Original Research Article

A comparative study between bier's block and axillary brachial plexus block for upper limb below elbow surgery

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Abstract

Introduction: Intravenous regional anaesthesia is a simple method of producing analgesia of the arm or leg by intravenous injection of a local anaesthetic, while the circulation is occluded. However, it was not long before simple and reliable techniques of brachial plexus block were developed and the intravenous method declined in its popularity. IVRA is a simple procedure and easily applicable, economical and time saving. **Aims:** This is a study conducted to compare two regional anaesthesia techniques i.e. the axillary brachial plexus block and Bier's Block with respect to Onset of analgesia, Degree of sensory and motor blockade, duration of analgesia and Complications**. Materials and methods:** A comparative study of axillary brachial plexus block and intravenous regional anaesthesia was carried out in Sixty patients of the age group 15 and 50 years of both sexes requiring both elective and emergency surgery of the upper extremity below elbow were selected and divided into two groups of 30 patients each. **Results:** IVRA appears to be a better alternative with regards to the onset of analgesia, the quality of analgesia and degree of motor blockade. More recent studies are more in favor of using adjuvants to local anaesthetics in IVRA which improved the quality of blockade and also the post-operative outcome with regards to analgesia even though it is not as comparable as brachial blockade. **Conclusion:** IVRA stands out as a better alternative for regional blockade indicated in upper limb surgeries below the elbow joint.

Keywords: Axillary brachial plexus block, Motor blockade, Duration of analgesia and Complications.

Introduction

The techniques of peripheral nerve blockade were developed early in the history of anesthesia. The american surgeons Halsted and Hall described the injection of cocaine in to peripheral sites including the ulnar musculocutaneous supratrochlear and infraorbital nerves for minor surgical procedures. Labats textbook focussed on the intraoperative management of patients undergoing intra-abdominal, head and neck procedures and extremity procedures under infiltration, peripheral plexus and splanchnic blockade. peripheral blockade remains a well-accepted component of comprehensive anesthetic care. Its role has expanded from the operating suite into the arena of post-operative and chronic pain management. Skillful application of peripheral neural blockade broadens the anesthesiologists range of options in providing optimal anesthetic care. The axillary approach to the brachial plexus is the most popular because of its ease, reliability and safety. Blockade occurs at the level of the terminal nerves. Although blockade of musculocutaneous nerve is not always produced with this approach, it can be supplemented at the level of axilla or at the elbow. Indication for axillary block include surgery on the forearm and hand[1]. This block is ideally suited for outpatients and is easily adapted to the pediatric population.

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The introduction of percutaneous axillary and supraclavicular techniques was received enthusiastically, which was given an even greater impetus by the First World War because of the many upper extremity injuries resulting from war. Brachial plexus block is widely used today to provide anaesthesia for upper extremity. There are four usual sites of approach. Interscalene Supraclavicular Infraclavicular Axillary. Intravenous regional anaesthesia is a simple method of producing analgesia of the arm or leg by intravenous injection of a local anaesthetic, while the circulation is occluded. His method of IVRA consisted of isolating a segment of the arm with tourniquets and injecting a solution of 0.5% procaine into a vein in the isolated segment[2,3]. However, it was not long before simple and reliable techniques of brachial plexus block were developed and the intravenous method declined in its popularity. It was revived in by Holmes, who used lidocaine which appeared to give more reliable anaesthesia than procaine and is now regarded as one of the fundamental techniques of anaesthesia for limb surgeries. IVRA is a simple procedure and easily applicable, economical and time saving.

Materials and methods

A comparative study of axillary brachial plexus block and intravenous regional anaesthesia was carried out in patients belonged to the inpatient section of the Departments of Anesthesia in 60 patients requiring both elective and emergency surgery of the upper extremity below elbow were selected and divided into two groups of 30 patients each.

Inclusion criteria

Age group 15 and 50 years of both sexes under going elective and emergency surgery of the upper extremity below elbow

Exclusion criteria

The patients who were highly nervous and uncooperative, shock, with infection and cellulitis and history of hypersensitivity to local anaesthetic

The patients were randomly divided into two groups:

Group 1 – were anaesthetized by axillary brachial plexus block

Group 2 – were anaesthetized by IVRA

The procedure of the technique and the development of paraesthesia were explained to the patient to ensure good co-operation. The procedure of the surgery was chosen in such a way that the surgery should be finished within 60 minutes. All the elective patients were premedicated with 5-10mg of diazepam orally HS, previous day. The technique was conducted in the major operation theatre.

The following investigations were done: Hb% estimation, Urine examination - Albumin, Sugar and Microscopy Screening chest / X-ray chest. **Blood** - FBS, Urea, Creatinine, B.T., C.T. E.C.G

Since the technique used relies on the production of paraesthesia and requires patient's cooperation, premedication is required to relieve apprehension and anxiety. We used diazepam which was easily available at any time. All patients were premedicated with injection diazepam intravenously (0.1mg/kg) ten to fifteen minutes before the procedure. This not only relived anxiety and contributed sedation, but also produced high degree of retrograde amnesia in most cases. In addition diazepam elevates the convulsant threshold of the patient to local anaesthetics and hence enhances the safety of the local anaesthetic agent.

All cases also received 10mg of diazepam tablets orally night before surgery.

All aseptic precautions were taken throughout the procedure. All the necessary equipments and emergency drugs were kept ready for resuscitation in order to cope with the toxic and untoward reactions occurring during the procedure. The patients were brought to the Operation Theatre and advised to lie in supine position with due comfort on the tiltable (operating) table. Once again the procedure was explained to the patient.

Procedure

This is indicated for procedures of the elbow, forearm, and hand. The patient lies supine, the arm to be blocked abducted A "multiple compartment approach" or "perivascular non paresthesia approach is used with the arm held at 90 degrees to the body, elbow flexed at 90 degrees, forearm elevated on a pillow, and hand supine. The non dominant hand fixed the artery in upper axilla against the humerus, and dominant hand is used to maneuver a 10 ml control syringe and needle in three passes cephalad to the pulse. Each pass of the needle is "fanned" slightly more distant from the pulse with 3 ml of local anaesthetic incrementally deposited with each pass. This process is repeated on the cauded side of the axillary pulse. When and if parasthesia happen to be encountered, 5 ml of local anaesthetic may be additionally deposited. The key to success with this approach is to view the anatomy of the axilla in cross-section. In cross-section, the musculocutaneous and median nerves can be found cephalad to the pulse: the radial and ulnar nerves can be found caudad. These nerves arep roximate to the pulse and (in general) superficial to the skin. Recently, it has been suggested that multiple injections technique for axillary block provide more effective anaesthesia than either double or single injection techniques.As mentioned, because the musculocutaneous nerve does not lie within the axillary sheath, it will likely retain full function. Anaesthesia of the forearm is incomplete unless the musculocutaneous nerve is also blocked at the antecubital fossa.

IVRA

Venipuncture

The veins were made prominent by occluding the venous flow in the limb to be operated and a 22G IV cannula mounted on a syringe loaded with normal saline was passed in the direction of the blood flow in the vein and fixed with adhesive plasters. In most of the cases the veins on the dorsum of the hand was taken except in patients who had come for wound debridement of the hand, in whom the vein in the forearm was selected. One IV cannula was passed in the other limb and connected to an IV drip to maintain a patent line.

Exsanguination

The limb to be operated was kept elevated above the level of the heart for 2 to 4 minutes for gravity drainage. Esmarch's bandage was applied to ensure complete exsanguinations. Both the methods were used for all the patients.

After exsanguination, the tourniquet was applied to occlude the vessels by first wrapping the site where the tourniquet was to be applied with cotton roll to reduce tourniquet discomfort.

a) A pneumatic (first or proximal) tourniquet was used and the cuff pressure was raised 50mm of Hg above the systolic BP. Esmarch's bandage which was used for exsanguination was removed after the application of the tourniquet and the time of application of tourniquet was noted.
b) A second tourniquet was applied distal to the first tourniquet after anaaesthesia was elicited in the forearm and the pressure inflated to the same level as the first tourniquet The first tourniquet was then released and removed. This was done to reduce tourniquet discomfort.

The anaesthetic drug of choice in the study was plain lignocaine hydrochloride 0.57%. The concentration of the drug was kept constant for all the patients. The dose and volume of the drug was chosen according to the weight of the patient. As the drug was injected, the skin usually became mottled and analgesia developed rapidly. The muscle relaxation was profound and appeared at the same time. As the drug was injected, the forearm was tested for analgesia every minute till complete analgesia (loss of sensation for pin prick) was elicited. The time of onset of analgesia after injection of the drug was noted. The IV cannula 22G was either removed or locked in situ depending on the site of surgery. Then the surgeon was allowed to proceed with the operation.

It was assumed that deflating the tourniquet soon after the injection could be equivalent to a rapid intravenous injection of lignocaine and could produce toxic effects. Hence the cuff was kept inflated for a minimum period of 25 minutes. Tourniquet was released soon after the surgical procedure when the duration of surgery was more than 25 minutes and the tourniquet was released 25 mins after its application if duration of surgical procedure was less than 20 minutes. The patients were monitored continuously for evidence of toxicity, change in pulse, BP and respiration for first 10 minutes, there after at an interval of 5 minutes. The time taken for reappearance of pain sensation after the release of tourniquet was noted by pin prick method. The patients were kept for observation for 30 minutes for noting any signs of toxicity and then shifted to the ward.

The parameters observed were time of onset of analgesia in minutes(This was recorded as the interval between the time of injection and the development) loss of sensation to pin prick, Quality of analgesia(The onset and completion of analgesia was tested by loss sensation to pin prick.)

The effect of analgesia after injection was graded as:

Grade I: Good analgesia, sedatives were given only to relieve apprehension.

Grade II: Inadequate, incomplete or patchy analgesia, supplementation was given with N2O/O2
halothane or ketamine.

Grade III: Very poor analgesia. General anaesthesia was administered.

Degree of motor blockade

Motor blockade produced by the two techniques was assessed as follows:

Grade I: Complete block, no active movement of entire arm and shoulder.

Grade II: Almost complete block, slight active movement of the fingers retained.

Grade III: No block, nearly full range of movement retained.

1) Complications

During the procedure

Post operative for 24 – 48 hours.

All patients were followed up on the day of surgery and on the following day, for 48 hours to note any complications. All observations and particulars of each patient were recorded in the proforma enclosed. Duration of analgesia was measured as a time interval between onset of analgesia and time at which patient complained of pain.

Results

A comparative study between axillary brachial plexus block and IVRA was carried out on 60 patients divided into 2 groups of 30 patients each in the age group of 15 and 50 years. The following observations were made.

Age (years)	Group I.	Group II	Total
15 – 24	9	4	13
25 – 34	10	9	19
35 – 44	10.	10	20
45 – 54	1	7	8
Total	30	30	60
Gender			
Male	20	23	43
Female	10	7	17
ASA			
I	29(96.6%)	26(86.6%)	55(91%)
II	1(3.3%)	4(13.3%)	5(9%)

Majority of the patients of patients are in the age group of 35 – 44 years and male patients (71.6%). The common diseases found in the ASA Grade II patients were controlled hypertension or diabetes.

Table-2: Various surgical procedures carried out on the selected atients under axillary block and IVRA

Diagnosis	Group I		Group II	
	No.	%	.No.	%
Both bone fracture forearm	7	23.3	8	26.6
Crush injury	5	16.6	4	13.3
Fracture radius or ulna or colles	6	20.0	8	26.6
Tendon injury	2	6.6	1	3.3
Others (Exostosis, FB, # 1st MC bone post burns contr., osteosarcoma myositis ossificans, implant, dermoid).	10	33.3	9	30.0

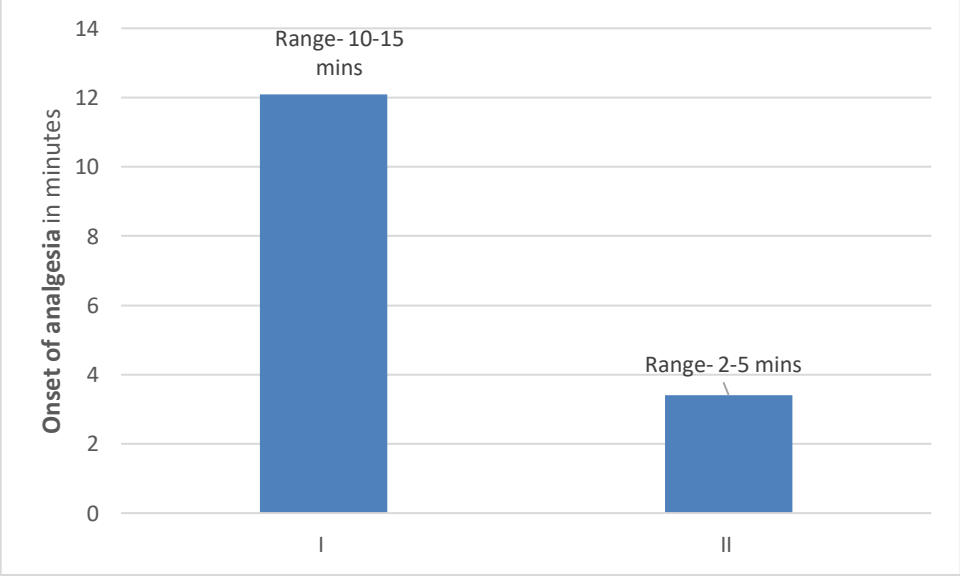

Fig.1:Onset of analgesia after injection of drug

There is early onset of analgesia with IVRA and the result was found to be significant. The mean onset of analgesia with IVRA was 3.4 mins as compared to brachial block where mean was 12.1 mins.

Table-3: Quality and Duration of analgesia

Quality of analgesia .	Group I		Group II	
	No.	%	No.	%
I	15	50	23	76.6
II	15	50	7	23.3
III	-	-	-	-
Total	30	100	30	100
Duration (minutes)				
30 – 40	-	-	10	33.3
40 – 50	-	-	8	26.6
50 – 60	1	3.3	10	33.3
60 – 70	23	76.6	2	6.6
70 – 80	6	20	-	-
Total	30	100	30	100

The above table compares the quality of analgesia. Among patients receiving axillary block 50% had grade I analgesia whereas with IVRA the percentage was 76.6%. None of the patients had grade III analgesia and hence did not need general anaesthesia to complete the surgical procedure. In case of brachial block the duration was between 60-80 minutes where as with IVRA it was between 30-70 minutes depending upon the time of release of tourniquet.

Table-4: Degree of motor blockade

Degree of motor blockade	Group I		Group II	
	No.	%	No.	%
I	8	26.6	17	56.6
II	22	73.3	13	43.3
III	-	-	-	-
Total	30	100	30	100

The above table compares the degree of motor blockade achieved. With axillary block 26.6% patients had Grade I blockade with the remaining having Grade II (73.3%) blockade. With IVRA the degree of motor blockade was Grade I in 56.6% with 43.3% achieving Grade II blockade. None of the patients had Grade III motor blockade.

Table-5: Return of sensation after release of tourniquet

Time of return of sensation (min)	No. of cases	Percentage
2–4	30	50
4–6	8	13.3
6–8	10	16.6
8 – 10	12	20
Total	60	100

The time of return of sensation was noted. It was taken as the time from the release of tourniquet to the time when the patient complained of pain. The wearing time of anaesthesia ranged from 2 to 10 minutes.

Table-6: Comparison of duration of analgesia between the two study groups

Group	Duration of range	Analgesia mean	(min) S.D.	Significance
I	60 – 76	66.1	4.5	P < 0.001*
II	30 – 62	48.1	8.8	

The above table shows that the mean duration of analgesia with axillary block was found to be 66. 1mins when compared to IVRA which was 48.1mins.

Axillary site pain and discomfort was complained of by 2 patients in the axillary plexus block group whereas bradycardia and hypotension was observed in 3 patients in the IVRA group which came to normal within 25 minutes.

Discussion

Regional Anaesthesia is becoming more popular especially with the advent of safer drugs and techniques; brachial plexus and IVRA are two such techniques which have become more useful in the last few decades. Since both the procedures share similar indications and site of action, an attempt has been made to compare the two. Various drugs such as tetracaine, prilocaine, mepivacaine, lignocaine and bupivacaine have been used for the procedures from time to time. Etidocaine is twice as toxic as lignocaine. Chlorprocaine can produce CNS effects and thrombophlebitis. Bupivacaine is more cardiotoxic and does not provide adequate muscle relaxation. Lignocaine is a safe local anaesthetic has moderate potency, relatively early onset of action and reasonable duration of action[4].

IVRA was conducted by Edson D. Carel in pediatric age group by B R.K. Mehta et al., White and Colizza and Said and supraclavicular brachial block in combination with general anaesthesia was used for microvascular surgery in children by Inberg P. et al[8]. In this study only adult patients were selected because of good patient cooperation with regard to the procedure. In the present study 60 patients who received either brachial plexus block or IVRA, were in the age group of 15 and 50 years. In the present study all elective cases were given 5-10 mg of diazepam orally as sedation on the previous night.

In this study lignocaine was used as an anaesthetic agent for all the cases in a concentration of 1% for axillary block and 0.5% for IVRA. The recommended maximum dose used was 3-5mg/kg body weight. All these doses recommended serve only as a base upon which a person using the drug in the technique should apply a sensible judgment and make appropriate adjustment. Palve H et al[9], stated that maximum recommended dosage of lignocaine are frequently exceeded in clinical practice as some blocks may need more lignocaine to produce adequate anaesthesia. They used up to 900 mg of lignocaine with adrenaline without any toxic symptoms. Hariramani, Garg and many others used 0.5% lignocaine for IVRA[10,11].

The onset of action of analgesia after injection of 1% lignocaine was 12.1 ± 1.6 minutes whereas with 0.5% lignocaine for IVRA it was found to be 3.4 ± 0.9 minutes. The observation for IVRA is comparable and similar with that of Mehta and many others. Schulte-Steinberg et al[12]., reported a mean onset time of 12 minutes with unalkalinized lignocaine.

Vikram Uday Lahori, Anjana Raina et al, found mean onset of analgesia to be 13.68±7.28 minutes in their study on 60 patients[13].

Mehta, Verma, Gupta in their study on 60 subjects reported mean onset of analgesia for axillary block without bicarbonate to be (Mean±SD) 12.1±4.43. Adil Ababou, MD Nizar Marzouk, MD et al (2007) found in their studies that mean onset of sensory blockade in group ABD(abduction) to be 12 ± 3 minutes. Ali Movafegh, MD, Mehran Razazian,(2005),in their studies on 60 subjects found mean onset of analgesia 34 mL lidocaine 1.5% with 2 mL of isotonic saline chloride 11 ±4 minutes[14,15,16,17].

This was graded into three groups as mentioned earlier. In the axillary approach Grade I analgesia was observed in 50% of patients when compared to IVRA in which 76.6% of the patients were found to achieve grade I analgesia. The remaining patients in both the groups achieved Grade II analgesia. In a study conducted on patients receiving brachial bock by suraclavicular approach widest variations in the extent of blockade was observed (P<0.05). The preferentially blocked sensory nerves resulted in analgesia in about 50% of blocks within 5 minutes after injection of local anaesthetic. In IVRA the results were excellent with very few failures. Bier had 100% excellent results[18].

The degree of motor blockade observed in Group I (i.e. Axillaty approach) was found to be Grade I in 26.6% of patients and 56.6% in Group II patients. Grade II motor blockade was found to be 73.3% and 43.3% in Group I and Group II respectively. These findings are comparable to the findings of Shulte Steinberg and Hariramani who found it to be around 40% in case of brachial block. who found good motor blockade in 58% of their patients[11,12].

The mean duration of analgesia with Axillary brachial block was found to be 66.1 min, whereas the duration of analgesia with IVRA depends on the time of release of tourniquet with an average of 48.1 minutes. The above findings were similar to the findings of Schulte-Steinberg et al.[12], who stated the duration to be around 60 minutes with brachial block when using unalkalinized lignocaine. The duration of analgesia with regard to IVRA depends upon the time of release of tourniquet. The reappearance of pain after tourniquet release in the present study was found to be between 2 to 10 minutes.

Mehta, Verma, Gupt ,in their study on 60 subjects found the mean duration of Sensory blockade in axillary block to be (Mean±SD) 87.1±17.10 minutes[14,15].

Axillary pain or discomfort was the only complication encountered in the axillary approach group in 2 patients whereas bradycardia and hypotension (transient) was observed in 3 patients in the IVRA group. Hence this correlates with the finding of studies who stated that complications were mild and transient with brachial block. Toxic reactions with IVRA appear to be more common when the injection release interval is less than 25 minutes as observed by Bier (1908), who advocated an interval of minimum 30 minutes. Holmes series had mild symptoms referable to CNS in 8 out of 30 cases in which he used 200-400 mgs lignocaine and the surgery lasted for 15-75 minutes with 3mg/kg body weight dose. In the present study patients had an injection release interval of more than 25 minutes and no toxic reactions were observed. Vikram Uday Lahori, Anjana Raina et al, found complications like accidental vascular puncture in 2 patients of axillary block group.No other complications or significant adverse effects appeared in both the study groups[13].

Conclusion

The techniques of brachial plexus block and IVRA for upper limb surgery are an additional to the armamentarium of the anaesthetist, particularly when the patients present for emergency surgery with full stomach or in the presence of chest diseases like severe respiratory tract infection, emphysema, bronchiectasis etc. After conclusion of the present study and suggestions form previous reference, IVRA appears to be a better alternative with regards to the onset of analgesia, the quality of analgesia and degree of motor blockade. More recent studies are more in favor of using adjuvants to local anaesthetics in IVRA which improved the quality of blockade and also the post-operative outcome with regards to analgesia even though it is not as comparable as brachial blockade. Duration of analgesia was more with axillary brachial plexus blockade. With the advent of latest technique of continuous brachial plexus blockade by insertion of catheter, pain relief was still more pronounced. With regards to complications, no significant difference has been found and both the techniques were found to be equally safe with mild temporary complications. Hence after the conclusion of the above study IVRA stands out as a better alternative for regional blockade indicated in upper limb surgeries below the elbow joint.

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