A COMPARATIVE STUDY OF INTRAVENOUS REGIONAL ANESTHESIA USING A FOREARM VERSUS UPPERARM TOURNIQUET

A STUDY OF 60 CASES

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CHENNAI, TAMILNADU

BONAFIDE CERTIFICATE

This is to certify that the dissertation entitled **"A COMPARATIVE STUDY OF INTRAVENOUS REGIONAL ANESTHESIA USING A FOREARM VERSUS UPPERARM TOURNIQUET"** is a bonafide record work done by **Dr. R. KANIMOZHI** under my direct supervision and guidance, submitted to the Tamil Nadu Dr. M.G.R. Medical University in partial fulfillment of University regulation for DM, Branch X –Anesthesiology.

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DECLARATION

I **Dr. R. KANIMOZHI** solemnly declare that the dissertation titled **"A COMPARATIVE STUDY OF INTRAVENOUS REGIONAL ANESTHESIA USING A FOREARM VERSUS UPPERARM TOURNIQUET"** has been prepared by me. I also declare that this bonafide work or a part of this work was not submitted by me or any other for any award, degree, diploma to any other University board either in India or abroad.

This is submitted to The Tamilnadu Dr. M. G. R. Medical University, Chennai in partial fulfillment of the rules and regulation for the award of Doctor of Medicine degree Branch –X (Anesthesiology) to be held in March 2009.

Place : Madurai **Dr. R. KANIMOZHI**

Date :

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CONTENTS

INTRODUCTION

Intra Venous Regional Anesthesia is a safe and effective technique for providing anesthesia as well as bloodless field during hand surgery. Traditionally, an upperarm tourniquet has been used for these procedures. However, upperarm IVRA does have some disadvantages including the potential for local anesthetic toxicity, Tourniquet pain and lack of postoperative analgesia. Toxicity may be caused by leakage past the tourniquet because of high venous pressures or tourniquet failure. Adverse reactions have also been reported upon tourniquet release, especially when larger doses of local anesthetic are used.

The application of a Forearm tourniquet offers several advantages to the use of an upperarm tourniquet. Forearm IVRA allows the dose of LA to be decreased by upto 50 %, without affecting the quality of analgesia. In addition, the forearm tourniquet can be tolerated longer and was consistently rated less painful when compared with the upperarm tourniquet. Finally, using a forearm tourniquet allows for preservation of some motor function of the long flexors and extensors of the wrist and hand which is useful in certain operations such as Tenolysis and fixation of hand fractures.

The routine use of a forearm tourniquet has previously been avoided because of the potential risk of nerve injury, incomplete hemostasis and leakage of local anesthetic into the systemic circulation. However, these theoretical concerns have not been substantiated in any studies. Several investigations revealed that the forearm tourniquet is a safe and effective technique for hand surgery. In fact, the use of a forearm tourniquet may be a safer alternative to upperarm IVRA by reducing the local anesthetic dosages to nontoxic levels.

AIM OF THE STUDY

To evaluate the efficacy of forearm tourniquet, in comparison with upperarm tourniquet in Intra Venous Regional Anesthesia on the quality of the block and the post operative pain relief.

HISTORY

Intra Venous Regional Anesthesia was first described by August Bier in 1908. He described a method of “venous anesthesia” in 134 patients with good anesthesia and no “bad effect” He observed that when local anesthetic was injected intravenously, between two tourniquets on a limb a rapid onset of anesthesia occurred in the area between the tourniquets and a slower onset occurred beyond the distal tourniquet.

Adams, in a 1944 review article, cited Bier as well as Alms, who in 1886 had described intravenous injection of local anesthetic with subsequent analgesia in the area of the body drained by the vein. The technique was reintroduced and slightly modified by Holmes in 1936, using either a single or a double tourniquet at one site and injecting local anesthetic as distal as possible to the cuff. Since then many reports have touted its simplicity and benefits.

Reuban et al and Steinberg stated that IVRA with forearm tourniquet provided an enhanced postoperative analgesic effect when compared with an upperarm tourniquet.

INTRA VENOUS REGIONAL ANESTHESIA

Intra Venous Regional Anesthesia is technically simple and does not require specific anatomical knowledge. Success rate is 96-100% with a low incidence of side effects. It is a reliable, simple and safe method of providing anesthesia for minor surgical procedures of the extremities, if administered by experienced clinicians.

Mechanism of Action:

Local anesthetic diffuses into the small veins surrounding the nerves and then into the vasa nervorum and capillary plexus of the nerves, leading to core of mantle (centrifugal) conduction block in the nerves involved local anesthetic then diffuses into the small nerves in the skin, blocking their conduction. The tourniquet produces ischaemia, which contributes to the analgesic action of the local anesthetic by blocking, nerve conduction and motor end plate function twenty minutes after tourniquet application alone there will be analgesia to pinprick without injection of any local anesthetic. However, the speed of onset and density of anesthesia are greater with injection of local anesthetic.

Site of action:

Carbon 14 labelled 1%Lignocaine readily permeates tissues by direct migration through the walls of vascular beds. Support for the view that anesthetics act on the nerve trunks, comes from intravenous injection of

radiopaque dyes and the observation that the more distal parts of the extremity are innervated by the core fibres of the nerve trunk. Since the core is well supplied with abundant vascular channels that could carry the anesthetic to the core fibres, the more distal parts of the extremity should become anesthetized first as has been noted clinically. Impulse transmission studies indicate that the site of action is at the branching points of the nerve fibres.

PROCEDURE:

QUALIFICATIONS OF THE PERSON ADMINISTERING IVRA:

Local anesthetics can cause serious morbidity and mortality in small amounts through allergic reactions and in the large amounts used in IVRA by direct toxic effects on the brain and heart. So the person administering the anesthetic must be trained and qualified to handle convulsions, respiratory arrest, myocardial depression and cardiac arrhythmia and arrest decisively and appropriately. A current ACLS or comparable certification, a facility with rapid endotracheal intubation and artificial ventilation and familiarity with cardiac arrest and seizure treatment protocols should be the minimal acceptable qualification.

Advantages:

- Speed of onset and rapid recovery
- Reliability (in the absence of local infection and with adequate equipment)
- Muscle relaxation
- Technical simplicity

Disadvantages and Complications:

- Poor post operative analgesia
- Limited time of surgical anesthesia (<90 minutes)
- The potential of systemic local anesthetic toxicity
- Nerve damage secondary to direct compression by the tourniquet
- Compartment syndrome and loss of limb (very rare)

INDICATIONS:

IVRA is used for surgical interventions on the hand, forearm or elbow that will not exceed 1 hour. These include manipulation of forearm fractures, excision of ganglion, palmar faciotomy, debriding wounds, removing foreign bodies, wrist and ankle arthroscopy, carpal tunnel decompression, repair of ruptured tendons, incision and drainage of abcesses and paronychia, podiatric surgery, microsurgical repair of limbs, suturing extensive lacerations that would otherwise require a large and

possibly toxic dose of local anesthetic infiltrated into the wound edges, excision of painful scars and grafting.

CONTRAINDICATIONS:

Contraindications are mainly related to tourniquet use. Absolute contraindications include sickle cell disease, Raynaud's disease or scleroderma, allergy to local anesthetics and patient refusal. Relative contraindications include severe hypertensive or peripheral vascular disease, local infection and skeletal muscle disorder or pagets disease where local anesthetic may spread to the systemic circulation via venous channels in bone, patients who are unable to cooperate because of psychosis and dementia, progressive neurologic disease, coagulation disorders, and patients with calcified peripheral arteries.

The equipment required for IVRA includes:

- Pneumatic tourniquet (checked for leaks before the procedure) and a pressure gauge.
- Esmarch bandage or Rhys-Davis exsanguinator
- Local anaesthetic solution
- Resuscitation equipment and drugs.

Intra Venous Regional Anesthesia of the arm:

A 22 G cannula is placed intravenously as distal as possible in the arm to be anaesthetized. Venous access is established in the opposite arm to

allow administration of fluids or drugs if necessary. The double tourniquet (two tourniquets each 6 cm wide) or a single one (14 cm wide) is applied on the arm with generous layers of padding, ensuring that no wrinkles are formed and the tourniquet edges do not touch the skin. The arm is exsanguinated either by using the Esmarch bandage or a Rhys-Davis exsanguinator. If this is impossible, exsanguination can be achieved by elevating the arm for 2-3 minutes while compressing the axillary artery. The distal tourniquet is inflated to at least 100mgHg higher than the patient's systolic blood pressure (250-300mmHg). The proximal tourniquet is inflated to the same pressure. After ensuring inflation, the distal cuff is deflated.

Before injecting local anaesthetic it must be confirmed that no radial pulse is palpable. The local anaesthetic is then injected slowly. A standard volume for injection into the upper limb is 40ml, which can be increased to 50ml in a fit, large adult. If the injection is too rapid, the venous pressure may exceed the tourniquet pressure and the local anaesthetic solution may escape into the systemic circulation. Surgical Anesthesia is usually achieved within 15 minutes. The distal tourniquet, which overlies part of the anaesthetized arm, can then be inflated and the proximal one deflated to relieve tourniquet pain.

The cuff should not be deflated until 20 minutes after local anaesthetic injection because systemic toxic doses of local anaesthetic may

occur. After 20 minutes, 30% of the injected drug is fixed within the tissues and is unavailable for immediate release into the systemic circulation. Cuff deflation should be performed in cycles with deflation / inflation times of less than 10 seconds until the patient no longer exhibits signs of systemic toxicity (e.g. tingling of the lips, tinnitus, drowsiness). Severe signs of systemic toxicity include bradycardia, hypotension, ECG abnormalities, seizures and loss of consciousness. Maximum blood levels of local Anesthesia occur within 10 minutes of cuff deflation. Therefore, the patient should be monitored closely for 30 minutes following tourniquet release.

Ten minutes after cuff deflation, blood levels will be less than 2 micrograms/ml, when Lignocaine is used in a dose of 2.5 – 3 mg/kg.

If severe CNS intoxication occurs, appropriate resuscitation guidelines should be followed. Emergency drugs must be readily available and 100% oxygen should be administered.

Forearm Intra Venous Regional Anesthesia:

Forearm IVRA has been infrequently used in the past because of concerns of local anesthetic leakage, difficulty maintaining a bloodless field, and possible nerve injury. It was thought that “compression forces of an inflated forearm tourniquet cannot obliterate the anterior and posterior interosseous arteries seated in the deep ‘valley’ between the prominent

radius and ulna". It was therefore assumed that tourniquet leakage was inevitable.

In addition, concern was expressed that the distal part of the limb is too small to withstand the higher localized pressures with the use of a forearm tourniquet. It has also been suggested that proximal tourniquet placement is more likely to transfix the ulnar nerve, resulting in an increased incidence of traction neuritis.

However, these theoretical concerns have not been substantiated in any studies. In fact, several studies revealed that the forearm tourniquet is a safe and effective technique for hand surgery. A review of more than 1000 patients undergoing surgery using a forearm tourniquet resulted no significant increases in the incidence of peripheral nerve injury.

Furthermore, adequate intraoperative analgesia occurred in all subjects using fifty percent less Lignocaine than normally used for IVRA. Forearm IVRA provides significant postoperative analgesia benefit. The reason for this enhanced analgesic effect is not known. One possible explanation may be an increased binding of analgesics to the local tissues during forearm IVRA. The prolonged sensory block observed in the forearm IVRA is clinically useful to surgeons at the end of the operative procedure. Because recovery of pain sensation is rapid after tourniquet deflation with upperarm IVRA, subsequent hemostasis and wound closure may be difficult

to achieve. So surgeons recommend routine wound infiltration or metacarpal block immediately before tourniquet deflation. Because forearm IVRA provides prolonged sensory analgesia, it may reduce or eliminate this need to supplement the IVRA.

Forearm IVRA not only provides enhanced postoperative analgesia, but also increases the safety margin of this technique. This allows for a 50% reduction in the dose of Lignocaine, therefore this approach reduces the risk of local anesthetic toxicity in the event of tourniquet failure.

Duration of effective analgesia:

Usually about 45 minutes after, tourniquet inflation, discomfort becomes bothersome. The anesthetist can then inflate the distal tourniquet and when assured that satisfactory occlusion pressure for that tourniquet plus 100mmHg is present and stable in the cuff, deflation of the proximal tourniquet is done. This will give some relief and allow another 15 to 30minutes before tourniquet pain again becomes relatively bothersome.

Continued switching from proximal and distal tourniquet and vicecresa, will allow often another half hour pain free IVRA. Judicious use of small doses of intravenous sedatives, anxiolytics and narcotics will also contribute to extending the time the tourniquet will be tolerated. If the surgical procedure extends beyond 1.5 hours a light general anesthesia such as nitrous oxide and oxygen is almost always necessary. The effectiveness of

the anesthetic can be markedly enhanced by inflating the tourniquet 10-20 minutes prior to injecting the anesthetic. Only half the dose of the anesthetic is needed for satisfactory analgesia if this is done.

TOURNIQUET RELEASE:

If surgery has lasted less than 30minutes, it is suggested that the tourniquet be deflated for only 15 seconds and reinnflated for 30 seconds to 2minutes and this cycle be repeated several times before the cuff is let down permanently. If the tourniquet has been inflated for over 30 minutes it is generally safe to let the tourniquet down all at once. During the procedure there is a constant leakage of anesthetic out of the extremity, via intramedullary bone channels and after 30 minutes a nontoxic amount of anesthetic remain in the extremity. Some sources have shown that it is safe to deflate the tourniquet all at once even if the surgery has taken as little as 5-15 minutes.

REINJECTION:

After the tourniquet is deflated and the anesthetic is deflated and the released into the general circulation, the lungs act as a giant reservoir and clear a large amount of anesthetic as it passes through them, releasing it over subsequent circulation times. Peak levels of the anesthetic are 20-80% less than if the same amount of local anesthetic had been given i.v. Approximately 30% of the drug is released from the extremity at first and

50% still remain in the arm after 30 minutes. It is possible to reinject one half of the original dose, 30 minutes after tourniquet release and to achieve adequate analgesia for an additional 30 -45 minutes of surgery without raising the intravascular anesthetic concentration.

Intra Venous Regional Anesthesia of the leg:

The basic technique is the same as for the arm but the dose and volume of local anaesthetic has to be doubled for IVRA of the leg, which is associated with an increased potential for local anaesthetic toxicity. The tourniquet pressure must be higher in the leg (350-400mmHg), to occlude blood flow in the femoral artery. This may increase the occurrence of tourniquet pain. Tourniquet may be applied to the thigh (two tourniquets about 9 cm wide) or one at the calf (below the head of the fibula) and one at the thigh. The latter is for safety in case of distal cuff failure and is not usually inflated.

Choice of drugs

Many local anaesthetic drugs, with or without additives, have been used for IVRA, but 0.5% prilocaine, 3-6 mg/kg, is the drug of choice, because it has less systemic toxicity and is partially taken up in the lungs before reaching the systemic circulation. The usual dose is 40ml (200mg) without epinephrine. However, the manufacturers have ceased production of 0.5% prilocaine. 1% prilocaine remains available and is licensed for IVRA,

though its stability is not guaranteed if diluted. If prilocaine is unavailable and 0.5% Lignocaine, 3 mg/kg, is used. If IVRA is applied to the leg a larger volume must be injected (upto 100 ml). Prilocaine can be used undiluted (maximum recommended dose is 400mg in adults) but Lignocaine is commonly diluted to lower concentrations (e.g. 0.2-0.25%)

Prilocaine can cause methaemoglobinaemia but unless doses in excess of 600 mg are used, it is clinically insignificant in most patients. Although one has to be aware that in patients with anaemia or cardiac conditions even small amounts of methamoglobin can significantly impair the oxygen carrying capacity of their red blood cells. Intravenous regional Anesthesia with prilocaine in these patients should be considered carefully for its benefits.

Other local anaesthetic agents have been used but do not provide superior analgesia or more rapid onset of block. Severe toxic reactions and death have been observed with bupivacaine and its use is contraindicated. In one study, 0.2% ropivacaine used intraoperatively was as effective as 0.5% prilocaine, but postoperative analgesia was prolonged;

Additives to local anaesthetics have not been consistently shown to have an effect during IVRA but may increase the length of postoperative analgesia, probably because of a systemic effect following tourniquet

release. The reported enhancement of IVRA with pethidine, 1 mg/kg, may reflect intrinsic local anaesthetic activity of the drug.

Experiments with the addition of muscle relaxants produced marked muscle relaxation but did not augment analgesia.

TOURNIQUETS

Operations on the extremities are made by the use of a tourniquet. A pneumatic tourniquet is safer than Esmarch tourniquet or the Martin sheet rubber bandage. A pneumatic tourniquet with a hand pump and a pressure gauge is probably the safest, but a constantly regulated pressure tourniquet is quite satisfactory. Sphygmomanometer cuff when used, must be wrapped with a gauze bandage to prevent slipping.

The extremity is then elevated for two minutes or the blood is expressed by a sterile sheet rubber bandage or a cotton elastic bandage. Beginning at the fingertips or toes, the extremity is wrapped proximally to within 2.5-5cm of the tourniquet. The tourniquet should be inflated quickly to prevent filling of the superficial veins before the arterial blood flow has been occluded.

TOURNIQUET PRESSURES:

Reid, Camp and Jacob used pneumatic tourniquet pressures determined by the pressure required to obliterate the peripheral pulse using a Doppler stethoscope; they then added 50-75mmHg to allow for collateral circulation and blood pressure changes. Tourniquet pressures from 135-255mmHg for the upper extremity and 175-305mmHg for the lower extremity were satisfactory.

Esterson and Sourfman recommended pressures of 90-100mmHg above the pre operative systolic arm blood pressure. Others have recommended 50-75mmHg above the systolic blood pressure for the surgery in the upper extremity and 100-150mmHg for surgery in the lower extremity.

According to Crenshaw et al, wide cuffs are more effective at lower inflation pressures than are narrow one. Any solution applied to the skin must not be allowed to run beneath the tourniquet or a chemical burn may result.

TOURNIQUET TIME:

There is no rule as to how long a tourniquet may be safely inflated. The time may vary with the age of the patient the vascular supply of the extremity. In an average healthy adult, the author prefers to leave the tourniquet inflated no more than 2 hours. If an operation on the lower extremity takes longer than 2 hours, it is better to finish it as soon as possible. Alternatively the tourniquet can be deflated for ten minutes and reinflated again. If the tourniquet is absolutely essential and when the advantages justify the risk for lengthier procedure, tourniquet must be deflated atleast for 20 minutes to restore normal oxygenation, pH, chemistry of the limb. TT may be extended to 3 hours if tourniquet is deflated for 20 minutes at the end of each hour. But this usually interferes with the

operative procedure. So it is wiser to proceed with the tourniquet for two hours and then discontinue its use.

FOREARM TOURNIQUET:

Khuri and co workers found in a prospective study that applying a tourniquet to the forearm is safe and effective for surgery of the hand and wrist. They are safe, effective and well tolerated for surgery in the dlistal forearm, wrist and hand. The optimal tourniquet pressure for this technique is 75-100mmHg above the patients systolic blood pressure.

Wrap several layers of soft cost padding circumferentially around the proximal forearm and apply a pneumatic tourniquet approximately 5 cm below the medial condyle.

TOURNIQUET PARALYSIS:

It can result from

(1) Excessive pressure

(2) Insufficient pressure resulting in passive congestion of the part with hemorrhagic infiltration of the nerve

(3) Keeping the tourniquet for too long

(4) Application without consideration of local anatomy.

POST TOURNIQUET SYNDROME:

It is a common reaction to ischemia and is characterized by edema, pallor, joint stiffness, motor weakness and subjective numbness. This is due

to duration of ischemia and not to mechanical effect of tourniquet. Post tourniquet syndrome interferes with early motion and results in increased narcotic requirements. Spontaneous resolution occurs in one week

TOURNIQUET HYPERTENSION AND TOURNIQUET PAIN:

Differential blockade of some fibres but not others may explain the occurrence of Tourniquet Hypertension, despite adequate sensory level by pinprick. Tourniquet pain is mediated by unmyelinated slow conducting ‘c’ fibres and gate theory mechanism of large fibre block and small fibre activity.

Recommendation to ameliorate tourniquet pain is to use subarachnoid blockade than General Anesthesia or Epidural Anesthesia. Obtain adequate pin prick level. Epinephrine, clonidine, but not glucose can be added as adjuvants to decrease the tourniquet pain.

PHARMACOLOGY OF LIGNOCAINE

Lignocaine is a synthetic amide linked anaesthetic of intermediate potency and duration. In 1943 Lofgren synthesized Lignocaine in Sweden. First used by Gordh in 1948.

Lignocaine is the standard to which all other local anaesthetics are compared. It is currently the most widely used local anaesthetic. In addition, it is popular antiarrythmic. It an be given by almost any route.

Mechanism of action:

Lignocaine prevent transmission of nerve impulses by inhibiting passage of sodium ions though ion-selective sodium channels in the nerve membranes. This slows the rate of depolarization such that the threshold potential is not reached and thus action potential is not propagated. But resting membrane potential is not altered. Lignocaine binds to the inner portion receptor (i.e. Sodium channel) after entering the cell membrane.

Physiochemical properties:

Molecular weight 234

Weak base with a pka 7.6 – 7.8

Very stable, not decomposed by boiling, acids or alkalies

It is less lipid soluble than that of Bupivacaine

Pharmacokinetics:

Absorption:

It is absorbed from the site of application or injection into the blood stream. Rate of absorption depends on the blood flow to the area and use of epinephrine.

Metabolism:

Metabolized in liver by oxidative dealkylation to monoethylglycine xylidide followed by hydrolysis of this metabolite to xylidide. Metabolism is dependent on hepatic blood flow.

Monoethylglycine xylidide has 80% activity of the parent drug.

Xylidide has 10% activity of the parent drug.

75% of xylidide is excreted in the urine as 4-hydroxyl-2, 6-dimethylaniline.

Onset of action:

Rapid onset of action.

- Topical Anesthesia 5-10 mins
- Conduction Anesthesia

  For small nerves 5-10 mins

  For large nerves 10-15 mins
- Intravenous administration 1-2 mins

Protein binding:

It is 70% bound to α 1 acid glycoproteins

Volume of distribution:

91 litres

Distribution:

Lignocaine has a triphasic distribution

Rapid distribution phase (α):

In this phase, the drug is distributed to highly vascular regions.

$t^{½}$ α is 1 min.

Slow disappearance phase (β):

The drug is distributed to slowly equilibrating tissues.

$t^{½}$ β is 9.6 min.

Slow transformation and excretion phase (δ):

$t^{½}$ is δ is 1.6 hrs.

Clearance is 0.95 litres per minute

Availability:

a. 5% heavy 2ml ampoules which contain 50 mg of Lignocaine / ml with 75mg – 100 mg of dextrose.
b. 2% ligocacine (xylocard) without preservative – 50 ml vial for intravenous use

c. 2% Lignocaine – plain – 30 ml vial – contains methyl and propyl paraben as preservative.
d. 4% Lignocaine with 1 in 200000 Adrenaline – 30 ml vial.
e. 4% Lignocaine viscus
f. 4% Lignocaine aqueous solution
g. 10% Lignocaine spray
h. 2% Lignocaine jelly
i. 2% Lignocaine ointment
j. 5% Lignocaine ointment

Pharmacodynamics:

Local actions:

Causes nerve blockade with loss of pain and temperature sensation touch, motor power and vasomotor tone in the region supplied by the nerves blocked.

Systemic actions:

Result of systemic absorption from the site of administration or intravenous administration.

Cardiovascular system:

It has a stabilizing effect on the cell membranes of cardiac tissue.

Lignocaine, depresses myocardial automaticity by antagonizing the spontaneous phase IV depolarization and reduces the duration of effective refractory period.

Myocardial contractility and conduction velocity are depressed at higher concentrations.

These effects result from direct cardiac muscle membrane changes (i.e.) cardiac sodium channel blockade.

It stabilizes the membrane of damaged and excitable cells, tending to suppress ectopic foci.

Respiratory system:

Lignocaine depresses hypoxic drive (the ventilatory response to low P_aO_2)

Apnea can result from phrenic and intercostals nerve paralysis or depression of the medullary respiratory center following direct exposure to the local anaesthetic agents.

Relax bronchial smooth muscle.

Intravenous Lignocaine may be effective in blocking the reflex bronchoconstriction associated with intubation.

Vascular smooth muscle:

Produces vasodilatation

Central nervous system:

Produces a sequence of stimulation followed by depression. Produces sedation on intravenous administration.

Intravenous administration decreases cerebral blood flow and attenuates the rise in intracranial pressure that accompanies intubation.

Infusion of Lignocaine is capable of reducing the MAC of volatile anaesthetics by 40%.

Musculoskeletal:

Lignocaine is myotoxic leading to lytic degeneration, edema and necrosis.

Haematological:

It decreases coagulation and enhances fibrinolysis.

Indications:

1. For infiltration block, peripheral nerve blocks, epidural, spinal and topical anaesthetia & intravenous regional Anesthesia.
2. Antiarrythmic

Lignocaine is a class IB antiarrythmic

Ventricular tachyarrythmias

Arrythmias following acute MI during cardiac surgery

In digitalis toxicity – because it does not worsen AV – block

3. Prevention or treatment of increases in intracranial pressure during intubation

    - antitussive effect may be the reason.

4. Reflex induced bronchospasm is also attenuated by IV administration of Lignocaine.
5. Suppresses noxious reflexes such as coughing & sympathetic stimulations associated with endotracheal suctioning and intubation.
6. Used as an antiepileptic agent intravenously
7. Used intravenously as an analgesic for certain chronic pain states
8. Used as a supplement to general anaetheisa

Contraindications:

- Hypersensitivity
- Should not be used with vasoconstrictor in digits of hand, feet and penis.
- Stokes Adams syndrome, severe degree of heart block

Doses:

Maximum recommended dose:

a) Plain - 3mg/kg

b) With adrenaline - 7 mg/kg

c) For reflex suppression - 1.5 mg/kg iv.

Drug interactions: β Blockers:

Coadministration of Betablockers, increases serum levels of Lignocaine and its toxicity by decreasing Lignocaine's metabolism.

Anticonvulsant agents:

Increases Lignocaine's metabolism

Non depolarizing muscle relaxant

Blockade is potentiated by Lignocaine

Opioids and α_2 adrenergic agonists:

Potentiate Lignocaine's pain relief.

Antiarrythmic agents:

Potentiate the cardiac effects of Lignocaine

Toxicity:

- Mostly due to systemic absorption of locally administered Lignocaine or due to accidental intravenous administration of large doses of Lignocaine.
- The central nervous system is mostly vulnerable.

Blood levels and symptoms:

4 μg/ml : Light headedness, tinnitus, circumoral and tongue numbness (anticonvulsant and antiarrhythmic activity)

6 μg/ml : visual disturbances

10 μg/ml : convulsions

12 μg/ml : Unconsciousness

15 μg/ml : Coma

20 μg/ml : respiratory arrest

26 μg/ml : cardiovascular collapse

Treatment of toxicity:

Continuous monitoring of CVS and RS status helps to identify the toxicity earlier.

- If convulsions occur barbiturates or benzodiazepines can be given.
- Succinylcholine 1 mg/kg to paralyse the patient and aids in controlling the seizures.
- Cardiac toxicity like ventricular fibrillation can be treated by defibrillation
- Ventilatory support – 100% oxygenation, intubation, etc.,
- Maintain B.P. by rapid infusion of I.V. fluids, use of vasopressors and put the patient in Trendelenberg's position.
- Maintain fluid and electrolyte balance.

Adverse effects:

1. Allergic and hypersensitivity reactions

   Due to the preservative used – methyparaben

2. CVS:

   Bradycardia, hypotension

REVIEW OF LITERATURE

2) An evaluation of the analgesic efficiency of Intra Venous Regional Anesthesia using a forearm versus upperarm tourniquet. Department of Anesthesiology, Baystate medical center and Tufts University school of medicine, Springfield, Massachusetts. Anesthesia Analgesia 2002:95; 457-460. This prospective, randomized study was conducted in forty patients scheduled for hand surgery. The authors have concluded that forearm IVRA provides for both a longer duration of sensory block and prolonged postoperative analgesia compared with conventional upperarm IVRA. The technique is safer because it allows for a 50% reduction in the dose of Lidocaine.

3) Decreasing the toxic potential of IVRA Department of Anesthesia, Maisonnevve-Rosemont Hospital, Montreal. Canadial journal of Anesthesia 1989; 36:498-502.

In this study the volume of the forearm venous system was predetermined angiographically IVRA with three solution of lignocaine 0.25%, 0.355% and 0.5% was administered in a volume equal to the forearm venous system. Angiographic results indicated that a forearm tourniquet provides adequate vascular isolation.

The authors have concluded that Lidocaine 0.5% resulted in a dose of 1.5 mg/ kg and provided excellent analgesia, and the use of forearm tourniquet allows reduction of the local anesthetic dose to a non-toxic level and thus increases the safety of IVRA.

4) Results of IVRA with distal forearm application. Ankara Training and Research Hospital, Turkey. Acta Orthop Belg 2004, 70,401-405.

   In this study, 120 patients were operated under clistal forearm IVRA (3 cm above the wrist) using a 10 ml of local anesthetic solution. They have concluded that distal forearm IVRA proves safe, rapid and effective anesthesia.

5) IVRA with a forearm tourniquet CJA 1987, 34: 21. The authors have concluded that IVRA with a forearm tourniquet provides successful analgesia with prolonged postoperative analgesia, when 0.5% Lignocaine used in a dose of 2 mg/kg

6) Quantitative comparison of leakage under the tourniquet in forearm versus conventional IVRA. Department of Anesthesia and Division of nuclear medicine, Toronto-Canada. Anest-Anal 1999; 49-148.

This prospective randomized trial was conducted on 14 healthy volunteers using Radiolabeled 99^{M} Tc-Disofenin which structurally resembles lignocaine. The volume used was 0.6 ml/kg to a maximum of 45ml for the upperarm IVRA and 0.4ml/kg to a maximum of 25ml for the forearm. Radioactivity was recorded in the limb at 30 sec intervals for 20 min post tourniquet deflation. They have concluded that leakage under the tourniquet from forearm and upperarm IVRA is similar. A larger bolus of drug enters the circulation on tourniquet release in upperarm IVRA than in forearm IVRA both at 3 and 20 min deflation.

6. Efficacy of forearm versus upperarm tourniquet for local anesthetic surgery of the hand. Journal of hand surgery volume 25 No. 6; 573-74.

This prospective study done in 100 consequetive patients with an upperarm tourniquet were compared with 100 consecutive patients, with a forearm tourniquet. They have concluded scoring of perceived pain was not significantly different in the two groups. Fore arm tourniquet was well tolerated and was not associated with complications.

7. Comparison of anesthetic effect between 0.375% ropivacaine versus 0.5% Lignocaine in forerm IVRA. Regional anesthesia pain medicine 2002 Nov-Dec; 27(6) 595-599. 0.375%ropivacaine provides effective

anesthesia and superior postoperative analgesia when used in forearm IVRA.

8. Comparing the effectiveness of modified forearm and conventional IVRA for reduction of distal forearm fractures in children. Journal of paediatric orthopaedics 28(4) : 410-416. June 2008. This study was conducted in 62 patients. The modified forearm Intra Venous Regional Anesthesia, procedure is acceptable alternative for the relief of pain that usually accompanies the manipulation and reduction of forearm fractures.

9. Meperidine in forearm IVRA Anesthesia Analgesia 1999; 88:831

   They have concluded that prolonged analgesia is due to local effects. The dose of Local anesthetics required for successful blockade using the forearm method is approximately 50% less than used in conventional technique.

MATERIALS AND METHODS

This is a prospective, randomized comparative study conducted at Govt. Rajaji Hospital attached to Madurai Medical College.

After approval by the ethical committee 60 patients of ASA grade I and II age between 15-50 years who came for hand surgeries which lasted for less than 45 minutes were included in the study.

Patients with history of allergy to local anesthetics, sickle cell disease, raynaud's disease, scleroderma, local infection, paget's disease and patients with inadequate starvation <6 hours were excluded from this study. Preanesthetic evaluation was done.

No patients were premeditated. Resuscitation equipment and drugs were kept ready. Pulse rate, Blood Pressure and Oxygen saturation were estimated continuously. 18G iv cannula was started in the non operative hand.

Upperarm Intravenous Regional Anesthesia group (control group):

A 22G cannula was placed intravenously in the arm to be anesthetized. The double tourniquet was applied on the arm with generous layers of padding, ensuring that no wrinkles are formed and the tourniquet edges do not touch the skin. The arm was exsanguinated by using Esmarch bandage. If this was impossible, exsanguination was achieved by elevating the arm for 2-3 minutes while compressing the axillary artery. Tourniquet

pressure of systolic plus 100mmHg was used. Circulatory isolation of the operative arm was confirmed by inspection of the hand and by absence of the radial pulse. A standard volume of 40ml of 0.5% Lignocaine containing 200mg was used.

Forearm Intravenous Regional Anesthesia group (study group):

Here the double tourniquet was positioned 1cm below the medial epicondyle. A standard volume of 20ml of 0.5% Lignocaine containing 100mg of Lignocaine was used.

IVRA solution was administrated slowly via the cannula for 3 minutes. The distal tourniquet was used as a safety measure, it was not inflated in any patient.

After injection of the IVRA solution, sensory block was assessed at thenar eminence (median nerve), hypothenar eminence (ulnar nerve) and first web space (radial nerve) at 30 seconds interval. The cuff was not deflated until 20 minutes after local anesthesia injection even if surgery was completed before 20 minutes. Cuff deflation was performed in cycles of deflation/inflation times of less than 10 seconds until the patient no longer exhibits signs of systemic toxicity. Patients were observed 60 minutes after surgery.

Sensory regression was assessed at the same sites at 30 seconds interval, after tourniquet deflation. Postoperatively, pain was assessed by

using verbal analog pain scale between ‘0’ and ‘10’ with ‘0’ representing no pain and 10 representing the worst imaginable pain.

Intraoperatively the following parameters were noted:

Pulse rate, blood pressure, Oxygen saturation were monitored regularly at frequent intervals

- Sensory and Motor blockade onset times.
- Duration of surgery
- Mean tourniquet time
- Mean Tourniquet Pressure
- Modified Lovett’s Scoring to assess the motor power.

6	Good
3 – 5	Fair
1 – 2	Poor
0	No contraction

- Intraoperative verbal analog scale
- Verbal analog scale after deflation
- Field of surgery
- Sensory and motor blockade regression time

RESULTS AND OBSERVATIONS

FOREARM IVRA : Cases given Intravenous Regional Anesthesia using a forearm tourniquet

UPPERARM IVRA : Cases given intravenous regional Anesthesia using a upperarm tourniquet

TABLE 1: Age distribution

Age group	**Forearm IVRA**		**Upperarm IVRA**	
	No.	**%**	**No.**	**%**
Upto 20 years	-	-	-	-
21-30	15	50	13	43.3
31-40	12	40	11	36.7
Above 40 years	3	10	6	20
Total	30	100	30	100
Mean S.D.	30years 8.5 years		33.1 years 7.5 years	
'p'	0.0527 Not Significant			

The difference between the group with respect to age is not statistically significant. Hence the groups are comparable with respect to age.

TABLE 2: Sex distribution

	Forearm IVRA		**Upperarm IVRA**	
	No.	**%**	**No.**	**%**
Males	18	60	19	63.3
Females	12	40	11	36.7
Total	30	100	30	100
'p'	1.0 Not significant			

The difference between the groups with respect to sex is not statiscally significant. Hence the groups were comparable with respect to sex.

TABLE 3: Weight

Weight	**Forearm IVRA**	**Upperarm IVRA**
Mean	51.1	50.6
S.D.	4.4	3.7
'p'	0.9108 Not significant	

The difference between the groups with respect to weight is not statistically significant. Hence the groups were comparable with respect to weight.

TABLE 4: Mean Arterial Pressure during the procedure

MEAN ARTERIAL PRESSURE	**Forearm IVRA**		**Upperarm IVRA**		**'p'**
	Mean	**S.D.**	**Mean**	**S.D.**	
At 1 minute	106.53	6.7	104.5	4.7	0.8273 Not significant
At 5 minutes	104.34	6.3	102.8	5.3	0.9272 Not significant
Change in 5 minutes	1.53	4.34	1.43	2.37	0.7234 Not significant

Table 5 : Pulse Rate during the procedure

Pulse Rate	Forearm IVRA		Upperarm IVRA		'p'
	Mean	S.D.	Mean	S.D.	
At 1 minute	81.5	5.6	81.9	4.6	0.7113 Not significant
At 5 minutes	80.5	5.9	82.5	4.9	0.6326 Not significant
Change in 5 minutes	0.99	3.19	0.73	3.19	0.7414 Not significant

The difference between the groups with respect to the mean arterial pressure and pulse rate at 5 minutes interval intraoperatively was not statistically significant.

TABLE 6 : Mean Arterial Pressure after deflation

MAP AFTER DEFLATION	Forearm IVRA		Upperarm IVRA		'p'
	Mean	**S.D.**	**Mean**	**S.D.**	
At 1 minute	105.7	6.8	105.9	6.0	0.9274 Not significant
At 5 minutes	104.3	7.7	105	7.3	0.7417 Not significant
Change in 5 minutes	-1.33	6.8	-0.87	4.5	0.9662 Not significant

TABLE 7 : Pulse Rate after deflation

Pulse Rate After deflation	Forearm IVRA		Upperarm IVRA		'p'
	Mean	S.D.	Mean	S.D.	
At 1 minute	83.3	5.1	83.5	5.2	0.8994 Not significant
At 5 minutes	84.23	4.81	84.13	4.71	0.7758 Not significant
Change in 5 minutes	0.98	4.24	0.63	2.24	0.5582 Not significant

The difference between the groups with groups with respect to the mean arterial pressure and pulse rate at 5 minutes interval after cuff deflation was not statistically significant.

TABLE 8: Tourniquet Pressure

Tourniquet Pressure	**Forearm IVRA**	**Upperarm IVRA**
Mean S.D.	212 9.25	218 8.45
'p'	0.9373 Not significant	

The difference between the groups with respect to the Tourniquet pressure used is not statistically significantly. Hence the groups were comparable with respect to the tourniquet pressure.

Table 9: Onset time

Onset time	Forearm IVRA		Upperarm IVRA		'p'
	Mean	**S.D.**	**Mean**	**S.D.**	
Sensory Block	2.77	0.68	2.7	0.75	0.6348 Not Significant
Motor Block	5.93	1.38	7.17	1.53	**0.0025** **Significant**

The sensory block onset time in the study group and control group were 2.77 minutes and 2.7 minutes respectively. The difference in the sensory block onset time was not statistically significant.

The motor block onset time in the study group and control group were 5.93 minutes and 1.53 minutes respectively, the difference of which is statistically significant.

Table 10: Modified Lovett's Score

Modified Lovett's Score	Forearm IVRA		Upperarm IVRA	
	No.	**%**	**No.**	**%**
0	-	-	3	10
1	-	-	10	26.7
2	-	-	11	36.7
3	9	30	8	26.7
4	13	43.8	-	-
5	8	26.7	-	-
Total	30	100	30	100
Mean S.D.	3.97 0.76		1.8 0.96	
'p'	**0.0001** **Significant**			

The mean Modified Lovett's scoring for the motor power grading of the study and control group were 3.97 and 1.8 respectively, the difference of which was statistically significant.

TABLE 11: Tourniquet Time

Tourniquet Time	**Forearm IVRA**	**Upperarm IVRA**
Mean	32.47	32.37
S.D.	2.33	2.16
'p'	0.9326 Not significant	

The mean Tourniquet time of the study group and control group were 32.47 and 32.37 minutes respectively, the difference of which is statistically not significant.

TABLE 12: Duration of Surgery

Duration of Surgery	Forearm IVRA	Upperarm IVRA
Mean	37.5	37.43
S.D.	2.45	2.86
'p'	0.6051 Not significant	

The mean duration of surgery in the study group and control group were 37.5 and 37.43 minutes, the difference of which is not statistically significant.

Table 13 : VAS

VAS	Forearm IVRA		Upperarm IVRA		'p'
	Mean	**S.D.**	**Mean**	**S.D.**	
At 10 minutes	0.067	0.254	0	0	0.1538 Not Significant
At 20 minutes	0.267	0.583	0.033	0.183	**0.0639** **Not Significant**
At 30 minutes	0.567	0.858	0.233	0.504	0.112 Not significant
At 10 minutes after deflation	0.3	0.466	1.5	0.938	**0.0001** **Significant**
At 30 minutes after deflation	1.0	0.947	6.17	0.834	**0.0001** **Significant**
At 60 minutes after deflation	2.9	1.21	8.03	0.81	**0.0001** **Significant**

The difference in the mean VAS during the procedure was not statistically significant.

The difference in the mean VAS after cuff deflation at 10, 30, 60 minutes were statistically significant.

TABLE 14: Field of Surgery

Field of Surgery	Forearm IVRA		Upperarm IVRA	
	No.	**%**	**No.**	**%**
Excellent	17	56.7	21	70
Good	11	36.7	8	26.7
Oozing (+)	2	6.7	1	3.3
Total	30	100	30	100

The field of surgery in the study group was excellent in the study group was excellent in 56.7%, good in 36.7%, and oozing was present in 6.7%. in the control group it was excellent in 70%, good in 26.7% and oozing was present in 33% of the cases.

Table 15: Regression Time

Recovery Time	Forearm IVRA		Upperarm IVRA		'p'
	Mean	**S.D.**	**Mean**	**S.D.**	
Sensory Block	8.97	2.33	2.7	1.06	**0.0001 Significant**
Motor Block	7.87	2.03	8.43	1.22	0.3862 Not Significant

Sensory block regression time in the study group and control group were 8.97 minutes and 1.06 minutes respectively, the difference of which is statistically significant. Motor block regression time in the study and control group were 7.87 and 1.22 minutes, the difference of which is not statistically significant.

Statistical Tools

The information collected regarding all the selected cases were recorded in a Master Chart. Data analysis was done with the help of computer using **Epidemiological Information Package (EPI 2002).**

Using this software, range, frequencies, percentages, means, standard deviations, chi square and 'p' values were calculated. Kruskul Wallis chi-square test was used to test the significance of difference between quantitative variables. A 'p' value less than 0.05 is taken to denote significant relationship.

DISCUSSION

Intravenous regional anesthesia uses local anesthetics administered to one particular limb occluding the arm proximally, to provide conduction blockade. It must be safe not threatening or unpleasant to the patient. It allows adequate surgical access to the operative site and cause as little disturbance as possible to the internal homeostatic mechanisms.

Intravenous regional anesthesia has many advantages. It is simple, reliable with rapid onset and recovery. Despite these advantages, conventional IVRA has some limitations, including the potential for local anesthetic toxicity and lack of postoperative analgesia. It also has potential toxic effects which can occur despite an adequate tourniquet time. In this study, we attempted to eliminate these disadvantages by using a forearm tourniquet.

COMPARISON OF RESULTS:

In this study, the Forearm IVRA group and upperarm IVRA group patients were comparable in respect to age, sex, weight, tourniquet pressure, tourniquet time and duration of surgery.

The onset of sensory blockade was similar in both groups. It was 2.77 and 2.7 minutes respectively in the study and control group respectively. The onset of motor blockade was delayed in the study group. It was 5.93 and 1.53 minutes in the study and control group respectively. This is

contrary to the findings of Scott S. Reuban et al, where the motor block onset time were similar in both groups.

The Modified Lovett's score in the Forearm IVRA group was 3.97 which comes under the grading of motor power – fair category. Whereas the Modified Lovette's score in the upperarm IVRA group was 1.8which comes under the poor category. The 'p'value being 0.0001 which is highly significant. This results correlates with Nazim Karelezhi et al. they conclude that Forearm IVRA allows for the preservation of some motor function of the long flexors and extensors of the wrist and hand which is useful in certain operations such as tenolysis.

Tourniquet tolerance was good in both the groups. Intraoperative VAS was less than 1 in all patients. Two patients in the study group and one in the control group had tourniquet pain. The reason for this is the duration exceeded 40 minutes. So tourniquet was released and was supplemented by metacarpal block.

The motor block regression time was 7.81 and 8.43 minutes in the study and control group respectively. The sensory block regression time was 8.97 and 2.7 minutes in the study and control group. The 'p' value being 0.0001 which statistically significant. The recovery of pain sensation is rapid in the upperarm IVRA group after tourniquet deflation. Subsequent hemostasis and wound closure was difficult to achieve. So three cases were

supplemented using wound infiltration. No supplementation was used in the study group.

Intraoperatively the surgeons were comfortable with the field of surgery. Oozing was observed in 2 cases in the study group and 1 case in the control group, which was not cumbersome and no toxic reactions were observed.

VAS was least in the study group in the postoperative period 60 minutes after tourniquet deflation. The ‘p’ value being 0.000l which was statistically significant.

Forearm IVRA not only increases the safety margin of the technique but also provides enhanced postoperative analgesia. According to the study by Coleman et al who studied the quantitative comparison of leakage under the tourniquet in Forearm versus conventional IVRA the reason for this enhanced analgesic action may be an increased binding of analgesics to local tissues during Forearm IVRA.

In addition, a Forearm tourniquet can be tolerated for a longer period of time and is consistently rated less painful compared with the upperarm tourniquet as concluded by Edward et al. considering all the above said factors IVRA using a forearm tourniquet allows the dose of local anesthetic to be decreased by upto 50%without affecting the quality of analgesia, with improved duration of postoperative analgesia.

SUMMARY

This prospective, randomized comparative study of Intravenous Regional Anesthesia using a forearm tourniquet versus upperarm tourniquet was conducted a thirty patients in each group at Govt. Rajaji Hospital.

Intravenous Regional Anesthesia using forearm tourniquet increases the margin of safety of the technique by allowing fifty percent reduction in the dose of Lignocaine in comparison with the conventional technique. Therefore, this approach reduces the risk of local anesthetic toxicity in the event of tourniquet failure.

The sensory block regression time was 8.97 and 2.7 minutes in the study group and control group respectively, the different of which was statistically significant. The recovery of pain sensation was rapid in the upperarm IVRA group after tourniquet deflation. Subsequent hemostasis and wound closure will be difficult. So the block must be supplement with infiltration or metacarpal block. Because IVRA using forearm tourniquet provides prolonged sensory blockade it reduces or eliminates the need to supplement the block.

The modified Lovett's score of grading of motor power was 3.97 and 1.8 in the study and control group respectively. Usage of forearm

tourniquet allows for the preservation of some motor function of the long floors and extensors of the wrist and hand which is useful in certain operations like tenolysis and tendon repair, where complete motor blockade is not needed.

Patients in both the groups had adequate intraoperative analgesia. The difference in the mean VAS at 10, 20 and 30 minutes was not statistically significant in both the groups. The mean VAS at 60 minutes after tourniquet deflation in the study and control were 2.9 and 8.03 respectively the difference of which was statistically significant. Thus Intra Venous Regional anesthesia using forearm tourniquet provides prolonged post operative analgesia.

CONCLUSION

Intra Venous Regional Anesthesia using forearm tourniquet in comparison with upperarm tourniquet,

1. Has increased margin of safety, by allowing fifty percent reduction in the drug dosage.
2. Provides, adequate intraoperative analgesia
3. Offers, longer duration of sensory blockade after tourniquet deflation.
4. Provides, prolonged post operative analgesia.
5. Provides, lesser degree of motor blockade which is useful in certain tendon surgeries.

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PROFORMA

Name : Age : Sex :

Weight : IP/OPNo. : Date:

Diagnosis :

Procedure :

Anesthetic Technique :

Drug & Dose :

Time of inflation : Time of deflation :

Tourniquet pressure :

Sensory blockade onset time : Motor blockade onset time :

Vital signs	5 min	10 min	15 min	20 min	30 min
Pulse rate					
Blood pressure					
SPO2					

Vital signs after deflation	5 min	10 min	15 min	20 min	30 min
Pulse rate					
Blood pressure					
SPO2					

Modified Lovett Rating Scale for motor power :

6	Good
3 – 5	Fair
1 – 2	Poor
0	No contraction

VAS during surgery	0 min	10 min	20 min	30 min

VAS after deflation	0 min	10 min	20 min	30 min

Blood Less filed of Surgery :

Excellent Good Oozing +

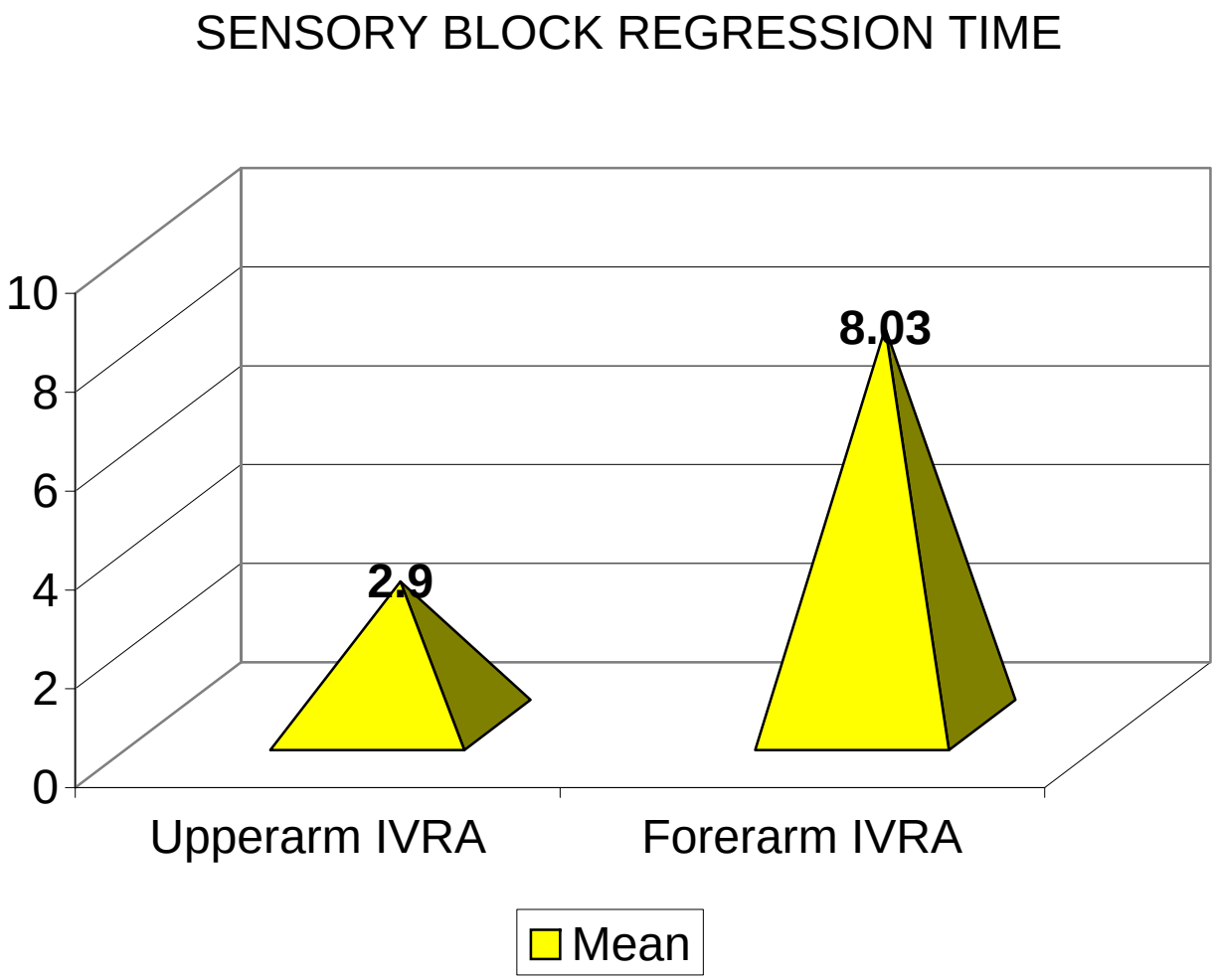
Duration of Surgery :

Tourniquet time :

Duration of sensory blockade after deflation :

Duration of motor blockade after cuff deflation :

Complications :


SENSORY BLOCK REGRESSION TIME
10
8
6
4
2
0
2.9
8.03
Upperarm IVRA
Forerarm IVRA
Mean

			INTRAVENOUS REGIONAL ANAESTHESIA USING A UPPERARM VERSUS UPPER ARM TOURNIQUET											
S.No.	Name	Age	Sex	IP/OPNo.	Weight	Diagnosis	Surgery	PR(1st min)	BP(1st min)	PR(5th min)	BP(5th min)	Tourniquet pressure	Onset of sensory block	Onset of Motor block
1	Moorthy	40	M	43226	55	Rt Ganglion wrist	Excision	70	110/70	72	110/70	210	4	8
2	Krishnan	42	M	44126	48	Rt Ganglion wrist	Excision	82	110/70	85	110/70	210	3	7
3	Sonai	30	M	46144	53	Lt Ganglion wrist	Excision	85	100/70	88	110/70	200	2	6
4	Annamalai	42	M	53772	48	Rt Palm crush Injury	Repair	88	110/70	85	110/70	210	3	7
5	Kollan	23	M	63112	50	Laceration fore arm	Suturing	80	130/80	82	130/70	220	4	6
6	Ponmani	31	F	62606	48	Dequervan's Disease	Tenolysis	78	120/70	75	120/70	220	2	5
7	Devika	26	F	63120	42	PBC Lt Index	Repair	81	110/70	84	110/70	210	2	8
8	Shanmugam	36	M	65602	51	Granulom Rt Index	Excision	86	120/70	88	120/70	220	3	9
9	Pongodi	40	F	68906	48	FR granuloma Rt Index	Excision	81	130/80	83	130/80	230	2	10
10	Chitra	21	F	101762	52	Ganglion Lt wrist	Excision	81	110/70	84	110/70	210	2	9
11	Kasinathan	23	M	101769	48	B Granuloma DorsumLt har	Excision	88	120/70	85	110/70	220	2	8
12	Povizhi	28	F	100278	52	Cut injury F4 Rt	Repair	78	110/70	75	110/70	200	3	9
13	Rajeshwari	43	F	100215	55	PIBC Rt Middle finger	Release	76	120/70	78	120/70	210	2	10
14	Dishab Begum	40	F	102062	56	Rt Ganglion wrist	Excision	82	110/70	88	110/70	200	4	7
15	Pothumani	43	M	21626	48	Lt Dequervan's Disease	Tenolysis	90	110/70	91	120/70	230	3	7
16	Lakshmi	40	F	21292	52	Rt Dequervan's Disease	Tenolysis	78	110/70	75	110/70	210	2	8
17	Karuppasamy	26	M	26111	51	PBC F3 Rt	Release	72	120/70	78	120/70	210	2	7
18	Sethupathi	33	M	68266	52	Ganglion Lt Palm	Excision	82	110/70	85	110/70	200	3	8
19	Seetharaman	21	M	68772	55	Ganglion Rt dorsum hand	Excision	84	120/71	86	120/70	220	3	7
20	Mayakal	40	M	38412	45	Left Middle finger cut injury	Repair	82	120/72	84	120/70	220	2	10
21	Noorjahan	30	F	76128	48	Ganglion Lt FA	Excision	86	110/70	88	110/70	210	2	6
22	Sambu	41	M	77161	50	Ganglion Rt wrist	Excision	84	110/70	80	110/70	220	2	5
23	Prabhakar	28	M	350612	55	ETI	Repair	90	110/70	88	110/70	200	3	7
24	Prabhu	36	M	371126	45	Ganglion Lt	Excision	90	110/70	85	110/70	210	3	7
25	Sudhakar	31	M	77891	50	Cut Injury Rt Index	Repair	76	110/70	80	120/70	210	2	5
26	Chandra	28	F	78120	55	Ext. pollicis tendon cut	Repair	88	110/70	85	120/70	220	2	6
27	Selvi	22	F	81011	45	Ganglion Lt	Excision	75	110/70	78	120/70	200	4	5
28	Pandiyan	39	M	178061	56	Ganglion Rt	Excision	72	120/70	75	120/70	210	3	5
29	Kaleswaran	28	M	81606	55	Stitch granuloma Lt Index	Excision	80	120/70	82	120/70	210	4	7
30	Muthu	41	M	82101	49	Ganglion Rt	Excision	88	110/70	83	110/70	210	3	6

Modified Lovett's score	Trouiquest Time	Duration of Surgery	VAS 10 min	VAS 20 min	VAS 30 min	Field of Surgery	Sensory block recovery	Motor block recovery	VAS 10 min after deflation	VAS 30 min after deflation	VAS 60 min deflation	PR 1st min after deflation	BP 1st min after deflation	PR 5th min after deflation	BP 5th min after deflation	Complications
3	32	35	0	0	0	Excellent	4	7	0	6	8	82	110/70	85	110/70	Nil
2	30	38	0	0	0	Excellent	2	10	0	7	9	80	110/70	81	110/70	Nil
3	35	40	0	0	0	Excellent	2	8	1	8	8	78	110/70	78	100/70	Nil
2	32	38	0	0	0	Good	4	9	2	7	9	76	110/70	78	100/70	Nil
1	30	35	0	1	1	Excellent	4	7	1	5	8	80	130/70	78	130/70	Nil
0	35	40	0	0	1	Excellent	2	10	2	6	9	90	120/70	91	110/70	Nil
3	34	38	0	0	0	Good	4	8	0	7	7	88	110/70	86	120/70	Nil
2	32	36	0	0	0	Excellent	2	7	1	6	8	96	120/70	95	120/70	Nil
1	30	35	0	0	0	Excellent	2	6	2	7	9	90	130/80	92	130/70	Nil
2	35	45	0	0	1	Excellent	4	8	1	6	8	78	110/70	79	110/70	Nil
3	35	40	0	0	0	Good	3	8	2	7	8	76	120/70	80	120/70	Nil
2	30	35	0	0	1	Excellent	3	9	2	5	7	90	110/70	91	120/70	Nil
3	31	35	0	0	0	Good	2	10	1	6	9	85	120/70	84	120/70	Nil
3	32	35	0	0	0	Excellent	4	10	2	7	9	86	110/70	88	110/70	Nil
1	30	35	0	0	1	Excellent	3	9	1	5	7	84	120/70	86	120/70	Nil
2	35	40	0	0	0	Good	2	10	2	6	8	88	110/70	90	110/70	Nil
1	32	38	0	0	0	Excellent	4	9	0	6	7	82	120/70	84	120/70	Nil
2	31	36	0	0	0	Good	2	8	3	5	8	82	110/70	86	110/70	Nil
1	32	38	0	0	0	Excellent	3	9	2	7	7	80	120/70	84	120/70	Nil
1	35	40	0	0	0	Good	1	10	1	6	9	82	110/70	84	110/70	Nil
3	30	35	0	0	0	Excellent	4	10	2	5	7	78	120/70	76	120/70	Nil
0	32	35	0	0	0	Good	1	7	3	6	8	88	110/70	89	110/70	Nil
1	33	38	0	0	2	Excellent	4	8	1	7	9	80	130/80	82	120/70	Nil
2	30	35	0	0	0	Excellent	2	7	2	7	9	86	110/70	85	110/70	Nil
3	31	35	0	0	0	Excellent	2	8	3	6	8	78	110/70	80	110/70	Nil
0	32	35	0	0	0	Excellent	4	10	0	5	7	82	110/70	80	110/70	Nil
1	35	40	0	0	0	Excellent	2	9	1	6	7	86	120/70	84	120/70	Nil
2	38	45	0	0	0	Excellent	1	7	2	7	8	88	120/70	84	120/70	Nil
2	30	35	0	0	0	Oozing(+)	2	8	3	5	9	90	120/70	86	120/70	Nil
2	32	38	0	0	0	Excellent	2	7	2	6	7	76	110/70	78	110/70	Nil