Intravenous regional anaesthesia

Alastair JM Baird
Colin B Donald

Abstract

Intravenous regional anaesthesia, or Bier's block, is a useful and safe technique for anaesthetizing distal limbs for short surgical procedures. It is most commonly used for reduction of forearm fractures within the emergency department and can be a useful method of providing anaesthesia in patients who may be unsuitable for a general anaesthetic, or when skills or equipment for other forms of regional anaesthesia are unavailable. When performed as recommended it has a proven safety record.

Keywords Bier's; distal limb surgery; emergency department; forearm fracture; intravenous regional anaesthesia; prilocaine; regional anaesthesia

Royal College of Anaesthetists CPD Matrix: 2G01, 2G02, 3A08, 3A09

Learning objectives

After reading this article, you should be able to:

- demonstrate the process of intravenous regional anaesthesia (IVRA)
- summarize the indications, contraindications and alternatives to IVRA
- recognize the safety concerns associated with IVRA
- discuss the choices of anaesthetics suitable for IVRA

Introduction

Intravenous regional anaesthesia (IVRA) is the injection of a local anaesthetic (LA) into a distal extremity which is isolated from the systemic circulation by the use of a tourniquet. It was first described in 1908 by August Bier, but was not widely used until 1963. Since then it has found popularity, particularly amongst emergency physicians for its utility in the reduction of distal forearm fractures; however, it has been successfully used for surgical procedures on both upper and lower limbs.

Current usage

IVRA is a useful technique for reduction of forearm fractures, particularly in patients who may be unsuitable for general anaesthetic when the expertise or equipment required for alternative regional anaesthesia techniques is unavailable. It is utilized most commonly within emergency departments for distal radius fractures, particularly in elderly patients or those with reduced functional demand where open reduction and internal fixation may not be indicated. The added benefit of this procedure is that it can often prevent admission to hospital and therefore the associated morbidity.

Within the authors' emergency department approximately 20 patients undergo IVRA each year, predominantly elderly patients with distal radius fractures. There have been no reports of significant complications locally despite more than 20 years of audited use.

Alastair JM Baird *MBChB MRCEM is a Senior Emergency Medicine Trainee in Ninewells Hospital and Medical School, Dundee, UK. Conflicts of interest: none declared.*

Colin B Donald *MBChB FRCEM is a Consultant in Emergency Medicine in Ninewells Hospital and Medical School, Dundee, UK. Conflicts of interest: none declared.*

Indications

Reduction of distal limb fractures, most commonly distal radius fractures.

Choice of anaesthetic

Prilocaine has been the anaesthetic of choice since 1983 when bupivacaine was withdrawn due to safety concerns.[1] Prilocaine 0.5% at a dose of 3 mg/kg, up to 400 mg, is recommended due to its lower cardiotoxicity and short duration of action. This is currently only available as 1% concentration and must therefore be diluted with saline 0.9%. Notably, there have been no documented cases of significant toxicity with a dose of 3 mg/kg of prilocaine.[2] While prilocaine is associated with methaemoglobinaemia, it is rare below 5 mg/kg in healthy adults.[3] Procedures on the lower leg will require larger volumes to achieve effective anaesthesia — up to 100 ml — and therefore may be associated with an increased risk of complications.

Lidocaine 0.5% in doses of 3 mg/kg up to 200 mg appears to be a safe alternative.[4] Ropivacaine has been studied; however, it appears to have a slower onset of action with significantly higher plasma concentrations after cuff deflation than prilocaine, although the clinical significance of this is unclear.[5]

The use of adjuvants, including opioids and muscle relaxants, continues to be a topic of debate and no definitive consensus has been reached on their use. At present they are not recommended. Preparations containing adrenaline must not be used for IVRA.

IVRA technique (Box 1)

Because of the potential complications a Bier's block should be performed by two practitioners in a resuscitative environment, at least one of whom is familiar with and competent to perform the procedure. Intra-lipid should be immediately available throughout the procedure. Contraindications are listed in Box 2.

The patient does not require to be fasted specifically for IVRA; however, if general anaesthesia is considered as an alternative this may be required. Consent should be gained, with the risks explained to the patient. Continuous ECG, blood pressure and pulse oximetry are required throughout the procedure. A small gauge venous cannula should be inserted into the dorsum of the hand on the side to be manipulated and a second IV access gained on the contralateral side. This second access is essential in case of local anaesthetic systemic toxicity.

Apply padding followed by a double cuff tourniquet to the upper arm (pneumatic compression should only be performed over a single bone) as shown in Figure 1. The affected side is then exsanguinated by elevation — this may be aided by digital compression of the brachial artery at the elbow. After 2 minutes,

IVRA technique

1. Gain bilateral IV access and establish monitoring
2. Apply padding and cuff to upper limb
3. Exsanguinate limb by elevation
4. Inflate cuff up to 300 mmHg and note time
5. Inject 3 mg/kg prilocaine 0.5% into the procedural side and remove cannula
6. Perform procedure once anaesthesia effective
7. Deflate cuff after >20 minutes and monitor for LA toxicity

Box 1

Contraindications to IVRA

- Allergy to anaesthetic
- Methaemoglobinaemia
- Morbid obesity (cuff reliability)
- Blood pressure >200 mmHg
- Lymphoedema
- Raynaud's syndrome
- Peripheral vascular disease
- Scleroderma
- Sickle cell disease
- Paget's disease of bone
- Anticoagulation (relative)

Box 2

with the arm still elevated, the proximal cuff should be inflated to 100 mmHg above the systolic pressure, up to a maximum of 300 mmHg, and the arm allowed to rest. Arterial occlusion is confirmed by absence of the radial pulse. Prilocaine 0.5% is injected, following which mottling of the hand and forearm will occur. The cannula may then be removed and prolonged pressure applied to the puncture site. Anaesthesia is usually effective within 10 minutes, at which point the distal cuff can be inflated before the proximal cuff is deflated to help reduce tourniquet pain. If this cuff rotation technique is performed it is essential that at least one cuff remains inflated at all times.

The tourniquet must remain inflated for at least 20 minutes up to a maximum of 45 minutes after LA injection to allow the anaesthetic to fix to local tissues and thus minimize the risk of toxicity. Throughout the procedure, and particularly on deflation of the tourniquet, the patient should be closely monitored for clinical signs of LA toxicity. If any features develop the cuff should be immediately re-inflated to 100 mmHg above the pre-procedure blood pressure and at least 50 mmHg above the current blood pressure, while oxygen and IV fluids are administered. If there are features of significant cardio- or neurotoxicity intralipid therapy should be commenced, as outlined in the AAGBI guidelines.[6]

Disadvantages of IVRA

IVRA is a safe and simple method of regional anaesthesia. Nevertheless, there are a number of disadvantages which make IVRA less favourable than other techniques if they are available.

While ischaemia is unlikely to develop before 90 minutes of tourniquet time, pain can become intolerable after 30–40 minutes making IVRA unsuitable for longer procedures. Rotating the cuffs as described above can help to alleviate this.

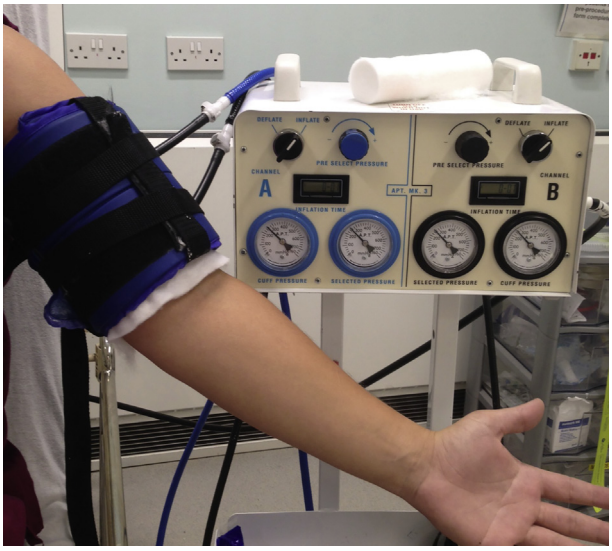

Figure 1 Padding and pneumatic double cuff tourniquet in place for IVRA of forearm.

Compartment syndrome has occurred and appears to be more common with IVRA of the lower limb, prolonged tourniquet times or when the anaesthetic has been diluted with hypertonic saline.[2]

Less serious complications include ecchymoses and petechiae which normally resolve after a few days. There is a theoretically higher risk of this in anticoagulated patients due to cuff trauma, however AAGBI guidance categorizes Bier's block as 'low risk' for significant complications in these groups.[7] ◆

REFERENCES

1 Bartholemew K, Sloan JP. Prilocaine for Bier's block: how safe is safe? *Arch Emerg Med* 1990; **7:** 189–95. Available from: https://doi.org/10.1136/emj.7.3.189.

2 Guay J. Adverse events associated with intravenous regional anesthesia (Bier block): a systematic review of complications. *J Clin Anesth* 2009; **21:** 585–94. Available from: https://doi.org/10.1016/j.jclinane.2009.01.015.

3 Guay J. Methemoglobinemia related to local anesthetics: a summary of 242 episodes. *Anesth Analg* 2009; **108:** 837–45. Available from: https://doi.org/10.1213/ane.0b013e318187c4b1.

4 Jakeman N, Kaye P, Hayward J, Watson DP, Turner S. Is lidocaine Bier's block safe? *Emerg Med J* 2013; **30:** 214–7. Available from: https://doi.org/10.1136/emermed-2011-200999.

5 Niemi TT, Neuvonen PJ, Rosenberg PH. Comparison of ropivacaine 2 mg ml(-1) and prilocaine 5 mg ml(-1) for i.v. regional anaesthesia in outpatient surgery. *Br J Anaesth* 2006; **96:** 640–4. Available from: https://doi.org/10.1093/bja/ael066.

6 Association of Anaesthetists of Great Britain and Ireland. Management of severe local anaesthetic toxicity. 2010. Available from: https://www.aagbi.org/.

7 Association of Anaesthetists of Great Britain and Ireland, Obstetric Anaesthetists' Association and Regional Anaesthesia UK. Regional anaesthesia and patients with abnormalities of coagulation. *Anaesthesia* 2013; **68:** 966–72. Available from: https://onlinelibrary.wiley.com/doi/abs/10.1111/anae.12359.