REGIONAL ANAESTHESIA FOR ORTHOPAEDIC SURGERY

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Regional anaesthesia has more to offer in orthopaedic surgery than in any other surgical specialty, either alone or as part of an anaesthetic sequence. The advantages of regional anaesthesia may include better postoperative recovery and analgesia, reduction in intraoperative blood loss and better preservation of mental function in the elderly. In this review, aspects of regional anaesthesia for orthopaedic procedures are discussed, first for central neural blockade and then for peripheral nerve blocks.

CENTRAL NEURAL BLOCKADE: EXTRADURAL AND SUBARACHNOID BLOCK

Central Neural Blockade is used mainly for surgery involving the lower limb. In this area, there is controversy on the role of regional anaesthesia in contemporary practice. The majority of evidence comparing the effects of regional anaesthesia with general anaesthesia exists for patients undergoing hip surgery. This includes elective total hip replacement and surgery for fractured neck of femur, including primary hip prosthesis or internal fixation.

In this section, regional anaesthesia is compared with conventional general anaesthesia for elective and emergency hip surgery as judged by their effects on various important aspects of morbidity and mortality.

Blood-loss

Substantial peri-operative blood loss is often associated with total hip replacement surgery. However, blood loss in association with surgery for fractured neck of femur is usually comparatively small.

In considering the effects of anaesthetic technique on blood loss during total hip replacement surgery, distinction must be drawn between intraoperative loss and total perioperative blood loss. Both extradural anaesthesia (Modig and Malmberg, 1975; Keith, 1977; Modig, Malmberg and Karlstrom, 1980; Modig, Borg, Bagge et al., 1983) and subarachnoid anaesthesia (Thorburn, Louden and Vallance, 1980) have been found to be associated with reduced intraoperative blood loss of approximately 50% in comparison with general anaesthesia for hip replacement. However, postoperative blood loss does not seem to be related to the anaesthetic technique used (Keith, 1977; Thorburn, Louden and Vallance, 1980). Because the blood loss after operation may be considerable and approach or equal the losses during operation, the effects of regional techniques on blood loss may be less impressive when total blood loss is considered. Keith (1977) found the mean total blood loss after hip replacement surgery under extradural anaesthesia was 743 ml, significantly less than the mean of 1168 ml in the patients who had received general anaesthesia with a “neuroleptanalgesia” technique. However, patients who had received general anaesthesia with halothane with spontaneous ventilation had a mean total blood loss of 986 ml and this was not significantly different from the value for extradural anaesthesia. Thorburn, Louden and Vallance (1980) found mean total blood loss after general anaesthesia (GA) for hip replacement was 1504 ml, but this was significantly reduced if subarachnoid spinal anaesthesia had been used—with a mean loss of 1001 ml. Seventy percent of patients in the GA group were transfused with blood, in comparison with only 10% of the spinal group, a difference which was statistically significant.

Intraoperative blood loss during repair of fractured neck of femur has been shown to be similar with both subarachnoid and general anaesthesia (McKenzie, Wishart and Smith, 1984), with a mean loss associated with “pin and plate” repair of 270 ml.

Arterial oxygenation

Patients undergoing hip surgery are at special
Evidence that the preoperative Po$_2$ in patients was around 60-65 yr and extrapolation of advancing age (Raine and Bishop, 1963; Conway, Payne and Tomlin, 1965; Marshall and Millar, 1967; Gillies et al., 1977). However, in these studies the upper age limit for the vast majority of patients was around 60-65 yr and extrapolation of the regression line demonstrating decreasing arterial Po$_2$ with age to include the very elderly is statistically unacceptable and may be misleading. Evidence that the preoperative Po$_2$ in patients with fractured neck of femur is indeed lower than would be expected in patients of this age is obtained by follow up of patients who demonstrate a considerable improvement in arterial Po$_2$ once they have recovered (Gray, personal communication). The reasons for the preoperative hypoxaemia are open to speculation, but may include subclinical fat embolus, immobilization and the recumbent position (Ward et al., 1966; Cardus, 1967; McKenzie et al., 1980). Patients who have sustained a fracture of a long bone, particularly shaft of femur, have been demonstrated to have a very significantly reduced arterial Po$_2$ which may be completely undetected (Tachakra and Sevitt, 1975). The mechanism of this hypoxaemia is likely to be pulmonary “fat embolism”, which develops very rapidly after fracture.

Insertion of femoral prostheses with or without cement is well known to be associated at times with marked reductions in systemic arterial pressure (Modig et al., 1975). In addition, marked reductions in arterial oxygen tension may occur after impaction of the femoral prosthesis and minor decreases in Pa$_\text{O}_2$ after insertion of the acetabular prosthesis have been shown to occur (Modig et al., 1975). These events are associated with increased pulmonary vascular resistance, increased total pulmonary venous admixture and an increase in mean pulmonary artery pressure (Modig and Malmberg, 1975). The decrease in Pa$_\text{O}_2$ in the study by Modig and Malmberg (1975) occurred when patients received either extradural analgesia or general anaesthesia with controlled ventilation. The decrease in mean Pa$_\text{O}_2$ was of the order of 8.8 mm Hg in the group receiving extradural anaesthesia. Arterial Po$_2$ had recovered by 30 min after impaction of the prosthesis. It is noteworthy that, in the patients under general anaesthesia, ventilation was controlled with room air and Po$_2$ had decreased from preoperative values by 10.4 mm Hg at 15 min after induction of anaesthesia. The mechanism of the haemodynamic and arterial blood-gas changes is complex and may include release of thromboplastic products, fat embolism or acryllic monomers into the circulation (Modig et al., 1975) or air embolism (Michel, 1980). These changes may produce particularly worrying consequences in the patient having hip surgery under regional anaesthesia, since the arterial pressure before insertion of prosthesis or cement may already be reduced and a further decrease may be potentially disastrous. There is thus a strong indication for direct intra-arterial pressure monitoring in such patients. In addition, because of the risk of unrecognized arterial hypoxaemia associated with insertion of the prosthesis, it would seem wise to administer added oxygen to patients having these procedures under regional anaesthesia, for the duration of the procedure and for a period of at least 1 h after insertion of the prosthesis.

Patients undergoing “pin and plate” repair of fractured neck of femur (that is, excluding those requiring primary hip prosthesis) show no changes in arterial blood-gases in the perioperative period if these procedures are performed under subarachnoid block (McKenzie et al., 1980). However, patients having these procedures under general anaesthesia exhibit a decrease in arterial Po$_2$ in the period immediately after operation. The extent of this deterioration in arterial Po$_2$ may be very severe in the first few minutes after general anaesthesia is discontinued if the patient is allowed to breathe room air (McKenzie, 1984).

Deep vein thrombosis (DVT)

Patients with fractured neck of femur are at very great risk of developing deep vein thrombosis and fatal pulmonary thromboembolism. Sevitt and Gallagher (1961) showed that, at postmortem, 83% of patients who died after femoral neck fracture had DVT and of these, 46% showed evidence of pulmonary thromboembolism. The incidence of DVT after elective total hip replacement has also been demonstrated to be extremely high. Pulmonary thromboembolism is probably the major cause of death after elective total hip replacement and is one of the main causes of the high mortality associated with fractured neck of femur. Johnson, Green and Charnley (1977) found...
an overall mortality following hip replacement of 1.68% and a total 1.04% was the result of pulmonary embolism.

Recently, evidence has emerged that anaesthetic technique, in particular regional anaesthesia, may influence the incidence of DVT in patients undergoing procedures with a high risk of DVT, particularly hip surgery both elective and emergency. The validity of any study of DVT incidence is crucially dependent on the accuracy of the method or methods of detection. Purely clinical assessment of incidence of DVT is notoriously inaccurate, except when signs are gross (McLachlin, Richards and Paterson, 1962). As few as 50% of patients with calf tenderness after operation do, in fact, have DVT, and over 60% of patients with proven DVT have no physical signs (Browse, 1978). At present, venography is the only research method for determining the incidence of DVT which is known to be accurate in patients who have had hip surgery. The fibrinogen uptake test has been used widely in studies of postoperative deep venous thrombosis, but is completely inappropriate and inaccurate after hip surgery (Field, Kakkar and Nicolaides, 1972; Morris and Mitchell, 1977; Browse, 1978; Louden et al., 1978). In particular, the fibrinogen uptake test is associated with a high false positive rate after hip surgery.

In comparison with general anaesthesia, subarachnoid block is associated with a reduced incidence of deep vein thrombosis both after total hip replacement and after repair of fractured neck of femur. Thorburn, Louden and Vallance (1980) demonstrated with venography that, of 47 patients receiving general anaesthesia for total hip replacement, 53% developed DVT, and of 38 patients receiving spinal anaesthesia 29% developed DVT—a significantly lower frequency in the spinal anaesthetic group. In a study of 40 patients having repair of fractured neck of femur, McKenzie and colleagues (1985) demonstrated, using venography, a significantly lower incidence of DVT after spinal anaesthesia (40%) compared with the incidence after general anaesthesia (76.2%).

Studies comparing the incidence of DVT after total hip replacement carried out under extradural or general anaesthesia give less “clear cut” results. Modig, Borg, Karlstrom and colleagues (1983), compared the incidence of DVT following total hip replacement under either extradural or general anaesthesia and also examined the incidence of pulmonary embolism by radio isotope perfusion lung scan. Unfortunately, they found it necessary to sub-divide the location of thromboses in order to demonstrate statistically significant differences between the groups. For example, the frequency of DVT involving the popliteal and femoral veins was 13% in the extradural group, compared with 67% in the patients having general anaesthesia. The frequency of pulmonary embolus as diagnosed by perfusion lung scan was 10% after extradural anaesthesia and 33% after general anaesthesia—a statistically significant difference. It must be remembered that perfusion lung scan is subject to false positive findings, but care was taken to try and eliminate these as far as possible. While this study is not entirely conclusive, the findings are in keeping with other studies and theoretical evidence that anaesthetic techniques might have an effect on incidence of DVT.

General anaesthesia may itself predispose to DVT by producing stasis in the deep veins of the lower limb. Reduced venous blood flow after induction of general anaesthesia has been demonstrated to reduce lower limb blood flow substantially (Clark and Cotton, 1968; Kemble, 1971; Poikolainen and Hendolin, 1983). It is unclear if general anaesthesia contributes to the postoperative increases in blood coagulability. However, it has been demonstrated that general anaesthesia in patients with fractured neck of femur results in decreased red cell deformability, which is one of the determinants of blood viscosity and which could lead to increased blood viscosity, were other factors to remain unchanged (Drummond et al., 1980). This effect can be reproduced by exposure to halothane in vitro.

By contrast, spinal anaesthesia is associated with a significant reduction in blood viscosity in patients with hip fracture, partly as a result of haemodilution, but also because of an increase in red cell deformability by an unknown mechanism. Extradural anaesthesia has also been demonstrated (Modig, Malmberg and Kalstrom, 1980) to increase arterial inflow, venous emptying rate and venous capacity in patients undergoing hip replacement. This effect would lead to an unfavourable milieu for development of clot. In addition, there is evidence that extradural anaesthesia may be associated with decreased blood coagulability. Postoperative fibrinolytic activity is less decreased after extradural anaesthesia than after general anaesthesia (Modig, Borg, Bagge et al., 1983). Simpson and colleagues (1982) demonstrated enhancement of fibrinolysis when
extradural block was combined with light anaesthesia in patients undergoing hysterectomy. Local anaesthetics themselves are known to inhibit platelet adhesion (O'Brien, 1961), platelet aggregation and release (Feinstein, Fiekers and Frazer, 1976; Cazenave, Benveniste and Mustard, 1979), and leucocyte migration and aggregation (Giddon and Lindhe, 1972). Interestingly, a lignocaine infusion given during total hip replacement and for 6 days afterwards has been shown to reduce the incidence of DVT significantly in comparison with a control group given 5% dextrose (Cooke et al., 1977).

The use of prophylactic perioperative anticoagulation is perhaps an absolute contraindication to the use of extradural and spinal anaesthesia, and the importance of the findings discussed above remains controversial.

**Mental function**

Many patients having hip surgery are elderly, particularly those with fractured neck of femur, and it is not surprising that confusional states are relatively common after such major procedures. However, there has been a strong clinical impression amongst many anaesthetists that these confusional states are less of a problem if regional anaesthesia is used. However, there seem to be only a few studies which have tackled this important problem. Hole, Terjesen and Breivik (1980) examined mental function before and after total hip replacement in elderly patients and compared the effects of extradural and general anaesthesia in this respect. Definite mental changes occurred in eight of 31 patients who received general anaesthesia and one of 29 patients who received extradural anaesthesia. Of these, one patient in each group showed clinical signs of central anticholinergic syndrome which was abolished by physostigmine. One patient in the general anaesthetic group remained mentally impaired until he died on the 9th day after operation and two patients were still mentally impaired on discharge from hospital 14 days later. Six of the seven patients with mental changes were followed up and, of these, only two thought they had completely regained pre-operative mental capabilities. One patient suffered from permanent complete dementia. The difference between postoperative mental function in patients who received general anaesthesia and that in those who received extradural anaesthesia was statistically significant as assessed by this study. However, Riis and colleagues (1983) reported only transient mental impairment occurring within the first week after operation in elderly patients and the degree of this impairment was similar whether general or extradural anaesthesia was used.

Bigler and colleagues (1985), could find no difference in postoperative mental function in 40 elderly patients undergoing surgery for hip fracture, whether spinal anaesthesia or general anaesthesia was used. This study utilized an abbreviated mental test of 10 questions of orientation and memory and this test was applied before operation, 1 week after surgery and 90 days after surgery. Mental function improved in both groups by 1 week after surgery and no persistent impairment in mental function was found in any patient. This is a surprising finding, as it is well known that a substantial proportion of patients after repair of fractured neck of femur appear to be confused. However, Bigler and colleagues (1985) did not include patients who suffered from preoperative dementia. In the study by the present author (McKenzie, Wishart and Smith, 1984), over 7% of patients were from psychogeriatric hospitals.

**Effect of anaesthesia on outcome**

Interest in possible differences in outcome between regional and general anaesthesia is not new. As early as 1911, Brownlee presented a paper to the German Surgical Society reporting that, of 71,000 patients who had received spinal anaesthesia, nine had died compared with 21 deaths in 71,000 patients who had received general anaesthesia. In recent times, interest has focused on comparative outcome after surgical repair of fractured neck of femur.

McLaren, Stockwell and Reid (1978) compared outcome after subarachnoid spinal or general anaesthesia with intermittent positive pressure ventilation for repair of fractured neck of femur. In this study of 53 patients, there was a mortality rate at 4 weeks after surgery of 31% in the group who had received general anaesthesia and 3.8% in the group who had received subarachnoid block. It is of interest that the group receiving subarachnoid anaesthesia received a unilateral block and sedation with Althesin infusion and nitrous oxide.

McKenzie, Wishart and Smith (1984) studied 148 patients undergoing "pin and plate" repair of fractured neck of femur. Patients were allocated randomly to receive either subarachnoid block or general anaesthesia with spontaneous ventilation.
with nitrous oxide and halothane. The patients were followed up for 1 year after operation. Early postoperative mortality was significantly reduced in the spinal anaesthetic group by 2 weeks after operation, being 4.2% in the subarachnoid group and 16% in the general anaesthetic group. In addition, there was a marked clustering of deaths between the 5th and 15th day after operation in the general anaesthetic group, a pattern which did not appear in the spinal anaesthetic group. However, longer-term follow up revealed that, by 2 months after operation, cumulative mortality was virtually identical at approximately 18% in both groups. Cumulative mortality up to 1 year after operation remained similar in both groups, by which time 44% of patients had died, 50% had returned home, 12% were in hospital or institutional care and 4% had been lost to follow up.

In addition, duration of hospital stay was not affected by anaesthetic technique. The main duration of stay in the acute hospitals was 42.9 days for the GA group and 38.8 days for the spinal group. Mean hospital stay, including convalescence, was 84.4 days overall and did not differ between groups. The pattern of reduction in early mortality associated with spinal anaesthesia, together with clustering of deaths in the general anaesthetic group between the 5th and 15th days after operation is suggestive of an increased incidence of thromboembolic phenomena in the general anaesthetic group. This hypothesis is supported by the evidence previously presented on reduction in DVT and pulmonary embolism associated with regional anaesthesia. It is disappointing that the reduction in mortality is short-term and it is unclear why this is so, but there certainly appears to be no major long-term benefit on outcome produced by spinal anaesthesia for repair of fractured neck of femur.

Wickstrom, Holmberg and Stefansson (1982) studied 169 patients having repair of fractured neck of femur and followed them up for 4 years after surgery. Five different anaesthetic methods were used, one of which was extradural anaesthesia, but no significant differences in mortality between techniques were demonstrated in either the short or long term. However, numbers in each group were relatively small.

Similar comparative mortality and outcome data for total hip replacement do not seem to exist. This is not particularly surprising as, in order to demonstrate differences in mortality, a very large study would be required.

For total hip replacement surgery, spinal and extradural anaesthesia significantly reduce blood loss during operation and may reduce total blood loss and thus requirements for blood transfusion. There is also evidence that regional analgesia reduces the incidence of deep vein thrombosis and possibly also that of pulmonary embolus. Whether this results in an improved outcome is unknown.

Mental function in elderly patients having total hip replacement may be superior after extradural compared with general anaesthesia. Postoperative analgesia may also be superior if extradural “top-ups” can be used.

Particular attention must be paid to systemic arterial pressure and oxygenation at the time of insertion of prosthesis and cement, particularly if central neural blockade has been used.

Thus, extradural anaesthesia is probably the technique of choice for total hip replacement, although no data exist as to whether outcome is actually improved by its use. The ability to use extradural “top-ups” in the postoperative period is a very definite and unquestionable advantage.

The superiority of regional anaesthesia over general anaesthesia for repair of fractured neck of femur is much more debatable. There is no doubt that the deterioration in postoperative arterial oxygenation associated with general anaesthesia is avoided if subarachnoid anaesthesia is used. There is also evidence that DVT incidence is reduced in association with spinal anaesthesia and there is reduced early postoperative mortality. However, the clinical impression of reduction of confusion states associated with spinal anaesthesia in this category of patients is not confirmed by controlled studies and, furthermore, blood loss is not affected by anaesthetic technique. In addition, long term outcome in terms of mortality, bed occupancy and numbers of patients returning home does not seem to be influenced by anaesthetic technique.

In the patient with fractured neck of femur, subarachnoid anaesthesia has certain disadvantages. It may be unpleasant and painful for the patient to be positioned for the block, because of the fracture. A method of reducing the discomfort of positioning the patient for lumbar puncture in the presence of fractured hip is the use of ketamine 20–30 mg i.v. The block may be difficult to perform because of degenerative disease and calcification in the spine, and a failure rate is
inevitable. Of particular concern is the frequency of dehydration in patients presented for surgery of fractured neck of femur. This may lead to sudden and profound decrease in arterial pressure, particularly when spinal anaesthesia is used. Adequate preoperative resuscitation with i.v. fluids is most important to minimize the risks of intraoperative hypotension, but clinical assessment of hydration in the elderly is notoriously difficult. In general, patients tend to receive inadequate preoperative fluids because of the fear of fluid overload.

It is the authors’ opinion that spinal anaesthesia should not be used in fractured neck of femur by inexperienced anaesthetists and, overall, the author feels that general anaesthesia is the recommended technique. However, there is no question that in certain patients, for example with severe respiratory disease, spinal anaesthesia is an extremely useful technique and should continue to be taught to junior anaesthetists by those experienced in its use in the elderly. In any patient having primary hip prosthesis for fractured neck of femur, extreme vigilance should be taken at the time of insertion of prosthesis, particularly if the procedure is performed under regional blockade, and the inspired oxygen concentration should be increased in all patients.

PERIPHERAL NERVE BLOCKS

Peripheral nerve blocks have more to offer in orthopaedic surgery than in any other specialty, both as part of an anaesthetic sequence and also for the provision of postoperative analgesia. In practice, the choice of nerve block is dictated largely by the frequency with which orthopaedic surgeons use a pneumatic tourniquet—the technique chosen must provide analgesia for the resulting ischaemic pain. Although peripheral nerve blocks may be used as an adjunct to light general anaesthesia, they may readily be used alone with the patient sedated, using one of the newer benzodiazepines such as midazolam. Sedation of this type blurs the distinction between general and regional anaesthesia and increases the acceptability of local blocks to patients (and surgeons). Small doses of midazolam (1–3 mg) may be sufficient and larger doses easily produce a confused and restless patient, a situation best remedied by inducing general anaesthesia. At the end of the operation, residual sedation may be reduced using aminophylline (Arvidsson et al., 1984); a specific benzodiazepine antagonist (flumazenil, RO-151788) is expected to be available shortly.

Regional anaesthesia is most readily applicable to the upper limb, since the innervation of the limb is concentrated geographically in the brachial plexus; by contrast the lower limb is served by three major nerve trunks and three or more minor nerves. Also, increasing interest in microsurgical reconstruction of the hand and arm after trauma has led to new demands for regional anaesthesia, principally because of the accompanying sympathetic blockade and consequent vasodilatation.

Brachial Plexus Block

The brachial plexus may commonly be approached by the axillary, supraclavicular or the interscalene routes; the advantages and disadvantages of these approaches are summarized in table I.

Axillary approach

The axillary approach produces fewest complications and is therefore the best choice for outpatient or accident and emergency work. It is, however, less consistently successful than the alternative approaches: the 80% success rate reported by Selander (1977) is typical. Commonest causes of failure are insertion of the needle too deeply and the use of an inadequate volume of local anaesthetic solution. Bryce-Smith (1976) stressed how superficial the neurovascular sheath is in the axilla, where it lies subcutaneously. If inserted too deeply, the needle may enter the axillary artery or pass through the medial intermuscular septum, leaving the axilla altogether. The axial paravascular approach of Winnie (1975) allows insertion of the needle to a greater depth, thus stabilizing the needle during injection, and improves the likelihood of staying within the fascial sheath. The volume of solution injected must be great enough to fill the sheath at the point of injection, extending around the axillary artery so that none of the branches of the plexus escapes block. This may be assisted by compression of the sheath immediately distal to the point of injection by using a tourniquet. Peripheral streaming of the injected solution if this is not done had been demonstrated radiologically by Ang, Lassale and Goldfarb (1984). Winnie (1975) noted that, with the arm abducted, the prominent head of the humerus might compress the sheath posteriorly, denying access to posterior elements of the plexus, and suggested that the degree of abduction of the arm.
### TABLE I. Comparison of the standard approaches to the brachial plexus. (Reprinted with permission from Loach (1983))

<table>
<thead>
<tr>
<th>Approach</th>
<th>Suitable for</th>
<th>Most likely failure</th>
<th>Complications</th>
<th>Contraindications</th>
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<tr>
<td>Axillary</td>
<td>Forearm</td>
<td>Musculocutaneous nerve</td>
<td>Intravascular injection</td>
<td>Infection of the hand or arm</td>
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<td>Supraclavicular</td>
<td>Arm</td>
<td>Median nerve</td>
<td>Pneumothorax</td>
<td>Respiratory disorders</td>
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<td></td>
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<td>Reduction of shoulder dislocations</td>
<td>Stellate ganglion block</td>
<td>Day-case surgery</td>
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<tr>
<td>Interscalene</td>
<td>Arm</td>
<td>Ulnar nerve</td>
<td>Phrenic nerve block</td>
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<td>Shoulder</td>
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<td>Subarachnoid injection</td>
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<td>Extradural injection</td>
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<td>Recurrent laryngeal nerve block</td>
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should be reduced before commencing injection. In a study of the volume required for best results, Vester-Andersen and colleagues (1984) found that 50 ml was superior to 40 ml and that 60 ml was no better. This volume would appear to be larger than the capacity of the sheath, and the anatomical study of Ang, Lassale and Goldfarb (1984) suggests that the perivascular space occupied by the local anaesthetic solution is in fact greater than the neurovascular sheath.

Axillary block gives excellent analgesia of the hand and forearm and is thus most suitable for surgical procedures of the hand and for reduction of forearm fractures. Analgesia for procedures proximal to the elbow is poor and pain from the tourniquet itself may be a problem. This may be treated by an injection of 1% lignocaine along the proximal border of the tourniquet. With this approach, the musculocutaneous nerve which supplies sensation to the radial side of the forearm often escapes blockade because it leaves the plexus early, and for surgery of the forearm it may be necessary to block the nerve peripherally where it becomes superficial at the elbow. Lignocaine 5 ml should be injected s.c. to the intermuscular groove lateral to the tendon of biceps, 2.5 cm from the elbow skin crease.

**Supraclavicular approach**

The supraclavicular approach gives the most consistently good results and, with the modifications suggested by Winnie (1975), is most unlikely to be followed by a pneumothorax. The block is easily carried out, produces more rapid onset of analgesia than either alternative route and more extensive analgesia than the axillary approach. In particular, analgesia is complete for a pneumatic tourniquet, which may be an important advantage when lengthy surgery of the forearm or hand is envisaged. Whilst skin sensation over the shoulder is preserved (this is served by the supraclavicular nerves), analgesia of the shoulder is usually adequate for reduction of dislocations. Although the supraclavicular approach is the most consistent and the quickest in onset, there must always be concern at the possibility of creating a pneumothorax, which is often not manifest for several hours after operation. For this reason, this approach is unsuitable for day-cases and for patients with chronic lung disease.

**Interscalene approach**

The interscalene approach avoids the hazard of pneumothorax whilst providing even more extensive analgesia than the supraclavicular approach. However, serious complications have still arisen, resulting primarily from inadvertent cervical extradural block (Kumar et al., 1971) or total spinal block (Ross and Scarborough, 1973); cardiac arrest has been reported (Edde and Deutsch, 1977). Because phrenic nerve block and hemidiaphragmatic palsy are common, the interscalene approach is again unsuitable for patients with pre-existing pulmonary disease. The block may also be unsuitable for patients with a significant restrictive ventilatory defect, such as that caused by ankylosing spondylitis.

The commonest deficiency of this approach is a failure to block the ulnar nerve. This occurs when the local anaesthetic solution does not track down
the neck to block the C8 and T1 roots. The likelihood of this is reduced if the block is carried out with the patient sitting up, supported by a nurse, and the injected solution is massaged down the neck afterwards.

Peripheral Blocks of Upper Limb

More peripheral nerve blocks at the elbow, at the wrist and of the digits may be used alone in the accident and emergency department to provide analgesia for the surgical repair of trauma, but these blocks may also be used to make good any deficiency in a brachial plexus block so that a surgical procedure can still go ahead under regional anaesthesia. Caution is called for with block of the median nerve at the wrist and the ulnar nerve at the elbow: block at these sites should be avoided in patients with symptoms of compression neuritis.

Intravenous blocks

Intravenous regional anaesthesia (IVRA) is simple and reliable; it is in widespread use, particularly in accident and emergency departments, and is often used by surgeons when an anaesthetist is not available. The technique provides good analgesia for procedures on the forearm and hand whilst the tourniquet remains inflated, but postoperative analgesia is minimal. A series of accidents has led to the introduction of minimal safeguards (DHSS, 1982). It is now established that the most suitable agent is prilocaine, which causes minimal systemic toxicity should it leak out into the circulation, because it is readily metabolized by plasma cholinesterase. The tourniquet should be regularly maintained, old tubing replaced, connections checked for security and the pressure gauge calibrated. The technique may fail in the obese or the hypertensive patient (Ogden, 1984), through failure to achieve arterial occlusion because of arterial calcification (Jeyasseelan, Stevenson and Pfitzner, 1981) or in the presence of a vigorous osseous circulation (Cotev and Robin, 1966) such as might occur in Paget's disease of the bone. Finally, many surgeons find that the exsanguination achieved by this technique is not adequate for fine work on the hand and prefer brachial plexus blockade if regional anaesthesia is indicated.

Regional anaesthesia for microsurgery

Microsurgical reconstructive procedures following trauma to the hand and arm, initially developed in replantation centres throughout the world (Louisville, Munich, Shanghai) are becoming increasingly widespread, and all orthopaedic surgeons in training now acquire microsurgical experience. The prominence of regional techniques as techniques of anaesthesia for these patients is noteworthy, principally because of the vasodilata- tion resulting from sympathetic blockade and the superb postoperative analgesia which avoids the development of vasoconstriction as a result of pain. The brachial block may simply be repeated as often as is necessary, or a catheter may be inserted in the vicinity of the brachial plexus and fixed so that top-ups may be administered as required (Selander, 1977; Lassale and Goldfarb, 1984). Special approaches have been devised to render this easier: a parascalene approach (Vongvises and Panajayanond, 1979), an infraclavicular approach (Sims, 1977) and a longitudinal supraclavicular approach (Hempel, Van Finck and Baumgartner, 1981).

Blocks of the Lower Limb

Regional anaesthesia for the leg is less satisfactory. However, two peripheral blocks are of particular value when used in association with light general anaesthesia: femoral nerve block and ankle block.

Femoral nerve block

Femoral nerve block is easy to perform and carries a very low morbidity. The paravascular approach of Winnie, Ramamurthy and Durrani (1973) has the virtue of blocking three of the nerves supplying the lower limb with a single injection. The block nicely illustrates the novel view of regional anaesthesia advanced by Winnie, who replaces the concept of peripheral nerve block achieved by small injections of more concentrated local anaesthetic precisely placed upon a nerve trunk, with the concept of flooding the appropriate fascial plane with large volumes of dilute local anaesthetic solution. A single injection of 20 ml of local anaesthetic solution beside the femoral artery in the groin will block the femoral nerve, the obturator nerve and the lateral cutaneous nerve of the thigh, all of which share common root values. This block is suitable for easing the pain of fractures of the shaft of the femur and reducing quadriceps spasm, and for providing analgesia for procedures on the knee joint. Arthrotomy and meniscectomy, in particular, are very painful after operation and this pain is very elegantly circumvented by using a femoral nerve block.
Innervation of the knee joint is via the femoral and obturator nerves and the tibial and common peroneal branches of the sciatic nerve. However, the majority of sensation travels in the articular branches of the posterior division of the femoral nerve so that, whilst analgesia is far from complete, postoperative pain is very much reduced with a simple femoral nerve block.

There is a steady increase in arthroscopy of the knee and arthroscopic surgery, and a growing proportion of this work is taking place as day surgery. If a femoral nerve block is used as part of the anaesthetic sequence for arthroscopy alone, then long acting local anaesthetic agents should be avoided if the patient is to go home the following day, whilst for day-case arthroscopy any femoral nerve block will persist and delay the patient’s return home. In general, spinal anaesthesia using a 26-s.w.g. needle (most of the patients are young and lumbar puncture is therefore technically easy) gives excellent results and its use for day surgery was argued by Flaatten and Raeder (1985) and supported by a provocative editorial (Atkinson and Lee, 1985).

Sciatic nerve block

Sciatic nerve block is seldom simple and the best approach remains that of Bryce-Smith (1966). Other approaches, such as from the front or the side (Guardini, Waldron and Wallace, 1985) are clearly desirable so that the patient with a fracture or other painful lesion need not be disturbed. However, these are best carried out using a nerve stimulator to identify the nerve if an acceptable success rate is to be achieved.

Ankle block

Ankle block carried out with separate injections for the anterior tibial nerve and posterior tibial nerve is, again, a simple and useful block. It may be used either as sole anaesthetic for amputations for peripheral vascular disease (using a solution without vasoconstrictor) or diabetes mellitus, or with light general anaesthesia for orthopaedic procedures on the feet, for which a pneumatic tourniquet is used to produce a bloodless field. In each case, useful postoperative analgesia lasting 8 h or more is obtained (Edmonds-Seal, Paterson and Loach, 1980) and patients’ requirements for analgesia thereafter are often met with simple oral analgesics.

Although in this country there is little enthusiasm for regional anaesthesia for paediatric orthopaedic procedures, Serlo and Haapanemi (1985) report high success rates and excellent acceptance of regional techniques in 199 patients, of whom 157 had a brachial plexus block. The children were heavily premedicated and techniques were chosen which did not require active co-operation of the child; suitable doses of local anaesthetics were chosen related to the patient’s weight. However, regional anaesthesia in association with light general anaesthesia has a great deal to offer in this group of patients, since the success rate of blocks is high and the postoperative analgesia is good and minimizes further injections of parenteral analgesics. Replantation of traumatically severed parts is particularly successful in children and is a strong indication for regional anaesthesia.

Finally, safety is just as much a consideration for regional anaesthesia as for general anaesthesia. Disposable needles with a cutting bevel should not be used for nerve blocks, but instead a needle with a straight-cut bevel, which is blunter and tends to separate tissue rather than cut it (Becton Dickenson now manufacture a suitable disposable local needle—so far only in one size and length). Selander, Dhuner and Lundborg (1977) described and photographed the microscopic damage caused to nerve trunks by the passage of a cutting needle; local experience has been that the large nerve trunks such as the sciatic nerve are particularly vulnerable.

The management of systemic toxicity resulting from local anaesthetic agents was outlined succinctly by Moore and Bonica (1985). They stressed the danger of accidental i.v. injection of local anaesthetics and urge that a 10-ml syringe should be used for all injections. This reduces the risk of failure to aspirate blood by invaginating the vein wall to the bore of the needle, forcibly limits the rate of injection of drug and reminds about repeated aspiration. These recommendations were made for extradural anaesthesia, but have relevance for other types of regional anaesthesia also.

REFERENCES


