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INTRAVENOUS REGIONAL ANAESTHESIA FOR SHORT UPPER LIMB SURGERIES IN AN EMERGING TEACHING HOSPITAL

Afolayan Jide Michael*[1], Popoola Sunday Ogunsuyi[2], Salawu Adebayo Idris[2], Kadiri Innih[2], Ogunlusi Johnson Dare[2] and Olaogun Julius Gbenga[2]

[1]Deparment of Anaesthesia, Ekiti State University, Ado-Ekiti, Nigeria.
[2]Department of Surgery, Ekiti State University Teaching Hospital, Ado-Ekiti, Nigeria.

***Corresponding Author: Dr. Afolayan Jide Michael**

Deparment of Anaesthesia, Ekiti State University, Ado-Ekiti, Nigeria.

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ABSTRACT

Objective: To report the outcome of Intravenous Regional Anaesthesia (IVRA) in patients with upper limb surgeries in a result poor country. **Methods:** A prospective study of Intravenous Regional Anaesthesia in patients with upper limb surgeries from January 2013 to December 2016 was carried out using two sets of sphygmomanometer cuffs (the ones used to measure blood pressure) in lieu of standard double-lumen pneumatic cuffs. Intravenous access in the uninvolved extremity was established. One percent Lidocaine (3mg/kg) was diluted to 3mg/kg 0.5% Lidocaine solution. Two sets of sphygmomanometer cuffs were placed in the arm of the involved extremity. Small IV cannula was also inserted near the pathological lesion and secured. The affected extremity was elevated and exsanguinated. Proximal cuff was inflated 100mmHg above systolic and then the extremity was lowered. Lidocaine 3mg/kg 0.5% was infused. The infusion needle was removed and the site was taped. The surgery was performed. Patients' age, sex, weight, ASA status, blood pressure, pain score, intra-operative and post-operative values were documented. **Results:**. Fifty-eight patients were recruited for the study. Twenty seven patients were male while other patients were female. No incidence of pain intra-operatively. Induction of Bier's block was successful in all the 58 patients studied. There was a transient incidence of hypotension in one patient. Time to first analgesia was 110 (13.1) min. Post-operatively, there was incidence of dizziness in one patient. **Conclusion:** The study highlights that the use of two sets of syphgmomanometer cuffs, in lieu of standard double-lumen pneumatic cuffs, is possible during Intravenous Regional Anaesthesia.

KEYWORDS: Regional anaesthesia, pneumatic cuffs, syphgmomanometer, Lidocaine, Prilocaine.

INTRODUCTION

Intravenous Regional Anaesthesia (IVRA) also known as Biers block, was first introduced in 1908 by August Bier.[1,2] He succeeded in using Esmarch bandage to produce exsanguination of the arm and then injected Prilocaine between the two tourniquets to quickly produce anaesthesia in the operating site.[1,2,3] Though this award winning invention proved effective, the technique was thrown into obscurity for many years. During this period, IVRA remained relatively unpopular.[3] This landmark invention was re-introduced and subsequently re-popularised again in 1963 by Holmes and has since steadily maintained its popularity even till now.[2]

With the novel use of lidocaine and in his bid to repopularize the technique, Homes published a series of 30 patients in Lancet[2] and found that there was good analgesia on the operating site of the patients. Repopularization of the procedure is due in part to its ease of administration, rapid onset and recovery.[2] Studies have been done using a double-lumen pneumatic tourniquet with good results. Intravenous Regional Anesthesia (IVRA) or Bier's block anesthesia is a regional anesthetic technique for surgical procedures on the body's extremities where a local anaesthetic agent especially Prilocaine or Lidocaine is injected intravenously.

In order to force blood out of the involved extremity, the technique usually starts with exsanguination. This is immediately followed by the application of pneumatic tourniquets to safely prevent blood flow to area that has just been exsanguinated. The anaesthetic agent of choice, such as Prilocaine or Lidocaine is introduced into the limb while tourniquets confine the local anaesthetic agent within the desired area.[2,3,4,5]

Several authors found that IVRA was useful for short procedures on the arm or leg that require anaesthesia, muscle relaxation, or a bloodless field, such as reduction of fractures and dislocations, repair of major lacerations,

removal of foreign bodies, debridement of burns, and drainage of infection.[3, 4,5] Intravenous regional anaesthesia is commonly used for extremity surgery, such as carpal tunnel surgery or tendon repair.[4,5,6] The procedure may be carried out on any patient of any age who is able to cooperate with the anaesthetist. IVRA is reportedly safe but not entirely without the risk of complications. Bupivacaine was once experimented for IVRA in an attempt to improve both intraoperative and postoperative analgesia.[7,8] Its use was abandoned after reports of Local Anaesthetic Systemic Toxicity (LAST) when tourniquet was released. This was especially true in cases of premature release of the tourniquet.[9,10,11] LAST complicating IVRA may still occur despite the use of less cardiotoxic lidocaine. LAST comprises neurological and cardiovascular features. The earliest descriptions of LAST highlight several of its prominent clinical features, namely respiratory failure, seizures, palpitations, and 'irregular heart action' even cardiac arrest.[9,10,11] Seizures have been reported at even low doses, as low as 2.0 mg/kg where there was a technical error.

This study was designed to explore whether two sphygmomanometer cuffs could be used in lieu of standard double-lumen pneumatic cuffs in centres, such as ours, where standard double-lumen pneumatic cuffs may not be readily available.

METHODOLOGY

This was a prospective study. The study received Institutional Ethical Committee Research Review approval from Ekiti State University Teaching Hospital, Ado-Ekiti, Nigeria. Fifty eight patients scheduled for short upper limb elective or emergency surgeries under Intravenous Regional Anaesthesia were enrolled for the study. Informed consent was received directly from all patients who participated in the study. They were reliably informed that Intravenous Regional Anaesthesia could be converted to general anesthesia if there was any failure or difficulty while inducing the block. The patients were mostly recruited for day cases who underwent final clinical review a day before surgery.

After moving the patients to operative theatre, they were placed on tiltable operating table on arrival in the operating suite. Monitors for electrocardiography (ECG), pulse oximetry, and non-invasive blood pressure were attached in order to measure and record both baseline and intraoperative vital parameters such as heart rate, respiratory rate, oxygen saturation, systolic and diastolic blood pressure. Other materials include local anaesthetic agent such as 1% or 2% lidocaine HCL, which was to be diluted to 0.5% solution, rubber tourniquet, IV cannula (16-18 guage), 500 mL bag of IV fluid (crystalloid), infusion set, two sets of sphygmomanometer cuffs in lieu of the standard pneumatic tourniquet with double lumen, one Esmarch bandage which is about 150cm long with 10cm in width and different syringes.

All patients were hydrated with intravenous fluid after establishing an intravenous access with 16-gauge cannula in the preoperative room.

The traditional dose of Lidocaine for the arm is 3 mg/kg. In this study 3mg/kg 0.5% Lidocaine was administered to each of the patients. One % Lidocaine would be diluted with sterile water (single dilution) to form 0.5% Lidocaine in a situation where there was no ready-made 0.5% Lidocaine solution. Therefore, each patient, after a single dilution of 1% to 0.5% Lidocaine, had 0.5% solution administered into his or her intravenous space. In case 2% Lidocaine was used, this was double diluted to 0.5% volume before administration. Whichever solution of Lidocaine that was available, it had to be diluted to 0.5% before it was injected into intravenous space of each of the patients. For instance, 1% Lidocaine mixed with equal parts sterile saline in a 50-mL syringe. Hence, for a 70-kg patient, 210 mg (3mg/kg) of Lidocaine (21 mL of 1% Lidocaine) was mixed with 21 mL of saline or sterile water to get a total volume of 42 mL of 0.5% Lidocaine in the infusing syringe. Also for example, 2% Lidocaine mixed twice (double dilution) with equal parts sterile saline in a 50-mL syringe. Hence, for a 70-kg patient, 210 mg of Lidocaine (10.5 mL of 2% Lidocaine) was mixed with 10.5mL of saline or sterile water to get an initial volume of 21 mL of 1% Lidocaine (first dilution). The 21 mL of 1% solution was diluted again (second dilution) with equal volume (21 mL) of saline or sterile water to get a total volume of 42 mL of 0.5% Lidocaine solution in the infusing syringe.

Every patient was placed supine on the operating table. Baseline vital signs were documented. Initial pain level was assessed using Visual Analogue Scale, pain assessment.[1-10] 1 means no pain while 10 means worst pain ever. Two cannula were left insitu, one around the operative site of the hand while the other was placed on the contralateral forearm for hydration and resuscitation.

Two tested, uninflated padded sphygmomanometer cuffs were applied to the operative arm in lieu of standard pneumatic tourniquet with double cuffs. The affected limb was elevated for about three minutes to aid venous drainage. Exsanguination could be both passive or active, without or with Eschmarch bandage. After a successful exsanguination, then the limb was lowered down on the table while proximal cuff was inflated to 250 mmHg or 100 mmHg above patient's systolic blood pressure. The time cuff was inflated was documented. Correct cuff inflation was ensured. The cuff was felt and optimum function was confirmed with the absence of radial pulse and blanching.

With the proximal tourniquet now inflated, the calculated dose of 0.5% Lignocaine solution in the 50mL syringe was injected through the cannula, into the intravenous space of the hand to be operated upon. Continuous monitoring of pulse rate, blood pressure, respiratory

rates, electrocardiography and oxygen saturation every minute for the first 10 minutes then subsequently every 5 minutes throughout the surgery.

The time it took the patients to experience paraesthesia or warmth sensation in the fingertips and or forearm was documented. Complete loss of sensory sensation, through pin prick, indicated the need to start the surgery. In case of inadequate block, 15 minutes from the time the first dose was given would be observed before infusing any additional Lidocaine. Alternatively, if analgesia was slow or inadequate after 15 minutes, an extra 10 to 20 mL of *saline* solution would be injected to supplement the total volume of solution to enhance the effect. Total dose of Lidocaine (3mg/kg) was not to be exceeded in this study. When the patient began to feel pain under the proximal cuff, the distal cuff was first inflated over an already anaesthetized area, and the pain-producing proximal cuff was then deflated. One must be certain to inflate the distal cuff before the proximal cuff was released. After the surgery, the total cuff inflation duration should not be less than 45 minutes before a final deflation of the distal cuff. When the patient began to feel pain under the distal cuff before cuff duration of 45 minutes, the distal cuff would be deflated for 10 seconds and inflated again. This was to be repeated until total cuff duration of 45 minutes was reached.

Following final deflation without subsequent inflation, patients were critically observed for any complications from intravenous administration of lidocaine, such as yawning, dizziness, headache, perioral tingling, numbness, lightheadedness, tinnitus, metallic taste, slurred speech, auditory disturbance, visual disturbance, hypotension, bradycardia, arrhythmia, twitching and seizures. Time for return of sensation , time to first analgesic, motor function, side effect and complications were recorded. Should complication arise, the plan was to call for senior doctor, especially anaesthetist. The cuff would be re-inflated if it had been deflated already. Hundred % oxygen would be administered. Pulse rate, Blood Pressure, Oxygen saturation would be continuously monitored. Patient could be turned into lateral position. Midazolam would be given to control any convulsion. Management could involve intubation and mechanical ventilation depending on the severity of the complication. Postoperatively, driving was prohibited for 6 to 8 hours, and the patient should leave with a responsible adult.

RESULTS

All the 58 patients had successful Bier's block for their surgeries as shown in Table 1. Twenty seven patients were male while the remaining ones were female. Most of the patients had secondary education. Fifty three of them were American Society of Anesthesiology (ASA 1) status. Mean onset of sensory block was 6 (2.8). Induction of Intravenous Regional Anaesthesia (IVRA or Bier's block) was successful in all the patients.

Table 1: Patients' characteristics.

Parameter	Values
Age (mean+SD	45 (4.6)
Gender	
Male	27 (46.6%)
Female	31 (53.4%)
Educational Status	
Primary	12 (20.7%)
Secondary	24 (41.4%)
Tertiary	22 (37.9%)
ASA Status	
1	53 (91.4%)
2	5 (8.6%)
Mean Baseline mmHg (mean +SD)	
Systolic BP	125 (9.7)
Diastolic BP	74 (4.1)
Onset of Sensory block min (mean +SD)	6 (2.8)
IVRA	
Successful	58 (100%)
Fail	0 (0%)

According to Table 2, various surgeries for Bier's block in the study ranged from ganglion excision 13(22.4%), Trigger finger release 10(17.2%), Contracture release 10(17.2%), Burn debridement 10(17.2%), repair of hand injury 8(13.8%) to distal forearm fracture reduction 7(12.1%).

Table 2: Surgical procedures performed with Biers' Block.

Procedures	Values
Ganglion excision	13(22.4%)
Trigger finger release	10(17.2%)
Contracture release	10(17.2%)
Burns debridement	10(17.2%)
Repair of hand injury	8((13.8%)
Distal forearm fracture reduction	7(12.1%)

Patients' intraoperative values were shown in Table3. Mean Visual Analogue Scale (ASA) Score intraoperatively was 2 (0.9). No incidence of pain. Intraoperative complications such as hypotension was observed in one person (01.7%) and bradycardia in two persons (03.4%). Mean duration (min) of surgery and anaesthesia were 52 (11.9) and 88 (13.5) respectively.

Table 3: Patients' intraoperative monitoring values.

Parameter	Value/percentage
Mean VAS	2 (0.9)
Incidence of Pain	
Pain Present	0 (0%)
Pain Absent	58 (100%)
Complications	
Hypotension	1 (01.7%)
Bradycardia	2 (03.4%)
Mean blood loss (ml)	217 (2.7)
Mean total fluid administered (ml)	840 (20.7)
Duration of surgery (Mean &SD)	52 (11.9)
Duration of anaesthesia (Mean & SD)	88 (13.5)

Time to first analgesic requirement (min) was 110 (13.1). Post operative incidence of dizziness in one patient (01.7%) was observed and managed. No incidence of hypotension postoperatively as documented in Table 4. Similar high percentages of Doctors and patients were satisfied with the block.

Table 4: Post operative clinical variables.

Parameter	Values
Time to first analgesic (min)	110 (13.1)
Incidence of complication	
Dizziness	1 (01.7%)
Hypotension	0 (0.0%)
Level of patient's satisfaction	
Satisfied	51 (87.9%)
Not satisfied	7 (12.1%)
Doctors' satisfaction	
Satisfied	58 (100.0%)
Not satisfied	0 (0.0%)

DISCUSSION

According to this present study, induction of Bier's block was successful in all the patients. This is in support of works of Brill et al that IVRA is a simple, effective anesthetic technique with a reported success rate of 96–100%.[3]

Protocols for the induction of intravenous regional anaesthesia vary depending on local standard procedures and the extremity being operated on. It has been more than 100 years that Bier first described Intravenous Regional Anaesthesia (IVRA) as a rapid-onset and safe anesthetic technique for upper and lower extremity surgery.[1,2,3] It has been documented that the process required exsanguination of the extremity, application of a pneumatic tourniquet, intra vascular access, and subsequent administration of local anesthetic agent.[12,13] However the technique was considered difficult with myriad of adverse effects, nevertheless, it fell into obscurity and was latter and largely forgotten due to the introduction of brachial plexus blockade.[14] Despite anything to the contrary, repopularisation of the technique came about in 1963, when Holmes published a case series in Lancet using diluted Lidocaine for intravenous anesthesia, thus stimulating mounting interest in the anaesthetic technique.[2]

According to the work of Bartholomew and colleagues [15] Prilocaine has become the agent of choice for Bier's block since 1983 when the product licencing of Bupivacaine was withdrawn for this purpose owing to fatal or serious complications. They observed that no serious complications have been documented in the literature relating to Prilocaine in IVRA. They also conducted a survey within the U.K. which indicated that about 45,000 Bier's blocks have been carried out with Prilocaine without adverse reactions such as convulsion, arrhythmia or fatality.[15] The causes of complication include cases of accidental cuff deflation or even failure to inflate the cuff, resulting in bolus doses to the circulation. They stressed that Prilocaine has now been in use since 1964 and the Committee for Safety of Medicines has no deaths on record over a 25-year period. They suggested that intravenous regional anaesthesia using Prilocaine was a safe technique. They were of the opinion that highly unlikely that fatalities would occur, provided present guidelines were adhered to. They therefore found no reason to limit its use to trained anaesthetists only, but recommended that a strict protocol is adhered to.[15]

Although the ideal local anesthetic agent for Bier's block is Prilocaine,[1,2,3,4] Brown et al[1] observed that Lidocaine is preferred to Prilocaine according to the study they carried out. Typically Prilocaine or Lidocaine(where there is no Prilocaine) without adrenaline, is slowly injected as distally as possible into the exsanguinated limb.[12] In this present study, Lidocaine was used in lieu of Prilocaine because Prilocaine was not available. Many researchers have shown that Lidocaine is a good alternate to Prilocaine whenever the latter is not available.[2,4,5,6,12] Cardiotoxic local anaesthetic agents such as Bupivacaine and Etidocaine are strictly contraindicated.[14]

According to this present study, Intravenous Regional Anaesthesia is possible with Lidocaine in some selected cases of upper limb procedures. Biers block was successful in all the patients that had the technique in this present study. This corroborates the works of Brown et al that Biers block was possible and safe in some selected cases of upper limb procedures.[1] Their experience with intravenous regional anaesthesia (IVRA) in 1,906 patients over a period of 20 years had confirmed that this technique is safe and effective. According to Brown et al, 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. Adjuvants improve the safety of IVRA by promoting anesthetic action and minimizing side effects. For example, benzodiazepine and fentanyl are often added to prevent seizures and to improve nerve blockage, respectively.[1] according this present study, adjuvants were not added to the Lidocaine solution that was administered into each of the patients. Some recent investigations have sought to improve the protocol for the technique using adjuvants such as fentanyl, pethidine, benzodiazepines, dexmedetomidine or reduced doses of local anesthetic with more distal tourniquets. But in all these, and as always documented, careful patient selection, vigilance and consideration of intercurrent medical ailments coupled with individual evaluation by a senior anesthesiologist or surgeon are necessary to ensure optimal outcomes.

In this present study, onset of sensory block was 6 (2.8). No patient had any form of sedation. No patient had

supplement medication (heavy or light). There was no patient who required general anaesthesia. Patients did not feel any pain intraoperatively.

The safety of the procedure should be the major focus whenever intravenous regional anaesthesia is instituted. Though the effectiveness of Biers block is well documented and established by some authors in clinical literature, cardiotoxic agent such as bupivacaine and etidocaine are absolutely contraindicated.[14] Brown et al [1] found that 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 authors concluded. Brown and co-workers [1] were of the opinion that the major cause of failure of the technique or serious adverse effects is technical error. 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.

The use of tourniquet is not advisable in some patients such as sickle cell anaemia, diabetes mellitus and peripheral vasculoneuratis in order to avoid the risk of massive hemolysis due to low oxygen tension or hemolytic crisis due to slow or ineffective blood flow [1,6,7,15] A systematic review of IVRA-related complications found that the type of anesthetic agent, improper equipment, and technical error are prominent factors in most instances of morbidity related to IVRA.[7,8, 9,10,11,16]

Modern practice now encourages several safeguards for improving safety. In this present study and in order to avoid mishap, the veins are filled with the lidocaine for about 6–8 minutes before surgery could commence. Two standard syphgmomanometer cuffs were used instead of the standard pneumatic double lumen cuff. It has been observed that the use of syphgmomanometer for Intravenous regional anaesthesia has not been documented. Manipulation of two syphgmanometer cuffs for Bier's block was successful in our study. It is pertinent to opine that they can be used with caution where there is no standard pneumatic cuff. Someone should be stationed by the cuffs to prevent adverse reaction from accidental deflation.

According to this present study, analgesic effect remained for up to one and half hours. The wait time (for about 45 minutes after injecting drug) is very important for avoiding toxic levels of anesthetics in the systemic bloodstream which can lead to cardiovascular collapse, convulsions and even death in extreme cases. In a child, the tourniquet is inflated to 50 mm Hg above systolic pressure. Intermittent deflations and re-inflations can start (after about 45 minutes of injecting the local anaesthetic agents) which prevents sudden surge of the level of the drugs in the blood stream. This can be done three times before the cuff is finally deflated.

Reports from anesthesiologists and other caregivers cited proper selection, inspection, and maintenance of equipment as important safety measures.[8, 9,10,15,16] Additionally, IVRA protocols should include procedures for regular preventive measures in selecting drugs, equipment and performance testing, whether manual or automated, prior to anaesthetic technique and surgery. Although Improved protocols, including adherence to standardized practice, may also help ameliorate the incidence and the effect of complications.[16] The patients in our study population did not have major adverse reaction. There should be enough and sufficient but not excessive tourniquet pressure for the drug to remain within the limb without any risk of adverse reaction or injury. In case complications occur, constant and continuous physiological monitoring is essential and patient should be made to have unrestricted access to senior doctor, resuscitative drugs and equipment.

Of 50 consecutive patients studied by Pickering et al,[17] all but two were satisfied with this form of anaesthesia. According to their study the pressure cuff inflation was considered the worst part of the procedure. They observed that Bier's block performed with prilocaine is at least as safe as other commonly used methods of anaesthesia for distal radial fracture reduction with high patient satisfaction. They concluded that procedure could be safely carried out by a single medical practitioner with appropriate patient monitoring and assistance from trained nursing staff.[17] This was in support of the present study where significant amount of patients and doctors were satisfied with the IVRA technique.

CONCLUSION AND RECOMMENDATION

Intravenous regional anesthesia is possible using two sets of Syphgmomanometer cuffs attached to the arm. Safety is guaranteed after exsanguination, followed by inflation of the proximal cuff (one close to the head of the patient),before injecting the local anaesthetic agent. However, a careful observer should be stationed around the cuffs to prevent cuff-accidental deflation. As always emphasized, vigilance, careful patient selection, consideration of comorbidities, case-by-case individual assessment and monitoring by a skilled anesthesiologist are necessary to ensure optimal outcomes.

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