Intravenous Retrograde Anesthesia

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Intravenous retrograde anesthesia (IVRA) of the limbs is an anesthesiological technique performed for the first time by Bier in 1908, who enjoyed a certain measure of success only after 1946, which was the year when new, less toxic local anesthetics became available on the market.

It is a technique that is easy to perform with failure rates below 1 % and is used in surgical operations on the forearm, hand, leg and foot lasting not more than 90 min. It is particularly indicated in allergic patients or in patients with COPD, in patients with a full stomach and in outpatient surgery.

The technique is based on the injection of an anesthetic solution into the vein of the limb to be submitted to surgery and rendered ischaemic at the root. It has a short onset time and affords good muscle relaxation.

The mechanism whereby the anesthesia sets in with this technique is still controversial. There are two different theories:

- peripheral: penetration of the local anesthetic injected, via the vasa nervorum and the capillaries, into the nerve trunks with distal block and subsequent penetration of the peripheral fibres with retarded proximal blockade;
- truncular: distribution of the anesthetic mainly at the level of the joint of the limb.

The most likely hypothesis is the peripheral theory inasmuch as the local anesthetic reaches both the main nervous system and the peripheral nerve endings via the vascular route. A number of authors, on the other hand, have proposed nerve ischaemia as the mechanism of action of IVRA, but this is only suggestive in that the onset varies in relation to variations in the local anesthetic used.

To shorten the latency of the block, an adjuvant such as sodium bicarbonate (alkalinization) can be used in conjunction with the local anesthetic as well as an analgesic agent for prolonging the analgesia (local peripheral action).

12.1 Indications and Contraindications

The characteristics and advantages of IVRA indicate it, if properly executed, as the technique to be preferred in outpatient surgery and in urgent operations on the distal segments of the limbs.

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IVRA is contraindicated when it is impossible to obtain satisfactory arterial occlusion in the presence of:

- major obesity (BMI >35);
- severe hypertension;
- major arterial calcifications;
- intolerance or allergy to local anesthetics.

It is not indicated in patients with:

- drepanocytosis;
- acute ischaemia of the limb;
- BAV grades II–III, not conducted;
- infectious cellulitis;
- arteritis;
- ischaemic cardiopathy; and
- severe liver failure.

12.2 Advantages and Disadvantages

The advantages of this technique are mainly related to its ease of execution, and the minimal complication rates and side effects, together with good stability of the vital functions, rapid onset of anesthesia, rapid reversibility, muscle relaxation and low cost.

Patient bed rest, fasting and postoperative somnolence are to be avoided. After a few hours, the patient can return home in a state of perfect well-being.

The disadvantages, on the other hand, are due to the potentially severe systemic toxic effects, the patient's poor tolerance of the tourniquet cuff (sometimes even painful), the short-lasting surgical time and the impossibility of controlling the surgical haemostasis before removing the cuff.

12.3 Technique

The preparation of the patient, as in the case of all anesthesiological procedures, entails the performance of laboratory examinations with coagulation screening, ECG and the preoperative anesthesiological visit, with the signing of informed consent. Chest X-rays can be omitted.

The technique must be performed after first monitoring the patient's vital parameters (ECG, blood pressure, SpO_2) to be maintained throughout the entire intervention.

A vein of the upper limb not involved in the intervention is cannulated for the fluid therapy and the administration of drugs; we then proceed with the premedication.

The vein is then sought for the execution of the technique as close as possible to the surgical site and a small-calibre (e.g. 22 G) needle cannula is positioned—equipped with an occlusion system—which is fixed to the skin (Fig. 12.1).

In order to avoid the entry of local anesthetic into the systemic circulation, also via the interosseous vessels, before it is completely absorbed, a double-cuff tourniquet with independent inflation control is applied above the main joint of the limb (elbow or knee) (Figs. 12.2, 12.3), or, failing that, two pneumatic cuffs at a distance of approximately 10 cm from one another and connected up to an inflation system capable of maintaining constant pressure of the cuffs throughout the entire procedure (e.g. the Tourniquet System produced by Officine Rizzoli in Bologna).

12.4 Drugs

The most commonly used local anesthetics are, in order of frequency of use, lidocaine (2–3 mg/kg bw), levobupivacaine or ropivacaine (0.25 mg/kg bw) and mepivacaine (1 mg/kg bw).

Bicarbonate solution is used for alkalinization, and opioids, NSAIDs or clonidine for prolonging the analgesia.

12.5 Procedure

First of all, the limb is rendered ischaemic either with the Esmarch bandage or by keeping the extremity of the arm raised for 10–15 min (Fig. 12.4). The proximal cuff is then inflated up to a pressure of at least 100 mm Hg above the patient's systolic pressure.

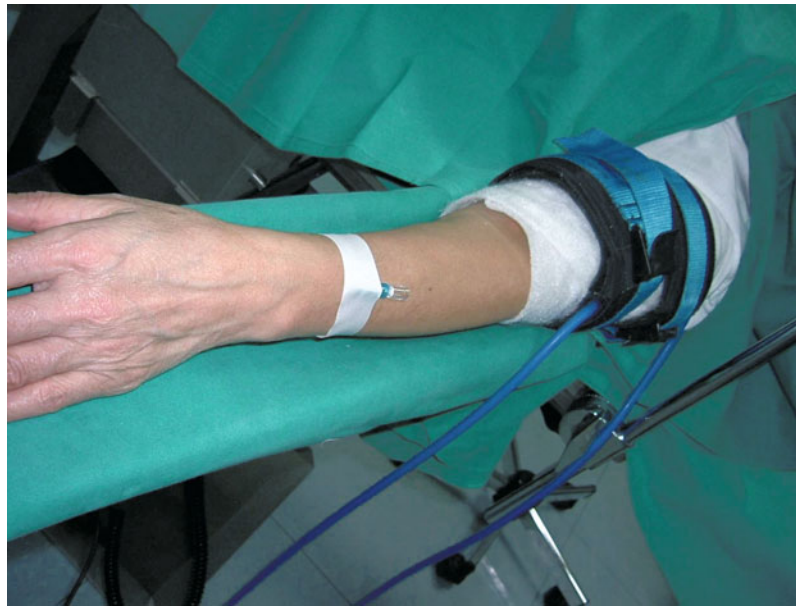

Fig. 12.1 Position of the needle cannula for injecting the anesthetic

Fig. 12.2 Electronic tourniquet (double-cuff type). G&M Tech Inc.—Gunpo City, Gyeonggi-do 435-632 Korea

After verifying the perfect sealing of the cuff, the limb is brought back to the resting position and the previously prepared anesthetic solution is injected via the predisposed needle cannula (Fig. 12.5).

The local anesthetic solution plus any adjuvants or synergistic agents is diluted with saline to a volume of 30–40 ml for the upper limb or 50–70 ml for the lower limb and injected slowly in at least 4–5 min.

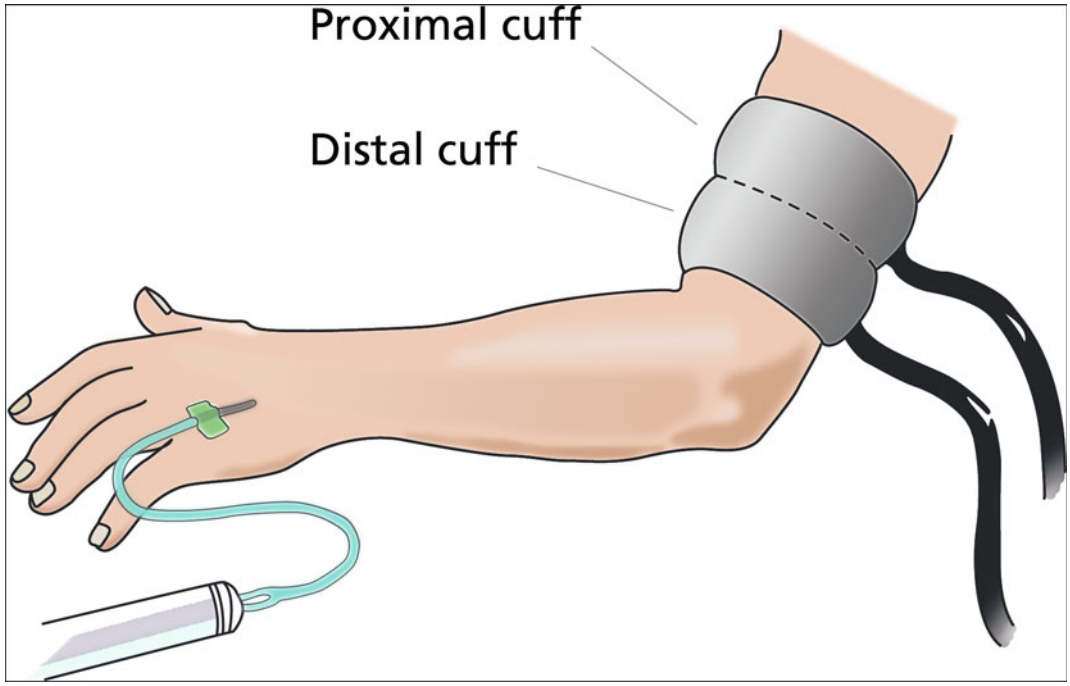

Fig. 12.3 Double-cuff tourniquet for IVRA

Fig. 12.4 Induction of ischaemia of the limb. The limb is raised for 10–15 min before inflating the tourniquet

The anesthesia sets in the space of approximately 15 min.

After checking that the anesthesia has set in also in the region immediately proximal to the distal cuff, the anesthetist proceeds to inflate the second (distal) cuff to the same pressure as the first and, only after ascertaining that the cuff is sealed, is the proximal cuff deflated.

In the anesthesia induction phase, the patient may manifest distress or pain due to the pressure exerted by the proximal cuff. To avoid this discomfort, anesthetic infiltration of the medial cutaneous nerve of the arm at the level of the axilla can be performed.

The duration of the intervention is limited by the ischaemia time of the limb concerned, which is normally set at 90 min. However, also in the case of very brief surgical interventions, the distal cuff should never be deflated at less than 40 min in order to avoid the massive entry of as yet unabsorbed or non-metabolized local anesthetic into the bloodstream. For the same reason, at the end of the intervention the cuff should be deflated

Fig. 12.5 Injection of local anesthetic

slowly. Also, the reappearance of the circulation in the ischaemic limb may cause disagreeable sensations, as may the entry into the bloodstream of free radicals accumulated in the segments of the ischaemic limb.

The anesthesia persists for about 10 min after completely deflating the cuff, and the analgesia persists for a period of 60–90 min. The addition of an analgesic agent to the anesthetic solution enables a postoperative analgesia of approximately 6 h to be obtained. In the postoperative period early walking and feeding are advisable so as to avoid the need for infusion therapy.

12.6 Side Effects

These include the following:

- The massive entry of local anesthetic into the bloodstream with numbness, tinnitus, palpitations or eye accommodation disorders;
- At revascularization of the limb, intense heat and numbness;
- Entry of free radicals into the bloodstream with consequent hypotension and transient skin rash.

12.7 Complications

The complications are caused by the prolonged ischaemia of nerve structures that may give rise to transitory or permanent lesions, and by the sudden, massive entry of local anesthetic into the bloodstream by direct injection due to a lack of or inadequate inflation of the cuff, or to

accidental or premature deflation of the latter. The sudden entry of local anesthetic into the bloodstream may cause disorders ranging from simple paresthesias of the tongue and lips to bradycardia and/or severe arrhythmia, agitation, tachypnea, nausea, vomiting and dizziness. In extremely severe cases, the patient may suffer convulsions, respiratory failure and even heart failure.

12.8 Conclusions

IVRA of the limbs does not require expensive equipment for its execution and has a very rapid learning curve. The cost of the materials used is very modest, and the frequency of accidents, complications and side effects is very low. Patient satisfaction, after an initial period of perplexity, is very good, as is that of the surgeons.

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