility (Nimmo et al., 1978). Extradural block, by eliminating or greatly reducing the need for opioids, avoids these problems, but it also has a direct effect on the bowel, mediated by the sympathetic system. Increased sympathetic activity inhibits bowel contractility and predisposes to distension. This in turn increases tension, and hence the likelihood of rupture, at sites of anastomosis. Extradural block, by reducing sympathetic activity, reverses these trends; paralytic ileus is minimized and the nasogastric tube, which contributes to inefficient coughing and expectoration, can be removed early. Peristalsis is sometimes very active and diarrhoea occasionally persists into the postoperative period. The author has in one instance had to discontinue an infusion for this reason. However, the overall benefits are considerable (Aitkenhead, 1984).

Monitoring

It is important, whether the patient is nursed in an intensive therapy unit, a high-dependency area or a general ward, that the nursing and medical staff are familiar with the behaviour and management of patients receiving extradural analgesia, and the ways in which they differ from those receiving opioids. Systolic arterial pressure remains low for the first 12-24 h, but usually increases without specific therapy on the 1st day after operation. Ephedrine is occasionally required. Fears that the relative hypotension and complete analgesia may mask abdominal signs, causing delay in diagnosis of surgical complications, are groundless. Patients suffering from haemorrhage or an anastomotic leak look and feel unwell, in marked contrast to those running a normal postoperative course with extradural analgesia.

It is possible to check the infusion rate and the integrity of the line without disturbing the patient, and this should be done hourly. The adequacy of the block should be assessed every 4 h during the day. The patient should not only be free from pain at rest, but should be able to lift his head off the pillow from the 45° sitting position, take a deep breath, and cough, without pain. If any of these tests cause discomfort, a bolus should be given and the tests repeated after 15 min. The patient should be able to move both lower limbs. If a patient has a stable and easily controlled block, it is unnecessary to disturb him for assessments during the night. However, an early assessment is essential the following morning so that any adjustments can be effective before the arrival of the physiotherapist.

OTHER BLOCKS

It is not always necessary or desirable for a block to extend over a wide area, involve the sympathetic system or act bilaterally. Many blocks are capable of providing excellent analgesia, with minimal systemic effect, over a limited field, but although they have been used satisfactorily as single-shot techniques, they have not gained widespread acceptance for prolonged postoperative analgesia because it has been assumed that they must be repeated every few hours. This assumption is not necessarily correct, because it has been found that a catheter can be inserted through the fascial sheaths which surround neurovascular compartments. The sheaths extend peripherally and invest individual nerves, and Winnie, Ramamurthy and Durrani (1973) have shown that local anaesthetic solution injected through the sheath of, for example, the femoral nerve can be made to track centrally in the neurovascular compartment so that it affects the obturator nerve and lateral cutaneous nerve of the thigh in addition.

Paravertebral

Eason and Wyatt (1979) used continuous paravertebral block for analgesia after thoracotomy. They located the paravertebral space by loss of resistance to injection of air, and passed an end-hole extradural catheter into the space through a Tuohy needle. They found that at least four segments were affected by a single, 15-ml injection of 0.375% bupivacaine. The advantages
claimed for the technique are that it can be performed comparatively easily in patients with kyphoscoliosis and other distortions of the bony spine, and hypotension is minimal since sympathectic block is unilateral.

**Intercostal**

Murphy (1983) inserted an extradural catheter through a Tuohy needle to an intercostal space in 25 patients who had undergone cholecystectomy through a Kocher incision. Only two patients required any supplementary opioid on the 1st day after operation, but on the 2nd this figure had increased to six. Peak flow measurements were made on the 2nd day before and after an injection of bupivacaine. A mean improvement of 37% was recorded 30–40 min after the top-up.

**Inguinal paravascular (three-in-one)**

Rosenblatt (1980) used this technique for postoperative analgesia after knee surgery in a 13-yr-old patient suffering from cystic fibrosis. An 18-gauge, 5-cm Teflon catheter was threaded over a 22-gauge, 8.75-cm spinal needle. When the needle had entered the fascial sheath surrounding the femoral nerve, local anaesthetic was injected to distend the sheath and facilitate passage of the catheter. On the 1st day after operation, 0.75% bupivacaine 15 ml was injected every 6 h. On the 2nd day, 0.5% bupivacaine was infused at 4 ml h⁻¹ and continued for 24 h.

**Sciatic**

Smith, Fischer and Scott (1984) described a technique for continuous sciatic nerve block which they used first to relieve the pain of an ischaemic foot and later, with an inguinal paravascular block, for postoperative analgesia following below-knee amputation. They located the sciatic nerve with a 16-gauge Medicut cannula connected to a nerve stimulator. After the injection of 2% lignocaine 8 ml to open up the neurovascular space, a 16-gauge extradural catheter was passed easily into it. Bupivacaine 0.5% was infused at a rate of 6 ml h⁻¹ through both the femoral and sciatic catheters for 48 h, and the patient was completely free of pain.

**Axillary**

Although the brachial plexus can be blocked at various points along its course, the axillary approach is the most suitable for insertion of a cannula. A 20- or 22-gauge i.v. cannula is recommended and it is less likely to be dislodged during an injection if an extension set is interposed between it and the syringe or pump (Hughes and Desgrand, 1986). Rosenblatt, Pepitone-Rockwell and McKillop (1979) performed an axillary block for the repair of injured tendons in the hand of a 15-yr-old boy. They infused 0.25% bupivacaine at a rate of 10 ml h⁻¹ for 2 days and the patient required no narcotic agents. Rosenblatt recommends that canulae should be sutured in position if they are to be used for postoperative analgesia. The application of an occlusive, transparent, adhesive drape probably immobilizes the cannula just as well and has the advantage that the puncture site and surrounding skin can be inspected easily for signs of infection.

**CONCLUSION**

"Slapping the patient on the face and telling him or her that 'it's all over' is a complete inversion of the truth. As far as the patient is concerned, it is just the beginning" (Berry, 1979).

There is irrefutable evidence that patients suffer considerable pain after operation (Donald, 1976; Foott, 1978). Suitable drugs, equipment and techniques are available. The problem is essentially the practical one of how to provide analgesia safely, simply and continuously for 2–3 days. The solution depends as much on organization and attitudes as on techniques. One reason for the inadequacy of conventional opioid analgesia is that it is prescribed by members of one profession and administered by members of another. The result is that neither doctors nor nurses take full responsibility for it. Analgesia should be the responsibility of a small number of designated individuals and its effectiveness should be their main concern. A second, related, requirement is that the experience and availability of staff must be taken into account when the method of local anaesthesia is being selected, so that it can be easily and safely managed. This factor may determine whether analgesia is best administered by intermittent injections or by infusion. Last, there is little prospect of patients enjoying complete, continuous analgesia as long as their attendant staff think and talk in terms of pain relief. Analgesia should be given with the intention of preventing pain rather than relieving it.

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