CHAPTER CONTENTS

17

Local analgesia

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Keywords

Choice of anaesthetic
Digital nerve trunk blocks
Field block anaesthesia
Local infiltration
Nerve trunk blocks
Techniques of administration
Tibial nerve toxicity
Safety considerations

Since the mid-1970s, the use of local anaesthesia by podiatrists has been a routine part of practice and has facilitated the application of many techniques that have been developed to the benefit of the patient. The methods employed range from local infiltration of the anaesthetic agent at the site of the lesion to nerve trunk block techniques that prevent sensory stimulus from the area of the foot the nerve supplies. The choice of method and site of injection depend on factors that are in the best interests of the patient and allow the lowest dosage of anaesthetic agent to be used.

A single site on the weight-bearing plantar surface will generally involve blocking the tibial nerve, whereas a single site on the dorsum can be anaesthetized by local infiltration. However, techniques can be employed whereby local infiltration is used on the plantar surface or is delivered by injecting towards the plantar between the metatarsal heads. Multiple sites on the dorsum may be better anaesthetized by a block of the nerve that supplies the area, which could be the sural, saphenous, deep or superficial peroneal. If both of the latter are to be blocked, it is better practice to block the common peroneal nerve, but it should be remembered that this might also affect motor function in the leg even if the total dosage of the agent used is closely controlled and kept to a minimum.

The most frequently used site for the administration of anaesthetics in the foot are the digital nerves, predominately those of the hallux. The nerve supply to each digit is by four small nerve trunks, two of which supply the dorsum and two the plantar aspect (Romanes 1987). Textbooks of anatomy identify these nerves as having a predictable location, but in many instances they can be shown to have subdivided well before entry to the toes (Bruce-Scott 1989). Their subdivision is usually accompanied by a similar branching of the small blood vessels, which will increase the vascularity of the area into which the injection is to be made.

As a general consideration, before giving an injection to produce analgesia the operator should have a clear understanding of the anatomical structures in the area to be injected, together with possible variations (Wildsmith & Armitage 1987). In addition, the following points should be observed:

- The anaesthetic agent to be injected should be deposited accurately to ensure that it is in effective contact with, and encircling, the nerve trunk. This will ensure that the local anaesthetic agent perfuses into the nerve trunk equally from all sides in a concentration sufficient to ensure the blocking of its central core fibres. These core fibres are responsible for the sensory supply of the most distal area from the site of the nerve block (Covino & Vassallo 1976). This is particularly important in the case of the thicker nerve trunks such as the tibial, the common peroneal and the popliteal nerves. If there are any suspected anomalies, such as early bifurcation of the nerve, the deposition of the fluid should be wider or, if possible, at a point before the bifurcation. To prevent an incomplete blockade (Wedensky block) of nerve conduction it is suggested that 8 mm of the length of the nerve must be bathed in anaesthetic solution (de Jong 1994). The ability to judge the dosage required to achieve this is gained by experience of administration and any temptation to overdose should be resisted.
- To minimize the risk of systemic toxic reactions, every effort should be made to avoid depositing the local anaesthetic intravascularly by aspirating before depositing the local anaesthetic agent. This is particularly important when administering the fluid in highly vascularized sites. The essence of good practice is to use the minimum dosage of the agent to avoid the risks of toxicity and tissue damage, therefore excessive quantities should be avoided.

Local anaesthetic agents in current use are very safe (Dollery 1999) but this safety is always dependent upon an accurate assessment of patients' physical and clinical states, the site of the lesion as well as the type and the composition of the anaesthetic solution (Covino & Vassallo 1976). Before administering a local anaesthetic, the patient's medical history should be clearly established and if there are any doubts as to the suitability of the patient for the dosage, the opinion of the patient's physician should be sought. However, it should be stressed that allergy or adverse reactions to amide anaesthetics are extremely rare and, if reactions do occur, they are usually the result of systemic toxicity, overdose or patient anxiety (Fink 1989). The procedures that should be followed to assess the patient's state of health are discussed in Chapter 2, but particular attention should be paid to the following points:

Drug interactions

Interaction with systemic drug therapy relates mainly to the drugs which impair aspects of the liver's ability to detoxify the anaesthetic agents. Two groups of drugs have this effect, namely the monoamine oxidase inhibitors (MAOI) and the procarbazine drugs. MAOIs are used to control acute depressive states and the procarbazines are antitumour drugs used in the control of Hodgkin's disease and in the treatment of other lymphomas (Dollery 1999). These drugs inhibit the action of the hepatic microsomes, in particular the microsomal cytochrome P450 enzymes responsible for the biotransformation of local anaesthetics to simpler chemical structures (Vickers et al 1984). In the case of procarbazine, drug interaction is less clear as this antitumour agent is usually administered in conjunction with other antitumour drugs (Dollery 1999).

Patients being treated with benzodiazepines should also be treated with special care because, although not a drug interaction, these tranquillizers can act as anticonvulsant drugs and mask the early signs of toxicity (Trimble 1983). If an adverse reaction to the local anaesthetic does occur, the patient may become suddenly and deeply unconscious (Wildsmith & Armitage 1987). Other drugs that can cause problems in association with local anaesthetics are the antihypertensive drugs, such as diuretics. This is not a drug interaction but, because local anaesthetics lower blood pressure (Gianelli et al 1967), and diuretics can cause vasodilation and slower heart rate, postural hypotension can result. Thus the combined effect of local anaesthetics and diuretics may produce a greatly increased risk of fainting when the patient resumes an upright position after treatment.

Steroid therapy

Patients on steroid therapy are more easily put under stress and have lower resistance to infection (Dollery 1999). Such patients will have a card identifying the details of the current steroid therapy. Similarly, patients who are receiving anticoagulant therapy will also carry a card indicating the drug prescribed – they will need special consideration in the control of bleeding. This precaution also applies to those who are haemophiliacs or have other haemorrhagic diseases and to patients with leukaemia, who have a lowered resistance to infection.

Local anaesthetics and pregnancy

Opinion varies regarding the administration of local anaesthetics to pregnant women. It is not seen as a risk in some texts (Dollery 1999), while others (Martindale 1993) maintain that there may be some risk. Provided the pregnancy is proceeding normally and the procedure is seen as an emergency that cannot wait until the conclusion of the pregnancy, and the anaesthetic agent is chosen with care, then the risks are not seen as great. However, as a general rule it is considered inadvisable to use local anaesthetics during the first 3 months of pregnancy.

The choice of anaesthetic agents and the dosage levels applied to the pregnant patient needs to be carefully assessed because of the effects on the fetus via transplacental transfer (Ala Kokko et al 1995). The longer-lasting local anaesthetics in particular, but not exclusively, may not be metabolized so easily due to lack of development of the enzyme systems in the fetal liver. The agent that crosses the placenta most easily is prilocaine (de Jong 1977) and its use should be avoided if possible in such patients.

Liver function

Patients who suffer from impaired liver function from such causes as infective hepatitis or cirrhosis may have a reduced or negative ability to metabolize amide-type anaesthetic agents. It is suggested that it would only be in extreme cases that the liver's metabolic reserve would be compromised (de Jong 1994). Care should be taken in the initial assessment of the patient to establish the possibility of liver disease or alcohol drinking patterns that could have potentially harmful effects. Systemic reactions have been noted in patients with severe hepatic disease (Seldon & Sashara 1967). A consideration associated with liver function occurs in the metabolism of prilocaine. One of its main metabolites is a substance called o-toluidine, which can induce methaemoglobinaemia in humans (Covino & Vassallo 1976). For this reason, high dosage levels of this agent should be avoided.

Renal function

An understanding of the patient's renal function is also necessary, although this is not so important as liver function (de Jong 1994). The kidneys excrete up to 10% of lidocaine and mepivacaine, and up to 16% of bupivacaine, in unaltered form but only 3–6 h after injection, therefore impaired renal function could be a complication to the use of local anaesthetics (Wildsmith & Armitage 1987).

Cardiovascular considerations

Patients with hypertensive cardiovascular disease should not be administered anaesthetic agents containing adrenaline as there is an increased risk of cardiotoxicity (de Jong 1994). Similarly, patients with peripheral vasospastic conditions, such as Raynaud's phenomenon, should not receive anaesthetics with added vasoconstrictors. The tourniquet effect of the anaesthetic fluid in plain solutions encircling the digit must be avoided by using the minimum dosage and a technique that deposits fluid only where needed around the nerve trunk.

Sepsis

Local sepsis at the proposed site of injection precludes the administration of the anaesthetic agent as the passage of the agent through the tissues to the site of its action could facilitate the spread of the sepsis. Around the site of sepsis the tissue pH is usually more acidic. Tissue acidity reduces the quantity of local anaesthetic base that can be mobilized and used to produce anaesthesia. This will inhibit the action of the anaesthetic agent and, as a result, the operator may be tempted to administer higher doses (de Jong 1994). Where an anaesthetic agent has to be used to facilitate the treatment of a septic condition, the site for the nerve block should be as far from the site of the sepsis as possible.

Secondary infections

A number of patients may have a lowered resistance to secondary infections and could be particularly at risk from infection introduced at the site of the injection. The general conditions that may cause this lowered resistance in patients would be nephritis, the anaemias, improperly controlled diabetes and steroid

therapy. Controlled diabetic patients should not be in danger from the use of plain solutions of anaesthetic. Skin preparation before injecting and the use of a suitable postoperative dressing at the site of the injection should be carried out scrupulously at all times.

Epilepsy

Epileptics not well stabilized by drug therapy could be influenced by the stimulation of the central nervous system, which may result from the administration of local anaesthetics. Consultation with the patient's general practitioner before administering a local anaesthetic is strongly advised.

Patient compliance

The administration of local anaesthetics require good patient compliance. Its use in certain groups may require additional justification as the only means of effecting treatment. It may not be suitable for use with the very old or young, the very nervous or hysterical, the mentally impaired and the insane. In all cases where local anaesthetics are used, the patient should have the process clearly explained so that rapport is built up between the patient and the practitioner. In addition to building a rapport between practitioner and patient, obtaining informed consent is the process by which a clear understanding by the patient of the process of the treatment is established and their acceptance of it recorded.

The administration of local anaesthetics does not require the elaborate range of preparations that is associated with general anaesthetics but the patient should be advised only to have a light meal about 4 hours before the procedure. The patient's normal medication can be taken provided it does not interact with the anesthetic agent, as defined by the previous paragraphs on drug interaction. Immediately prior to the administration of the local anaesthetic it is good practice to encourage the patient to empty their bladder. The patient should be advised not to drive for at least 1 hour after the administration of the local anaesthetic (Martindale 1993).

TOXICITY

Toxic effects from the administration of local anaesthetics can be considered to fall into three categories, allergy, systemic toxicity and local tissue toxicity (Covino & Vassallo 1976).

Allergy

A number of reports of suspected allergies have appeared from time to time but these were mainly associated with the ester type of anaesthetics derived from para-aminobenzoic acid. Most researchers suggest that allergy to amide-type local anaesthetics is extremely rare (Covino & Vassallo 1976). Additives are used in local anaesthetic agents that may be the cause of allergy but this, too, is extremely rare (Brown et al 1981). Examples of such additives include agents to alter the pH of the solution or preservatives in solutions stored in multidose bottles.

Systemic toxicity

The most common cause of toxicity is inadvertent injection into the bloodstream. This can be avoided by aspiration when the needle is located and before deposition of the fluid and each time the position of the needle is changed (Wildsmith & Armitage 1987). The toxicity of an anaesthetic agent of the amide type is dependent on its chemical structure and the ability to metabolize it by the liver enzymes. Prilocaine, which is metabolized at a much faster rate than lidocaine, is considerably less toxic. As a result, the practitioner should ensure that their knowledge of local anaesthetics is kept up to date regarding the choice of agent and the subsequent dosage.

The ability of local anaesthetic agents to affect the central nervous system (CNS) produces a range of progressive symptoms. At normal dosage levels, accurately administered, the patient may display the early signs of CNS stimulation, becoming excited, talkative and euphoric, although the first two of these may also be attributed to nervousness. Another symptom is numbness of the tongue and also the tissues around the mouth, this may be ascribed to the highly vascular nature of these areas which provide a focus for a purely local reaction from the anaesthetic in the blood stream.

The first real sign of CNS toxicity is lightheadedness and dizziness, soon to be followed by difficulty in focusing the eyes, and tinnitus. There may be slurred speech, shivering and light muscle twitch in the face and sometimes in the patient's extremities (Covino & Vassallo 1976). The patient may appear to be drowsy, disorientated or even become fleetingly unconscious. Should the toxic reaction continue the patient would become convulsive with generalized tonic/clonic state. Following this, depression of the CNS activity ensues with respiratory depression and arrest of function (Stricharz 1987).

The effects on the cardiovascular system at toxic levels result in decreased myocardial activity and cardiac output, which, combined with peripheral vascular vasodilation, can produce a lowered blood pressure. Toxic reactions resulting from the maladministration of local anaesthetics are usually due to intravascular injection, excessive dosage or careless administration on vascular sites. The treatment of such reactions consists of adequate ventilation of the lungs, and anticonvulsant agents such as diazepam. Vasopressor drugs, such as adrenaline, may be used to support circulation or physical methods may be used if necessary. Physical methods of life support are discussed in Appendix 1. Practitioners intending to use local anaesthetics should become familiar with the procedures for resuscitation of patients and ensure, by attendance at appropriate courses at regular intervals, that these skills are kept up to date (Wynne 1986). However, it is good practice to anticipate the possibility of adverse reactions with careful monitoring of the patient's reactions during the progress of the administration of the agent so that the process may be halted at an early stage.

Local tissue toxicity

Studies have been carried out to investigate the effects of local anaesthetic agents on certain body tissues to determine their potential for irritation (Covino & Vassallo 1976). In high concentrations local anaesthetics can cause haemolysis of red blood cells but this will be at concentrations much higher than are used generally in the UK. It is advisable to remember that if blood is drawn back into the syringe during aspiration it is prudent to discard the remaining anaesthetic agent left in the syringe and, if necessary, replace it with a new supply. Always ensure that the total volume and concentration does not exceed the maximum safe dose.

In studies it has been noted that local anaesthetic agents, again at high concentrations, have caused damage to the sciatic nerves of frogs (Covino & Vassallo 1976). It has also been noted that the preservatives sometimes used in local anaesthetics have caused neurotoxicity with some loss of ability to detect sensation (Gissen et al 1984). There are a few reports of some loss of sensation after the application of local anaesthetics but any neuropathy that develops is more likely to be as a result of trauma from the needle (Arthur et al 1987). Some reports exist of neuropathy after the use of chloroprocaine but it would seem that this was due to the addition of sodium bisulphite as an antioxidant (Covino 1984).

Inadvertent injection of local anaesthetic agents, particularly the longer-lasting agents (Benoit & Belt 1972), into skeletal muscle tissue has been reported as having a short-term effect on the tissue. This seems to be reversible and the effects seem to disappear after 2 weeks (Zener & Harrison 1974). This is an important consideration when locating local anaesthetic drugs close to skeletal muscle.

The effects of added vasoconstrictors are mentioned later.

CHOOSING AN ANAESTHETIC AGENT

The first factor in the sequence is determined by the procedure to be performed, its duration and possible postoperative pain. Procedures of short duration and little postoperative pain can be adequately covered using lidocaine or, if a higher dosage is required, prilocaine, which has a lower level of toxicity. Procedures that require longer time, or those that are perceived to produce unacceptable levels of postoperative pain, may require bupivacaine or etidocaine (where this is available). With both of these, clear instructions for postoperative management are necessary, as there is prolonged loss of sensation and proprioception may be affected.

The potency of a local anaesthetic is related to its lipid solubility, which determines the ability of the agent to penetrate the cell membranes, which present a fatty barrier. Greater lipid solubility increases the duration of action that in turn is also enhanced by the drug's protein binding ability. Lipid solubility also is important in determining the order in which the different fibres of a peripheral nerve are blocked (Wildsmith et al 1985).

Vasoconstrictors

Procedures where a prolonged duration of action is required of an anaesthetic agent without the toxic potential of bupivacaine, the use of an added vasoconstrictor such as adrenaline (epinephrine) may be required. Because of the action of the vasoconstrictor, the toxicity of the local anaesthetic with which it is mixed is lowered as the rate of absorption from the site of the injection is much slower; local tissue ischaemia will also be produced. This ischaemia may increase the risk of local damage to the nerve trunk, although it is thought that this could be due to the addition of sodium metabisulphate, which is added to most solutions containing adrenaline as an antioxidant (Wildsmith & Armitage 1987). Local ischaemic necro-

sis may also result from its use (Dollery 1999). Among the other systemic adverse effects that are possible with the use of adrenaline are anxiety, palpitations, tremors and coldness of the extremities (Dollery 1999). Adrenaline (epinephrine), the most commonly used vasoconstrictor, has systemic effects that are particularly undesirable in those patients with cardiac disease as a result of its effects on blood pressure and heart rate (Dollery 1999). It also can readily cross the placenta (Danon & Sapira 1972) and therefore its use in patients during pregnancy is best avoided (Fan Chung & Barnes 1987). Concentrations of adrenaline greater than 1:200 000 should not be used and it is recommended that the total dose administered should be limited (Jastak & Yagiela 1983).

Procaine

This was the first of the synthesized local anaesthetic agents. It was used extensively until lidocaine and the other amide compounds were introduced. Procaine is an ester-type substance that is metabolized predominantly by the plasma pseudocholinesterases to para-aminobenzoic acid (Van Dyke et al 1976). The duration of action of procaine is short (20–30 minutes) and its chemical structure unstable, particularly in relation to heat. Because of this, a related substance – chloroprocaine – is used because its chemical structure is less likely to cause an allergic response (Covino 1984). Procaine is little used clinically but chloroprocaine is widely used in the US. The use of procaine has largely been superseded by lidocaine.

Lidocaine

The normal preparation of the drug is as a hydrochloride salt; it is one and a half times more toxic than procaine. Its rate of onset is rapid, its effect is more intense and lasts longer than procaine, with effective anaesthesia of up to 3 hours, although this is normally accepted as 1.5 hours (Martindale 1993). The maximum safe dose (MSD) in the UK for an adult male weighing 70 k is 200 mg (approximately 3 mg/kg body weight) in plain solution and 500 mg (approximately 7 mg/kg body weight) with added vasoconstrictors (Table 17.1).

Vasoconstrictor additives are used to prolong its action unless contraindicated by the site of the injection or the patient's state of health. Lidocaine is an amino-acyl-amide and as such is detoxified in the liver with small amounts being excreted unchanged by the kidneys (less than 10%) and in the bile (less than 7%) (Dripps et al 1988).

Table 17.1 Maximum safe dosages (MSDs)

	MSD plain solution (mg)	MSD with vasoconstrictor (mg)	Dose per kg of body weight (mg/kg)
Lidocaine	200	500	3
Bupivacaine	150	150	2
Etidocaine	300	–	4
Mepivacaine	400	–	6
Prilocaine	400	600	6

The maximum safe dosages (after Martindale 1993) in this table are in mg of the agent for a 24-hour period. The MSD in column (1) is calculated on an average body weight of 70 kg based on information applicable to the usage of local anaesthetics in the UK. Variations may be found in other national formularies. The MSD with added vasoconstrictors is also shown where appropriate. For the purposes of administering doses of local anaesthetic a more accurate guideline is to relate the dosage in mg of the agent to kg of the patient's body weight. This takes account of variations in the size of patients and should be a principal consideration when assessing patients of small physique

There are few undesirable interactions with lidocaine although the administration of cimetidine, which inhibits hepatic metabolism, may result on increased plasma levels and toxicity (Feely et al 1982). Cimetidine is a histamine receptor antagonist used in the treatment of peptic ulceration and other conditions where the reduction of gastric acid production is desirable. The principal preparation is Tagamet. Patients receiving this drug should be monitored carefully and the dosage of anaesthetic kept to a low level. Ranitidine (Zantac), used in the treatment of excess gastric acid, also impairs hepatic function and similar caution should be applied (Robson et al 1985). Propranolol (Inderal) also reduces the clearance of lidocaine due to its effect on hepatic metabolism (Bax et al 1985).

Lidocaine is used in podiatry as a surface anaesthetic for very nervous patients (EMLA – a eutectic mixture of lidocaine and prilocaine), for local infiltration or nerve trunk block. It is mainly used by podiatrists in 1% and 2% plain solutions, for local infiltration and nerve trunk blocks, with the exception of digital blocks, with added adrenaline. As a surface anaesthetic it has to be applied to the skin for about 1 hour, after which it is possible to carry out venupuncture relatively painlessly, but usually little else (Wildsmith & Armitage 1987).

Bupivacaine

As with lidocaine, bupivacaine is prepared as a hydrochloride salt. It is four times as toxic as lidocaine

but, when used for specific nerve blocks, it has a duration of action up to 6 hours. The MSD in the UK is 150 mg (2 mg/kg of body weight) and it is generally used in concentrations of 0.25% or 0.50% in plain solution (see Table 17.1). With added adrenaline its duration of action is enhanced and at the same time the quan-tity used may be reduced and the MSD remains the same.

Bupivacaine is used when a longer-lasting analgesic effect is required after techniques that produce some postoperative pain. Its rate of onset is very slow and allowance should be made for this when using it. Over the years bupivacaine has been involved with a number of severe toxic reactions, some of which resulted in fatalities. All of these seem to have been as the result of inadvertent injection into the circulatory system (Covino 1984). Bupivacaine is detoxified in the liver, although about 4–8% is excreted through the urine (Dernhardt & Kondor 1980).

Bupivacaine is an inhibitor of plasma cholinesterase and may increase the toxicity of drugs that are metabolized by that enzyme (Zsigmond 1978).

Etidocaine

This substance (not currently available in the UK) is also a longer-lasting agent with effective analgesia of up to 4 hours duration. Although its duration of action is shorter than bupivacaine, its rate of onset is faster than that of lidocaine, which increases patient confidence in the effectiveness of the anaesthetic agent and thus the operator. It is capable of producing intense motor blockade, probably as a result of its high lipid solubility and, because of its high plasma binding property, it has the lowest transplacental transfer ratio (Martindale 1993).

It is prepared as a hydrochloride salt and is normally used in 1% concentration in plain solutions. The MSD is 300 mg in the UK.

Mepivacaine

This drug has properties that are clinically similar to those of lidocaine. Although it differs chemically, it is prepared and detoxified in the same way. It has a similar duration of action to lidocaine but is less toxic, the MSD is twice as high as lidocaine at 400 mg (for a body weight of 70 kg) and its rate of onset is faster. In ankle block techniques, the higher maximum safe dosage level of mepivacaine is particularly useful in permitting the use of higher volumes when required.

Prilocaine

Prilocaine has properties similar to lidocaine but has the lowest systemic toxicity of all the amide drugs. It is said not to produce any vasodilation and is also metabolized to a limited extent in the lungs (Akerman et al 1966a). Its effect on the CNS and cardiovascular system is less pronounced than lidocaine, but one of the main metabolites of prilocaine, produced in the first stage of its metabolism, is ortho-toluidine, which is considered to be responsible for the production of methaemoglobin in humans (Akerman et al 1966b), however, to produce such an effect it would be necessary to administer in the region of 600 mg, which is far in excess of the MSD (which is 400 mg for the average body weight of 70 kg). This may limit its use in podiatry where patients may not acknowledge the earlier stages of pregnancy and where fetal haemoglobin is more sensitive to this metabolite (Wildsmith & Armitage 1987). It is detoxified in the liver.

TECHNIQUES OF ADMINISTRATION

In podiatric practice, two techniques of administration of local anaesthetic agents are used: local infiltration and nerve trunk block. Infiltration is used to raise an intradermal, or subdermal weal around a superficial lesion, usually on a non-weight-bearing surface, to produce anaesthesia. It may also be used in nerve block techniques to facilitate painless access to deeper nerves. Nerve trunk blocks are most commonly used either to single nerves or in digital blocks.

Having the patient supine can reduce the risk of the patient fainting and, in cases where this happens, of further damage. Some elderly patients, obese patients or those with breathing difficulty may find it preferable to be semi-recumbent rather than laid flat. In addition, this allows the patient to be more relaxed and to be able to divert their gaze away from the operating area. Local skin preparation is important to reduce the risks of bacterial entry through the site of injection. The point of entry and the adjacent skin should be prepared with a suitable antiseptic skin cleanser, which may be preceded with a soap and water wash if necessary. The operator's hands should be washed thoroughly and single-use barrier gloves worn. The site of the injection should be further cleansed with a swab impregnated with isopropyl alcohol, and allowed to dry, immediately prior to the administration of the anaesthetic agent (Wildsmith & Armitage 1987).

The selection of hypodermic needles is important, as the finest needles (25 or 27 gauge), produce the least

pain. However, when it is necessary to advance to a more deeply placed nerve trunk, it may be advisable to use a more rigid needle. The use of blunt needles, i.e. needles produced without the sharp bevelled point or with a bevel at a much steeper angle, to reach deeply placed nerves such as the tibial nerve significantly reduces the danger of nerve damage and inadvertent entry into blood vessels. The use of these needles makes entry through the skin more difficult and makes the use of an intradermal weal essential (see below). In some cases operators use electric stimulating needles, which are useful to locate the site of deep nerve trunks and are of value to the less experienced practitioners. They sometimes may cause the patient some discomfort.

The use of plain solutions of local anaesthetic agents avoids unnecessary impairment of tissue nutrition due to local vasoconstriction when agents with added vasoconstrictors are used. Local anaesthetic agents with added vasoconstrictors, such as adrenaline, should not be used in sites where the blood supply is via end arteries, as in the digits. Accurate location of the site and minimizing the dosage used, coupled with aspiration before injecting will ensure minimal risks of toxic reactions (Bruce-Scott 1989).

Local infiltration

This technique of administration starts with the raising of an intradermal weal at a suitably selected site. This is done by inserting the needle at an angle of 45 degrees to the skin with the bevel uppermost. When the bevel is covered, pressure should be applied to the plunger so that fluid is expelled, sufficient to raise a small bleb or pool of fluid under the skin, which will show white against the surrounding skin. The needle can either be retracted or partially removed from skin contact and realigned to be passed through the skin and directed under the lesion depositing fluid. To ensure an area of complete anaesthesia around the lesion, the needle may have to be withdrawn to the point of entry and passed in other directions under the lesion, in a fan-shaped pattern. Local infiltration is seldom possible on weight-bearing areas of the foot because the subdermal structures will resist the passage of the fluid and the needle.

Nerve trunk blocks

Digital nerve block

The most commonly used form of nerve block in podiatry is the digital block, which, because of the nature of the nerve supply, requires separate consideration. As discussed earlier, the nerve supply to a digit is by way of four small nerves, two serving the dorsal area and two serving the plantar area, which may have subdivided before entering the septal planes of the digit. The techniques discussed assume that the anatomical norm applies; small compensatory deposits, the site of which could be identified by the areas remaining unaffected by the anaesthetic agent, would deal with premature subdivision of the nerve trunk.

The digit should be examined to select two sites on the dorsum so that the medial dorsal and plantar nerves can be reached from one point of entry and the lateral dorsal and plantar nerves can be reached from the other (Fig. 17.1). At the same time, it is useful to mentally subdivide the proximal phalanx into thirds, so that the site of injection will be over the proximal end of the medial third. At this point the phalanx is usually at its narrowest and will allow the easiest access to the plantar nerve trunk with the least possibility of striking the phalanx with the needle and possibly causing damage to the periosteum.

The amount of fluid required to raise the intradermal weal is unlikely to exceed 0.25 ml each site. The needle should then be directed towards the point of entry for the weal at a steeper angle (closer to 90 degrees) and towards the dorsal nerve trunk. After aspirating the syringe to ensure the needle is not inserted into a blood vessel, approximately 0.5 ml of fluid should be deposited slowly and steadily. Upon completion of this, the needle should be withdrawn. Aspiration should be carried out before each deposition of anaesthetic agent. If, on aspiration, blood is seen to enter the barrel of the syringe, no further use of that fluid and syringe should be made. This precaution is to protect against the remote possibility of re-entry into another blood vessel and the consequent deposition of damaged blood cells into the circulation.

The needle should be inserted through the original point of entry and advanced towards the plantar (see Fig. 17.1) until it is located over the nerve and up to 0.5 ml should be deposited around each nerve trunk. Satisfactory anaesthesia should be possible with up to 2.5 ml of a 2% anaesthetic agent. It is important in digital anaesthesia to avoid depositing excessive amounts of fluid or encircling the digit with a subdermal ring of fluid and producing a tourniquet effect, with risks in restricting circulation.

This two-point entry technique is a modification of the Stockholm technique. Although the lesser digits seem to allow further modification of this technique to a single entry on the dorsum, it is a modification capable of pro-

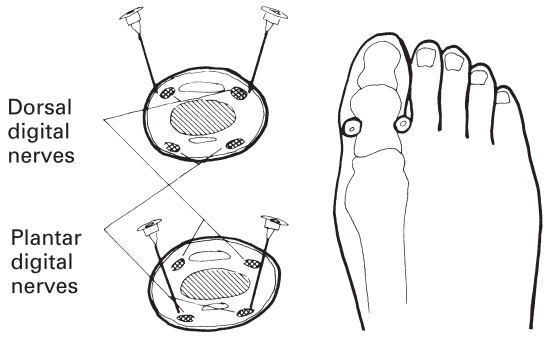

Figure 17.1 Location of dorsal and plantar digital nerves and sites for intradermal weals.

ducing internal damage and it is better to retain two points of entry.

Upon completion of the injection procedures, it is better to delay testing for loss of sensation until a digital hyperaemia appears, as this indicates the blockade of the sympathetic fibres and the onset of sensory loss. The patient may describe the toe as having a numb or tingling sensation. Delaying testing for sensation until the outcome is more predictable will ensure greater patient confidence in the whole process.

Specific nerve block

Anaesthesia of all or part of the foot may be obtained by selective nerve trunk blocks. The sensory supply from the larger nerve trunks should be more predictable, but areas on the margin may be served by more than one nerve trunk, making careful testing of the anaesthetic effect essential. The larger size of the nerve trunks allows them to be located accurately by palpation; digital pressure on the site will produce distal paraesthesia, which can be helpful in identification.

This precision in locating the nerves reduces the necessity to use large quantities of solution by enabling it to be deposited accurately as well as minimizing the risk of failure of the blockade. The increased size of the blood vessels that often accompany the nerve trunks necessitates exact location of the hypodermic needle to avoid intravascular injection (Fig. 17.2).

The raising of an intradermal weal is not always seen as essential but it allows pain-free relocation of the needle should this be necessary. Deposition of the fluid at the site should be slow, to minimize discomfort from the disruption of the fascial planes. The volume employed can be reduced to about 0.5 ml but it is

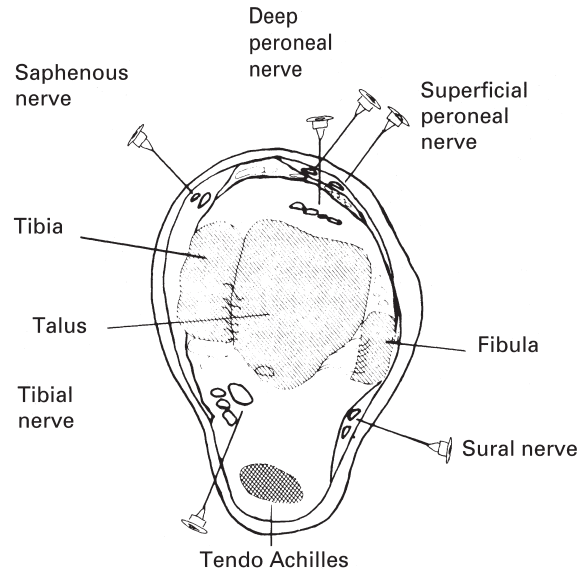

Figure 17.2 Location of the nerve trunks at a transverse plane through the ankle joint.

advisable to use higher concentrations to ensure an adequate length of blockade. Where suitable, the use of an added vasoconstrictor will allow a lower concentration of the agent. The nerves that can be blocked are the:

- tibial nerve
- sural nerve
- saphenous nerve
- deep peroneal nerve
- superficial peroneal nerve (before or after subdivision)
- common peroneal nerve.

The tibial nerve (Fig. 17.3). At the ankle, the tibial nerve passes behind the medial malleoleus, lying laterally to the posterior tibial artery. As it passes behind the flexor retinaculum, divisions start to take place into its three terminal branches (first the medial calcaneus, then the medial and lateral plantar nerves). Examination of cadavers shows that this bifurcation can take place proximally to the flexor retinaculum in a significant number of cases (Romanes 1987). In view of this the best clinical practice is to locate the nerve slightly proximally to the medial malleolus (approximately 2.5 cm from the central point of the medial malleolus towards the shaft of the tibia). On most patients, it is possible to elicit paraesthesia using digital pressure, thus confirming the location for injecting the anaesthetic agent. Some practitioners use

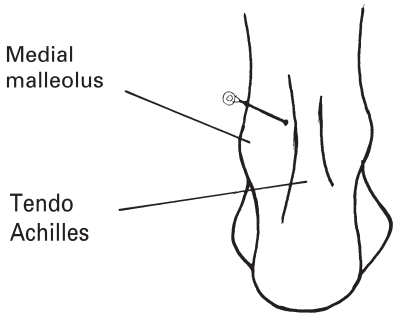

Figure 17.3 Site of injection for the tibial nerve.

low-voltage stimulating apparatus to locate the nerve trunk as described earlier, and this can be useful in the early stages for less experienced practitioners.

Where the nerve passes behind the medial malleolus, or just a little proximal, is usually the best site to locate it. The raising of an intradermal weal at the point of entry assists the operator in locating the needle accurately and allows it to be advanced slowly. The use of the blunt (non-sharp) needles allows the nerve to be located by eliciting paraesthesia while the risk of penetrating the artery or damaging the nerve trunk is much reduced. Once the patient has felt paraesthesia the syringe can be aspirated – an essential safeguard in this site (Zenz et al 1988). Blockade of this nerve can be effected using 2 ml of a 2% solution of lidocaine but it is sometimes helpful, where accurate location cannot be assured, to use a 1% solution, which allows greater volume to be deposited. It is also helpful to use local anaesthetics with added adrenaline which also can reduce the volume necessary.

The sural nerve (Fig. 17.4). This nerve is located on a line between the lateral aspect of the tendo-Achilles and the lateral malleolus. It is closely associated with the course of the short saphenous vein. Its sensory supply is to the lateral aspect of the foot, the fifth toe and, in a significant number of instances, a small portion of the lateral aspects of the calcaneal area. It may have subdivided into a number of its terminal branches and this, combined with its passage over relatively well covered areas, makes palpation difficult but not impossible. In most instances it can be located and blocked using small amounts of anaesthetic but occasionally, due to early bifurcation, it is necessary to lay a 'track' of fluid between the lateral malleolus and the lateral aspect of the tendo-Achilles (Fig. 17.4). Even the latter can be accomplished using 0.5 ml 2% solution. It is generally better to initiate the process with an intradermal weal.

The saphenous nerve (Fig. 17.5). This terminal branch of the femoral nerve supplies the medial aspect of the dorsum of the foot, occasionally extending to include the surface over the medial side of the metatarsophalangeal joint. It is found on entering the foot on the anterior aspect of the medial malleolus closely associated with the great saphenous vein (Bruce-Scott 1989). It is not easily located but it is possible to produce paraesthesia and thus locate the nerve by applying pressure at a site close to the vein on the anterior aspect of the medial malleolus.

The raising of a weal on the surface midway between the tendon of the tibialis anterior and the great saphenous vein (Fig. 17.5) allows the needle to be advanced towards the medial malleolus where, after aspirating, the local anaesthetic should be deposited close to the vein. Effective blockade of the nerve is

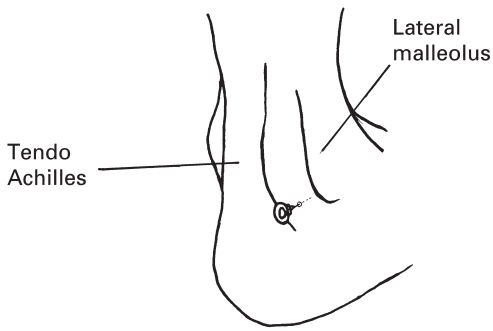

Figure 17.4 Site of injection for the sural nerve.

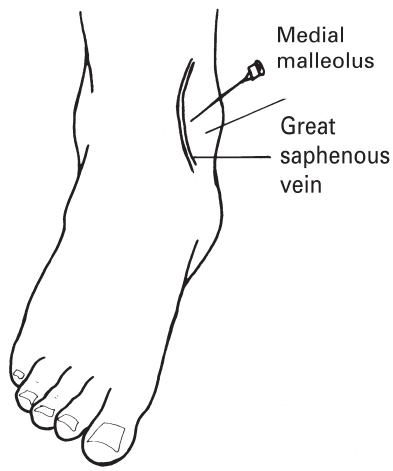

Figure 17.5 Site of injection for the saphenous nerve.

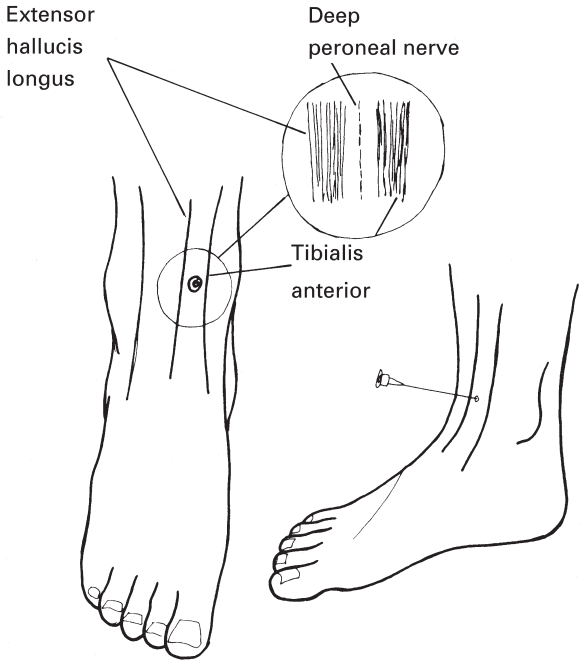

Figure 17.6 Site of injection for the deep peroneal nerve.

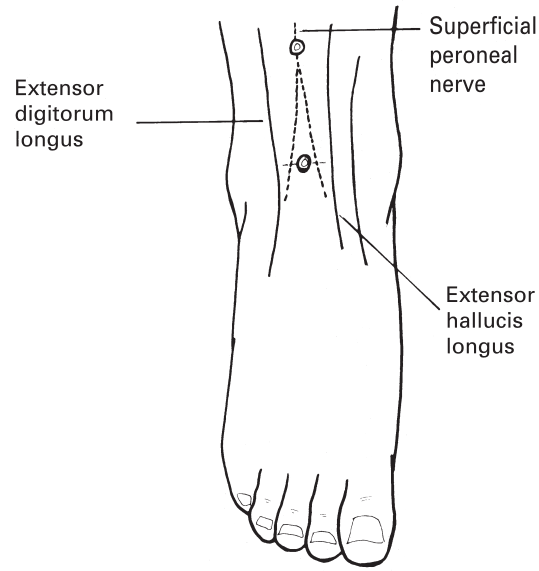

Figure 17.7 Site of injection for the superficial peroneal nerve.

possible with 0.5 ml of 2% solution, however, it may be necessary to use up to 1.5 ml of the solution.

The deep peroneal nerve (Fig. 17.6). This nerve is located lying deep to the anterior tibial artery placed between the tendons of the tibialis anterior and the extensor hallucis longus. This nerve, which is a terminal branch of the common peroneal nerve, has a very limited range of sensory distribution, usually supplying the opposing sides of the hallux and the second toe.

The artery may be located easily by palpation or by using Doppler apparatus. An intradermal weal should be raised over the site (Fig. 17.6), which will allow the needle to be advanced to one side of the artery. At this point it is possible to detect the force of the flow of the blood through the expansion of the artery and soon the patient should experience paraesthesia. In some instances paraesthesia is not felt and the needle should be advanced steadily until resistance is felt from the tibia. With either resistance or paraesthesia the needle should be withdrawn slightly (approximately a millimetre).

Holding the point of the needle steady in this position the syringe should be aspirated and, if this is clear, a suitable dose of the fluid deposited. This is usually about 1 ml of 2% solution. There may be some resistance to the fluid being deposited because of the closeness of the septal planes.

The superficial peroneal nerve (Fig. 17.7). This nerve, also a terminal branch of the common peroneal nerve, becomes subdermal at the proximal end of the lower one-third of the leg on the anterolateral surface. It is possible to produce paraesthesia at this site by applying firm pressure. On becoming superficial the nerve quickly divides into a medial and lateral branch and is responsible for the sensory supply to the lower anterior surface of the leg, as well as most of the dorsal aspect of the foot.

As the nerves pass into the foot, the medial branch lies immediately lateral to the tendon of the extensor hallucis longus. The lateral branch lies lateral to these structures at the same level.

The branches may be anaesthetized using small quantities of fluid (approximately 1 ml of a 2% solution) at either of the sites described or where the nerve becomes superficial in the lower part of the leg.

The common peroneal nerve (Fig. 17.8). This nerve, arising from the popliteal fossa, passes over the neck of the fibula before dividing to become the deep and superficial peroneal nerves. Where the nerve curves around the neck of the fibula it can be palpated easily, and access to it is simple because it is in a situation not complicated by the presence of major blood vessels. Raising an intradermal weal allows the needle to be

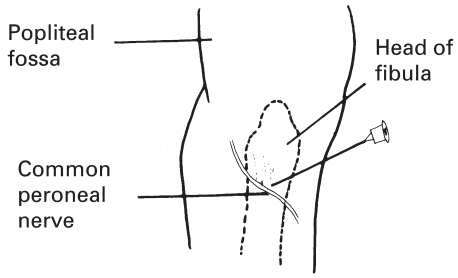

Figure 17.8 Site of injection for the common peroneal nerve.

advanced slowly towards the nerve (Fig. 17.8). Satisfactory anaesthesia can be obtained with 1 or 2 ml of 2% solution. Using the common peroneal nerve reduces the number of injections when both the deep and superficial nerves have to be blocked and reduces significantly the total dosage of anaesthetic agent required.

FIELD BLOCK ANAESTHESIA

This involves the blocking of nerve conduction to a whole segment of the forefoot, usually from the level of the base of the metatarsals. It is sometimes referred to as Mayo block or ray block. The location of the nerves at these sites is more predictable but is complicated by the close association of the nerves and the blood vessels and the necessity of having to pass through the dorsal and plantar interosseous muscles as well as the plantar intrinsic muscles. Variations in location may make it is necessary to lay a 'track' of anaesthetic fluid so it is essential that the needle is withdrawn along the same line as it was advanced, due consideration being given to the vascularity of the site. Variations in the location of the plantar nerve may make it necessary to supplement with a block to the tibial nerve.

The most commonly used field block in the foot is that to the first metatarsal segment and it is this that is referred to as a Mayo block. Blockade of the fifth metatarsal segment is less common, as is that to the other metatarsal segments, but all of these are described as they have minor variations in technique.

The dosage of anaesthetic substance may be quite high, with 6–8 ml of 2% lidocaine being normal for a profound blockade of a metatarsal segment. It may be necessary to use an anaesthetic agent with an added vasoconstrictor as the vascularity of the area reduces the effective time for anaesthesia. Patients who have a lower body weight may necessitate the use of lower

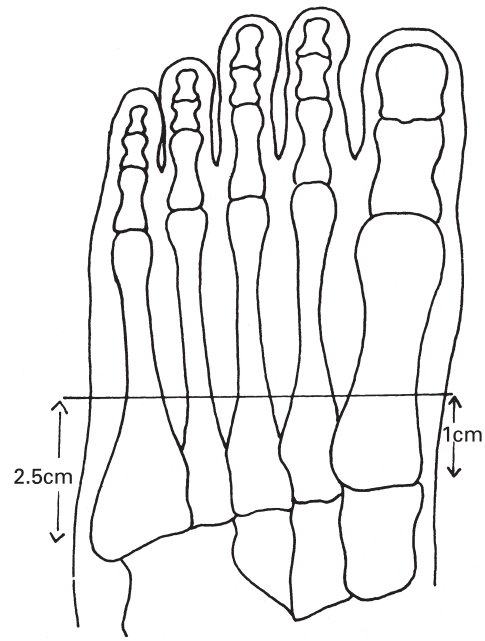

Figure 17.9 Guideline to intermetatarsal route.

percentage concentrations to avoid breaching the maximum safe dosage of the anaesthetic.

Anaesthetic block of the metatarsal segments involves the passage of hypodermic needles between the shafts of the metatarsals close to their base, thus it is necessary to establish clear clinical guidelines to determine the optimum passage between the bones. A simple guide is to locate a point on the medial aspect of the first metatarsal about 1 cm distal to its base, and a point on the lateral aspect of the fifth metatarsal, 2.5 cm distal to its base (Fig. 17.9). A line drawn between these two points will ensure clear passage between the shafts.

First ray or Mayo block

The nerve supply to the first metatarsal segment is from one of the terminal branches of the deep peroneal nerve (dorsolateral) with the other terminal branch supplying the dorsomedial aspect of the second metatarsal segment. The dorsomedial aspect of the first segment is supplied by the medial terminal branches of the superficial peroneal and in some cases terminal branches of the saphenous nerve. The terminal branches of the tibial nerve supply the plantar aspect of the first segment.

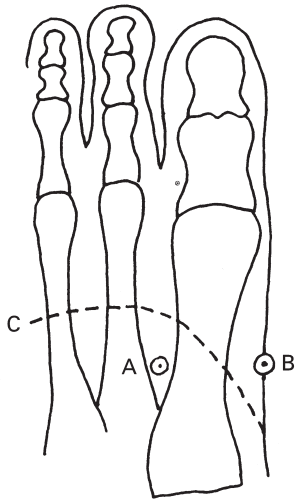

Figure 17.10 Site of injection for first ray block. A and B show the positions of the intradermal weals and the dotted line C is the line of the venous arch.

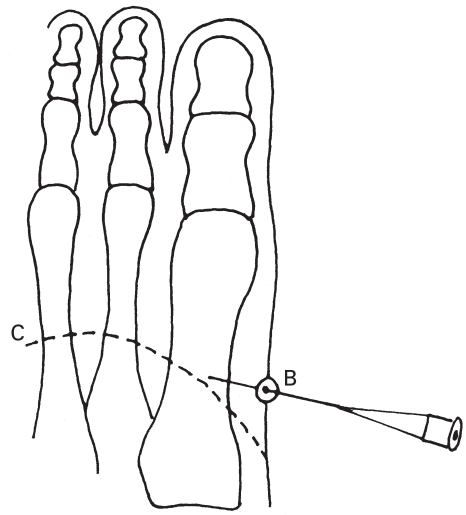

Figure 17.11 Anaesthetizing mediodorsal nerve trunks.

The nerve supply to the medial plantar aspect of the segment is superficial at the base of the first metatarsal and medial to the plantar aponeurosis. The nerve supply to the lateral plantar aspect of the segment lies deep to the plantar aponeurosis at the level of the base of the first metatarsal and is the second terminal branch of the medial plantar nerve.

The venous arch over the dorsum of the foot provides a good visual guide to locate the various nerves when used in conjunction with the osseous landmarks of the base of the first metatarsal. Using these two features it is possible to identify the two optimum sites of entry on the dorsum between the first and second metatarsals (point A; Fig. 17.10), and on the medial aspect of the first metatarsal shaft (point B; Fig. 17.10) where intradermal weals, to facilitate entry, can be raised. The dotted line (C; Fig. 17.10) represents the line of the venous arch.

To anaesthetize the dorsomedial branches of the first metatarsal segment, the hypodermic needle should be passed through the intradermal weal (B; Fig. 17.10) and directed towards the point where the venous arch crosses over the tendon of the extensor digitorum longus, where the major trunk will be located. After aspirating, up to 1 ml of the anaesthetic agent should be deposited and the needle should then be withdrawn steadily and unhurriedly, leaving a 'track' of fluid all the way up to the point of entry (Fig. 17.11). This will ensure that any small irregular branches are anaesthetized.

Using the same point of entry, the needle should now be advanced laterally over the plantar surface of the metatarsal to a point in line with the lateral aspect of its base. This should be close to the medial edge of the plantar aponeurosis (Fig. 17.12). Aspiration should not be necessary at this site and about 1–1.5 ml of anaesthetic fluid should be deposited. As the needle is withdrawn, continue to deposit the fluid leaving a 'track' to deal with any irregular branches of either the

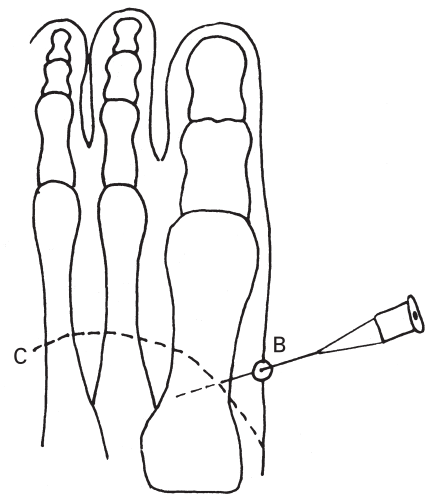

Figure 17.12 Injection site for medioplantar nerve supply to the first ray.

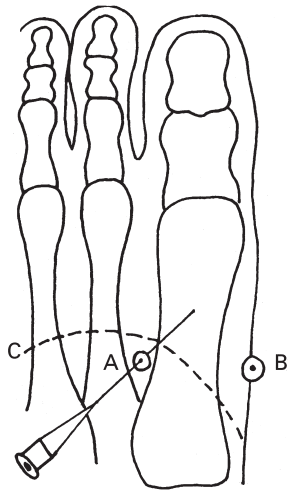

Figure 17.13 Direction of the needle for terminal branches of the superficial peroneal nerve (dorsolateral nerve supply).

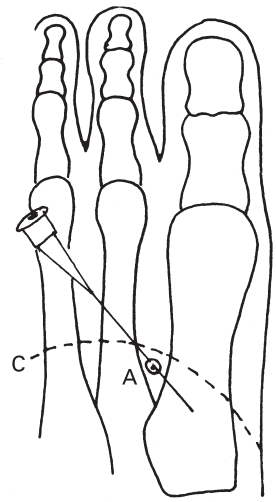

Figure 17.14 Injection to anaesthetize the deep peroneal nerve (dorsolateral nerve supply).

medial plantar nerve or the saphenous nerve that may be found at that level. This process will complete the blockade of the plantar medial aspect of the segment.

Small terminal branches of the superficial peroneal nerve often supply the dorsolateral aspect of the first metatarsal segment and it is necessary to ensure that these are also blocked. To accomplish this, the needle is passed through the intradermal weal (Fig. 17.13) and is directed medially over the surface of the metatarsal shaft towards the point where the venous arch crosses the tendon of extensor hallucis longus. At this point about 0.5 ml of the anaesthetic agent should be deposited after aspirating and the needle withdrawn, keeping positive pressure on the plunger so that a 'track' of fluid is left to catch any irregular nerve supply which may be present (Fig. 17.13).

To complete the dorsal block, it is now necessary to pass the needle through the intradermal weal (Fig. 17.14) and direct it towards the base of the first metatarsal shaft. It is necessary to ensure that the numerous vessels are avoided and that aspiration is carried out before depositing usually about 1 ml of the anaesthetic. On withdrawal of the needle it is essential not to deposit a 'track' of fluid in case of inadvertent intravenous injection in this vascular region.

The remaining nerve trunk serving the first metatarsal segment is the second terminal branch of the medial plantar nerve, which also serves the medial aspect of the second ray segment. The best palpable indicator of its position is the tendon of the flexor hallucis longus, to which it runs parallel at a distance of 8 to 10 mm on the lateral side.

Entry should be made through the intradermal weal (Fig. 17.15) and the needle directed in an anteromedial direction towards the plantar surface of the foot between the metatarsal shafts. The target area is the lateral aspect of the distal one-third of the metatarsal shaft and it will be necessary to pass through the

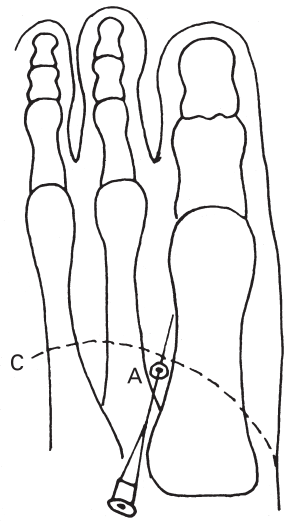

Figure 17.15 Injection to anaesthetize the second terminal branch of the medial plantar nerve.

muscle of the flexor digitorum brevis. Once the needle is considered to be in position then up to 2 ml of the anaesthetic should be deposited slowly. On withdrawal of the needle the plunger of the syringe should not be depressed in case of inadvertent intravascular injection.

Fifth ray block

Nerves from three sources supply this segment. The lateral branch of the superficial peroneal nerve supplies the medial dorsal aspect; the terminal branches of the sural nerve supply the lateral, the dorsal and, in some cases, the lateral plantar aspect. The plantar and, in most cases, the lateral plantar aspect of the segments are supplied by the lateral branch of the lateral plantar nerve, which lies superficial to the plantar aponeurosis, parallel to the line of the flexor digitorum brevis. The medial plantar aspect of the segment is supplied by the medial terminal branch of the lateral plantar nerve, which also supplies the lateral plantar aspect of the 4th metatarsal segment.

Two intradermal weals are necessary, with the first site placed proximally to the venous arch (Fig. 17.16) over the space between the two metatarsal shafts, where it will give access to the terminal branch of the superficial peroneal nerve as it lies superficial and medially to the tendon of the extensor digitorum longus (Fig. 17.17). It also allows access to the medial branch of the lateral plantar nerve by passing between the 4th and 5th metatarsal shafts and through the dorsal and plantar interossei muscles (Fig. 17.18). Because of the vascularity of the area it is necessary to aspirate before depositing the agent. Approximately 1 ml of the fluid should be adequate for anaesthesia and, again, as a result of the vascularity fluid should not be expelled on the withdrawal of the needle.

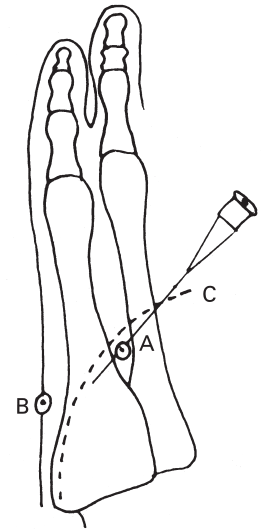

Figure 17.17 Injection site for the terminal branch of the superficial peroneal nerve.

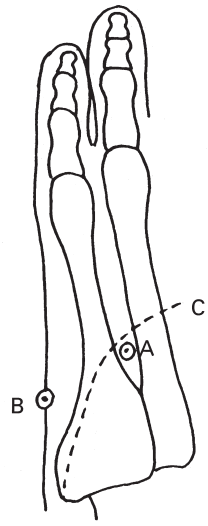

Figure 17.16 Sites for intradermal weals in the fifth ray block.

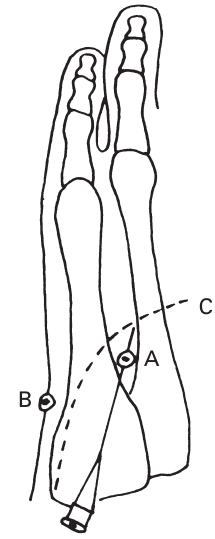

Figure 17.18 Injection towards the medial branch of the lateral plantar nerve.

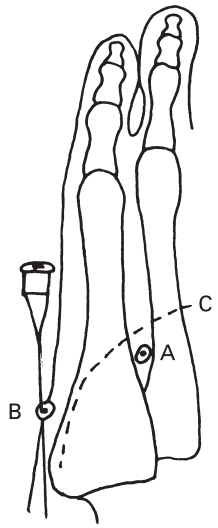

Figure 17.19 Injection towards the terminal branches of the sural nerve.

The terminal branches of the sural nerve are blocked by inserting the needle through the intradermal weal (Fig. 17.19) and advancing it posterodorsally towards the lateral side of the venous arch, avoiding penetration of the vessel. After depositing approximately 1 ml of the anaesthetic the needle should be withdrawn slowly, leaving a large 'track' of the fluid to block any irregular branches (Fig. 17.19).

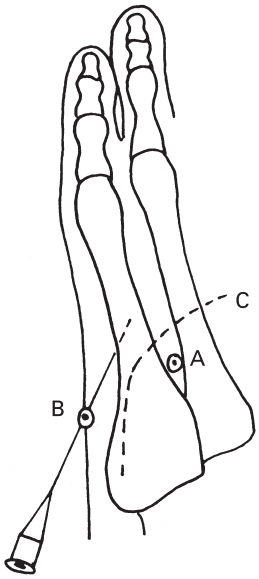

Figure 17.20 Injection site for the lateral plantar nerve.

The lateral branch of the lateral plantar nerve is also reached through the same intradermal weal (Fig. 17.20). The needle should be advanced anteromedially towards the line of the flexor digitorum longus. Once on site about 1 ml of the fluid can be deposited and the needle withdrawn, leaving a 'track' of fluid, as before, up to the point of entry. This should ensure that any small irregular nerves will be blocked (Fig. 17.20).

Middle ray blocks

To block the 2nd, 3rd and 4th metatarsal segments only minor modification of the techniques described is required. The 3rd/4th segments are usually supplied dorsally, on the medial and lateral borders, respectively, by the medial terminating branch of the lateral branch of the superficial peroneal nerve, which normally passes superficially to the venous arch. The plantar supply is from the lateral branch of the medial plantar nerve but may also be supplied from the lateral plantar nerve.

Both the dorsal and the plantar nerves may be reached from the intradermal weal sites (A) and (B) in Fig. 17.21. The line indicated by (C) in the same figure is the approximate line of the venous arch. On the plantar sites the nerves are accompanied by a number of blood vessels, making aspiration essential. Similarly

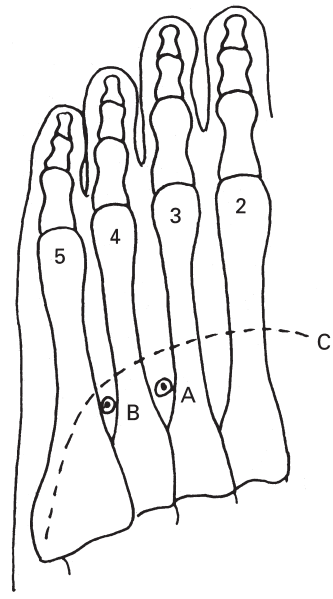

Figure 17.21 Sites of intradermal weals for the fourth ray block.

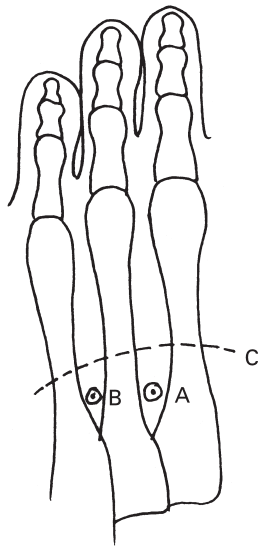

Figure 17.22 Sites of intradermal weals for the third ray block.

fluid should not be expelled from the needle as it passes through the tissues. The plantar nerves are located deeply to the plantar aponeurosis and the dosage of approximately 1 ml of anaesthetic should be delivered slowly to minimize disruption of the tissues and discomfort to the patient.

Anaesthesia of the 3rd metatarsal segment can be accomplished by raising intradermal weals at the sites indicated in Fig. 17.22 and following the same general directions as above. The 2nd metatarsal segment can be anaesthetized by raising intradermal weals at the points indicated in Fig. 17.23. The technique described in the first ray procedure for the deep peroneal nerve also needs to be applied.

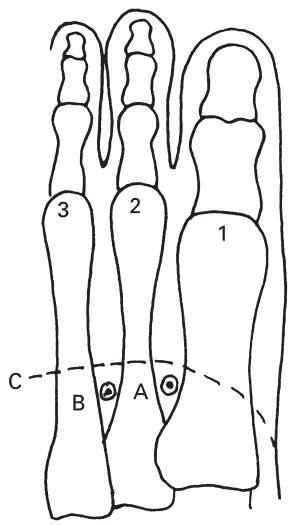

Figure 17.23 Sites of intradermal weals for the second ray block.

A general consideration, which applies to all the procedures described for ray blocks, is the location of the nerve supply deriving from the medial and plantar nerves and the proximity of the injection site to a very well-vascularized area. In addition to this there is the need to pass needles through muscle tissue to reach the sites. One way to minimize this risk is to block the tibial nerve as it passes behind the medial malleolus. At this site the nerve is more easily accessible and generally it is possible to administer a low dose of the agent. Ultimately, the site chosen must reflect the clinical needs of the patient and the limitations imposed by the procedure.

POSTOPERATIVE SUPERVISION

It is important to ensure that the patient is properly advised of all of the outcomes of the procedure that has been employed. Although the possibility of adverse results from the anaesthetic are rare it is wise to ensure that the patient has clear instructions in written form. This should also be explained to the patient before they leave the surgery and give details regarding the steps to be taken in case of problems arising, including emergency telephone numbers. It is also important to ensure that it is possible for the patient to have easy access to the practitioner who carried out the procedure in the 48 hours immediately after the procedure. Wherever possible, procedures that may have follow-on effects should not be performed close to holiday weekends.

SAFETY CONSIDERATIONS

The administration of local anaesthetics using syringes and needles imposes the obligation on the operator to apply stringent safety precautions to prevent the possibility of needle-stick injuries to the operator or the patient. Opinion varies on the methodology for containing the dangers and every effort should be made to ensure that the latest local and national regulations are known and applied.

The person administering the local anaesthetic should ensure that the material drawn up into syringes is correct. In the case of cartridges, the writing on each cartridge should be checked. Each container of local anaesthetic should be retained until the end of

the procedure and the details on them recorded in the patient's notes. If the containers all have the same details they need be recorded only once. All local anaesthetic substances should be transferred from the manufacturer's container to the syringe. They should not be decanted into galley pots.

All sharps should be discarded in the approved way in designated sharp disposal containers, which should ensure that they do not pose a risk to cleaning staff and others who are concerned with the control of the surgery. Syringes should not be held in the hand apart from when being used or transported to their container. The re-sheathing of needles after use is considered to constitute a risk of needle-stick injury to the operator and the use of needle holders is recommended.

The operator must wear suitable barrier gloves.

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