Review Article

Intravenous regional anaesthesia (Bier block): review of 20 years' experience

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Our experience with intravenous regional anaesthesia (IVRA) in 1,906 patients over a period of 20 years has confirmed that this technique is safe and effective. IVRA may be used to provide anaesthesia for surgery involving both the upper and lower extremities. The need for supplemental medication is ordinarily minimal, so the technique is particularly suitable for short procedures in an ambulatory surgery centre. Yet, prolonged surgery may be performed using a "continuous technique." Although various local anaesthetic agents may be used to induce IVRA no drug has been demonstrated to be superior to lidocaine. The major cause of failure of the technique or serious adverse effects is technical error. A specific protocol for avoiding technical error is presented. Significantly, over a period of 20 years, there has not been any mortality or major morbidity. The incidence of adverse reactions was 1.6 per cent and consisted of minor events such as transient dizziness, tinnitus or mild bradycardia.

Key words
ANAESTHETIC TECHNIQUES: Bier block, regional, intravenous; ANAESTHETICS, INTRAVENOUS: lidocaine; ANAESTHETICS, LOCAL: bupivacaine, lidocaine; COMPLICATIONS: death, morbidity; EQUIPMENT: tourniquets.

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Intravenous regional anaesthesia (IVRA) was introduced by Bier in 1908.[1] The technique did not gain any measure of popularity, however, until it was reintroduced by Holmes in 1963.[2] The major advantages of the technique are reliability and ease of administration. Major nerve blocks such as brachial plexus block and femoral-sciatic block require technical expertise. Conversely, the administration of IVRA requires only the skill necessary to perform a venipuncture. Recently, the safety and efficacy of the procedure have been questioned.[3–6] The purpose of this communication is to review our experience with IVRA over a period of some 20 years.

Method

A retrospective review of the medical records of all patients who received IVRA during the period from 1965–1986 was performed. During the last year, a concurrent review was performed. Nineteen hundred and six patients are included in the study. The information obtained from the chart review included age, sex, ASA physical status, site of surgery, tourniquet time, type and dosage of local anaesthetic agent, supplemental medication and adverse effects.

Results

Patient population

The distribution of age, sex and ASA physical status of the 1,906 patients included in this study appears in Table I. In the early years, almost all patients were inpatients. In 1971, we began to perform the technique on an increasing number of outpatients. At present, almost all IVRA is administered for surgical procedures on outpatients.

Site of surgery

One thousand six hundred and three anaesthetics were administered for surgery on the distal portionof the upper extremity and 303 for surgery on the lower extremity. Our early experience with surgery on the lower extremity was

TABLE I

Age				*Sex*		*ASA physical status*		
<20	20–40	40–60	>60	M	F	1	2	3
102	1207	540	57	614	1292	962	743	201

unsatisfactory because of a high incidence of tourniquet pain. During that time, we used a tourniquet pressure of approximately 500 mmHg as recommended on the inflating mechanism. More recently, following a study of arterial occlusion pressure using a Doppler, we found that a tourniquet pressure of 300 mmHg at the thigh was sufficient to assure occlusion of arterial flow in the lower extremity in all patients except those who have a systolic pressure greater than 150 mmHg. For these patients, we use a tourniquet pressure that is double the systolic pressure. Of the 303 procedures performed on the lower extremity, a total of 16 required general anaesthesia or very heavy sedation because of tourniquet pain. Almost all took place when we were using the higher pressure.

Tourniquet time

Total tourniquet time for the procedures varied from 20 min to more than 5 h. The tourniquet was never allowed to remain continuously inflated for more than two hours. Procedures that required more than two hours were performed under continuous IVRA in accordance with the technique previously described.[7]

Local anaesthetic agent

The local anaesthetic agents used to induce IVRA appear in Table II. The drug used most frequently was lidocaine plain with preservative. Concentrations less than 0.5 per cent were prepared by diluting commercially distributed lidocaine with sterile saline solution.

Supplemental medication

Of the 1,906 patients, 102 (5.3 per cent) required heavy sedation and 13 (0.6 per cent) additional patients required general anaesthesia. The other patients received either light sedation or no supplemental medication. Light sedation consisted of small doses of diazepam (less than 10 mg) and/or fentanyl (less than 0.1 mg). When patients required heavy sedation or general anaesthesia, it was due to either severe tourniquet pain or failure of the technique as a result of technical error.

TABLE II Local anaesthetic agent

	Upper extremity	*Lower extremity*
Lidocaine 1.0%	12 (40 ml)	0
Lidocaine 0.5%	1538 (50 ml)	89
Lidocaine 0.35%	0	109 (100 ml)
Lidocaine 0.25%	20 (50 ml)	105 (150 ml)
Prilocaine 1%	13 (50 ml)	0
Bupivacaine 0.25%	20 (50 ml)	0

TABLE III Adverse effects (no. of patients)

	Upper extremity	*Lower extremity*
Dizziness	7	0
Tinnitus	5	0
Bradycardia (>15 bpm decrease)	8	1
Nystagmus	2	0
Hives	3	0
Dysrhythmia	2	0
Drowsiness	2	0
Diplopia	1	0
Total	30	1

Adverse effects

The incidence of adverse effects was 1.6 per cent and consisted of minor events such as temporary dizziness, tinnitus or mild bradycardia. There was no mortality or major morbidity (Table III).

Discussion

Our experience using IVRA over a period of more than 20 years demonstrates that the technique is both safe and effective when used appropriately. We believe that the reasons for the absence of serious, adverse effects in our patients are close attention to proper maintenance of equipment; a detailed check of equipment prior to each use; strict adherence to a specific protocol for administering the anaesthetic; the requirement that the technique be used only in an area where there is adequate monitoring and resuscitation equipment available and only by physicians who are competent to recognize and treat local anaesthetic toxicity. The early recognition and prompt treatment of early signs of toxicity such as dizziness, tinnitus and bradycardia may prevent progression to more serious complications.

The major cause of adverse effects of IVRA and/or failure of the technique is technical error. It is essential that all equipment be tested prior to use. Thus, the inflating mechanism should be tested for accuracy against a mercury manometer or other type of manometer. All connections should be secure and rubber tubing should be tested for leaks.

A double tourniquet is used for both the upper and lower extremity. On the upper extremity, the tourniquet is placed above the elbow. On the lower extremity, it is placed on the thigh. Placement of the tourniquet below the thigh may interfere with the sterile field and could

conceivably cause injury to the common peroneal nerve. We have developed a double tourniquet for the lower extremity that is somewhat wider than the tourniquet used for upper extremity surgery and is tapered to conform to the anatomy of the thigh.

Following exsanguination of the extremity, the proximal tourniquet is inflated to the appropriate pressure. The radial or dorsalis pedis artery should be palpated to assure occlusion. The appropriate volume of local anaesthetic agent is injected. For upper extremity block, we use 50 ml of 0.5 per cent lidocaine plain. Though preservative-free lidocaine is recommended for use, we have used lidocaine with preservative in all of our patients and have encountered no ill effects. For lower extremity block, we use 150 ml of 0.25 per cent lidocaine. The purpose of using the greater volume is to assure an adequate distribution of drug in the larger, lower extremity. Approximately ten minutes following injection of the local anaesthetic agent, the distal tourniquet is inflated and the proximal tourniquet is deflated. This sequence reduces the incidence of tourniquet pain.

The use of IVRA for lower extremity block has been considerably less popular than for procedures on the upper extremity. The frequency of tourniquet pain when using a pressure 500 mmHg is a discouraging factor. Since we modified our technique to use lower occluding pressures, we have successfully administered IVRA for procedures on the lower extremity without encountering unacceptable discomfort due to the tourniquet.

It is important to note that the tourniquet is never deflated until at least 20 min has elapsed from the time of injection of the anaesthetic agent. Between 20 and 40 min, a cycled deflation technique is employed; i.e., the tourniquet is deflated for 5 sec, reinflated for 1 min, deflated for another 5 sec, reinflated for another min, then deflated totally. For procedures that last more than 40 min, the tourniquet is deflated without cycling. A tourniquet is not allowed to remain continuously inflated for more than 2 h. If the surgical procedure lasts more than 2 h, a continuous technique previously described[5] is utilized. A catheter is placed in an antecubital vein and secured. IVRA is induced in the usual manner but the catheter is not removed. After 1½–2 h, the tourniquet is deflated for approximately 5 min. At the end of that time, the surgeon re-exsanguinates the extremity using a sterile esmarch bandage, the distal tourniquet is reinflated and 25 ml of 0.5 per cent lidocaine are injected. The technique can then be repeated a second time if necessary for a very prolonged surgical procedure.

Although we have used local anaesthetic agents other than lidocaine, we have found none of them to be superior. Bupivacaine 0.25 per cent produces no significant increase in post-deflation anaesthesia. Although Magora demonstrated an increase in post-deflation anaesthesia when bupivacaine 0.5 per cent was employed,[8–10] there is sufficient evidence to indicate that this concentration is potentially lethal if systemic absorption occurs as a result of a technical mishap.[11–13] Theoretically, 2-chloroprocaine should be an ideal agent for IVRA because it is so rapidly biotransformed. Unfortunately, the high incidence of thrombophlebitis reported when this agent was used led to abandoning this agent for IVRA.[14] Prilocaine is another agent that is attractive because of its low toxicity. The possibility of methaemoglobinaemia has discouraged anaesthetists from using this agent, even though Mazze and others have demonstrated that methaemoglobinaemia was not a problem when prilocaine was used for IVRA.[15,16]

The fact that little or no supplemental medication is ordinarily necessary when using IVRA is a distinct advantage for ambulatory surgical procedures. Since the anaesthetic effect recedes within 15–20 minutes, patients can be safely discharged from the postanaesthetic care unit more promptly than when other anaesthetic techniques are used. For patients who require emergency surgery on an extremity, the danger of aspiration of gastric contents is decreased when depressant drugs are avoided.

We believe that the absence of major morbidity in our patients is significant particularly because the technique is used by all members of the anaesthetic staff including residents at every level of training. We emphasize attention to the details of the technical procedure and close observation of the patient so that early signs of local anaesthetic toxicity are detected promptly and treated appropriately to prevent progression to more serious effects.

Appendix

Protocols

UPPER EXTREMITY (single injection)

1 Test equipment
2 Start IV near surgical site
3 Apply Webril to arm to protect skin
4 Place double tourniquet over Webril
5 Exsanguinate extremity using Esmarch bandage and/or gravity drainage
6 Inflate proximal tourniquet to 250 mmHg
7 Remove Esmarch bandage
8 Assure absence of radial artery pulsation
9 Inject 50 ml of 0.5 per cent lidocaine *slowly*
10 10 min after administration of drug inflate distal tourniquet and deflate proximal tourniquet

UPPER EXTREMITY (continuous)

1 Test equipment
2 Start IV in antecubital vein
3 Apply Webril to arm to protect skin
4 Place double tourniquet over Webril
5 Exsanguinate extremity using Esmarch bandage and/or gravity drainage
6 Inflate proximal tourniquet to 250 mmHg
7 Remove Esmarch bandage
8 Assure absence of radial artery pulsation
9 Inject 50 ml of 0.5 per cent lidocaine *slowly*
10 IV remains in place
11 10 min after administration of drug inflate distal tourniquet and deflate proximal tourniquet.
12 At the end of 1½ hours, surgeon is asked to choose a convenient time within the next ½ hour to allow deflation of tourniquet
13 Tourniquet deflated for 5 min
14 Surgeon raises upper extremity and applies sterile Esmarch bandage to the extent possible
15 Distal tourniquet is inflated
16 25 ml 0.5 per cent lidocaine is administered

LOWER EXTREMITY

1 Test equipment
2 Start IV near surgical site
3 Place Webril over thigh
4 Place double tourniquet atop Webril
5 Exsanguinate extremity using Esmarch bandage and/or gravity drainage
6 Inflate proximal tourniquet to 300 mmHg or twice the systolic pressure whichever is greater
7 Remove Esmarch bandage
8 Assure absence of dorsalis pedis pulsation
9 Inject 150 ml of 0.25 per cent lidocaine slowly
10 Remove IV catheter
11 10 min after administration of drug inflate distal tourniquet and deflate proximal tourniquet

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Résumé

En 20 ans, nous avons éprouvé l'efficacité et la sûreté de l'anesthésie intraveineuse régionale (IVRA) auprès de 1906 patients. Cette technique, applicable aux membres supérieurs et inférieurs, est particulièrement appropriée aux interventions de courte durée en externe et elle ne nécessite alors que très peu d'adjuvants médicamenteux. Pour les chirurgies prolongées, il existe une technique équivalente dite "continue". Une variété d'anesthésiques locaux a été utilisée, sans toutefois détrôner la lidocaïne. La plupart des échecs de l'IVRA de même que ses complications sérieuses sont imputables à une ou des erreurs techniques et nous vous présentons un protocole détaillé pour éviter de tels problèmes. Nous n'avons noté en 20 ans, aucun décès ni complications importantes autres que des étourdissements passagers, du tinnitus ou des bradycardies bénignes.