EFFICACY OF PARACETAMOL WHEN ADDED AS AN ADJUNCT TO LIGNOCAINE IN INTRAVENOUS REGIONAL ANAESTHESIA- A PROSPECTIVE RANDOMISED DOUBLE BLINDED STUDY

Dissertation submitted to Tamil Nadu Dr. M.G.R Medical University in partial fulfilment of the rules and regulations for MD Degree examination in Anaesthesiology to be held in April 2016.

DEPARTMENT OF ANAESTHESIOLOGY

PSG INSTITUTE OF MEDICAL SCIENCES

& RESEARCH, COIMBATORE.

CERTIFICATE

This is to certify that Dr. S. SULEKHA a post graduate student (2012- 2016)in the Department of Anaesthesiology, PSG Institute of Medical Sciences & Research has done this dissertation titled "**EFFICACY OF PARACETAMOL WHEN ADDED AS AN ADJUNCT TO LIGNOCAINE IN INTRAVENOUS REGIONAL ANAESTHESIA**" under the direct guidance and supervision of guide Prof. Dr. SHAIK MUSHAHIDA in partial fulfilment of the regulations laid down by the Tamilnadu Dr. MGR Medical University, Chennai, for MD Anaesthesiology degree examination.

DR. S. RAMALINGAM

Dean and Director

PSGIMS&R.

Prof. DR.SHAIK MUSHAHIDA

Professor and Head of Department

Department of Anaesthesiology

PSGIMS&R.

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DECLARATION

I hereby declare that this dissertation entitled "**EFFICACY OF PARACETAMOL WHEN ADDED AS AN ADJUNCT TO LIGNOCAINE IN INTRAVENOUS REGIONAL ANAESTHESIA**" is a bonafide and genuine work carried out by me under the guidance and supervision of Dr**. SHAIK MUSHAHIDA** MD, Professor and HOD, Department of Anaesthesiology, PSG Institute of Medical sciences and Research centre, Coimbatore.

This dissertation is submitted to the Tamilnadu Dr.MGR Medical University in partial fulfilment of the university regulations for the award of MD degree in Anaesthesiology, Examinations to be held in April 2016.

Date:

Place: Coimbatore

DR.S.SULEKHA

Postgraduate in Anaesthesiology

PSG Institute of Medical sciences and

Research Centre, Coimbatore.

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PSG Institute of Medical Sciences & Research
Institutional Human Ethics Committee

Recognized by The Strategic Initiative for Developing Capacity in Ethical Review (SIDCER)
POST BOX NO. 1674, PEELAMEDU, COIMBATORE 641 004, TAMIL NADU, INDIA
Phone : 91 422 - 2598822, 2570170, Fax : 91 422 - 2594400, Email : ihec@psgimsr.ac.in

August 6, 2013

To
Dr S Sulekha
Postgraduate
Department of Anaesthesiology
PSG IMS & R
Coimbatore

Ref.: Proposal titled: *'Efficacy of paracetamol when added to lignocaine in intravenous regional anaesthesia'*

Sub.: Ethics Committee Approval for the study

The Institutional Human Ethics Committee, PSG IMS & R, Coimbatore -4, has reviewed your proposal on 30th May, 2013 in its full board review meeting held at College Council Room, PSG IMS&R, between 2.00 pm and 4.00 pm, and discussed your application to conduct the study entitled:

"Efficacy of paracetamol when added to lignocaine in intravenous regional anaesthesia"

The following documents were received for review:

1. Duly filled application form
2. Proposal
3. Informed Consent forms in English (Ver. 1) and Tamil (Ver. 1.1)
4. Data Collection Tool
5. Budget
6. CV

The members who attended the meeting at which your study proposal was discussed are as follows

Sl. No.	Name of the Member of IHEC	Qualification	Area of Expertise	Gender	Affiliation to the Institution Yes/No	Present at the meeting Yes/No
1	Dr. S. Bhuvaneshwari (Member-Secretary, IHEC)	MD	Clinical Pharmacology	Female	Yes	Yes
2	Mrs. R. Geetha	+ 2	Lay person	Female	No	Yes
3	Mr Gowpathy Velappan	BA., BL	Legal Advisor	Male	No	Yes
4	Mrs G Malarvizhi	M Sc	Nursing	Female	Yes	No
5	Mr. R. Nandakumar (Vice-Chairperson, IHEC)	BA., BL	Legal Expert	Male	No	Yes
6	Dr. G. Raavindran	DM	Clinician (Cardiology)	Male	Yes	No
7	Dr. V. Ramamurthy	Ph D	Biotechnology	Male	Yes	No
8	Dr. M. Ramanathan	M Pharm, Ph D	Non-Medical (Pharmacy)	Male	Yes	No
9	Dr. P. Sathyan (Chairperson, IHEC)	DO, DNB	Clinician (Opthalmology)	Male	No	Yes

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Institutional Human Ethics Committee
Recognized by The Strategic Initiative for Developing Capacity in Ethical Review (SIDCER)
POST BOX NO. 1674, PEELAMEDU, COIMBATORE 641 004, TAMIL NADU, INDIA
Phone : 91 422 - 2598822, 2570170, Fax : 91 422 - 2594400 Email : ihec@psgimsr.ac.in

10	Dr. Seetha Panicker	MD	Clinician (Obstetrics & Gynaecology)	Female	Yes	Yes
11	Dr. S. Shanmukunan	MD	Pathology, Ethicist	Female	Yes	Yes
12	Dr. Y.S. Sivan	Ph D	Social Scientist (Sociology)	Male	Yes	Yes
13	Dr. Sudha Ramalingam (Alternate Member-Secretary IHEC)	MD	Public Health, Epidemiology, Genetics, Ethicist	Female	Yes	Yes
14	Mrs. K. Uma Maheswari	M Sc, N Phil, B Ed	Retary	Female	No	Yes
15	Dr. D Vijaya	M Sc, Ph D	Basic Medical Sciences (Biochemistry)	Female	Yes	Yes

After due consideration, the committee has decided to approve the above proposal.

The approval is valid for one year.

We request you to intimate the date of initiation of the study to IHEC, PSG IM3&R and also, after completion of the project, please submit completion report to IHEC.

We hereby confirm that neither you nor any of your study team members have participated in the voting/ decision making procedure of the committee. The members of the committee who have participated in the voting/ decision making procedure of the committee do not have any conflict of interest in the referenced study.

This Ethics Committee is organized and operates according to Good Clinical Practice and Schedule Y requirements.

Non-adherence to the Standard Operating Procedures (SOP) of the Institutional Human Ethics Committee (IHEC) and national and international ethical guidelines shall result in withdrawal of approval (suspension or termination of the study). SOP will be revised from time to time and revisions are applicable prospectively to ongoing studies approved prior to such revisions.

PIs are required to send progress reports (in the form of an extended abstract with publications if any) to the IHEC every six months (and a month before expiry of approval date, if renewal of approval is being sought).

Request for renewal must be made at least a month ahead of the expiry of validity along with a copy of the progress report.

Dr S Bhuvaneshwari
Member - Secretary
Institutional Human Ethics Committee

SECRETARY
PSG IMS & R
COIMBATORE-641 004
INSTITUTIONAL HUMAN ETHICS COMMITTEE

PSG Institute of Medical Sciences & Research
Institutional Human Ethics Committee

Recognized by The Strategic Initiative for Developing Capacity in Ethical Review (SIDCER)
POST BOX NO. 1674, PEELAMEDU, COIMBATORE 641 004, TAMILNADU, INDIA
Phone : 91 422 - 2599822, 2570170, Fax : 91 422 - 2599900, Email : ihec@psgmsr.ac.in

July 4, 2014

To
Dr S Sulekha
Postgraduate
Department of Anaesthesiology
PSG IMS & R
Coimbatore

The Institutional Human Ethics Committee, PSG IMS & R, Coimbatore -4, has reviewed your proposal on 4th July, 2014 in its expedited review meeting held at IHEC Secretariat, PSG IMS&R, between 10.00 am and 11.00 am, and discussed your request to renew the approval for your study entitled:

"Efficacy of paracetamol when added to lignocaine in intravenous regional anaesthesia"

The following documents were received for review

1. Your letter dated 24.06.2014
2. Request for renewal
3. Study status report

After due consideration the Committee has decided to renew the approval for the above study.

The members who attended the meeting held on at which your proposal was discussed, are listed below

Name	Qualification	Responsibility in IHEC	Gender	Affiliation to the institution Yes/No	Present at the meeting Yes/No
Dr P Sathyan	DC, DNB	Clinician, Chairperson	Male	No	Yes
Dr S Bhuvaneshwari	M.D	Clinical Pharmacologist Member - Secretary	Female	Yes	Yes
Dr Sudha Ramalingam	M.D	Epidemiologist Alt. Member - Secretary	Female	Yes	Yes
Dr Y.S. Jiwan	PhD	Member -Social Scientist	Male	Yes	Yes

The renewal is valid for one year (from 06.06.2014 to 05.06.2015).

This Ethics Committee is organized and operates according to Good Clinical Practice and Schedule Y requirements.

Non-adherence to the Standard Operating Procedures (SOP) of the Institutional Human Ethics Committee (IHEC) and national and international ethical guidelines shall result in withdrawal of approval (suspension or termination of the study). SOP will be revised from time to time and revisions are applicable prospectively to ongoing studies approved prior to such revisions.

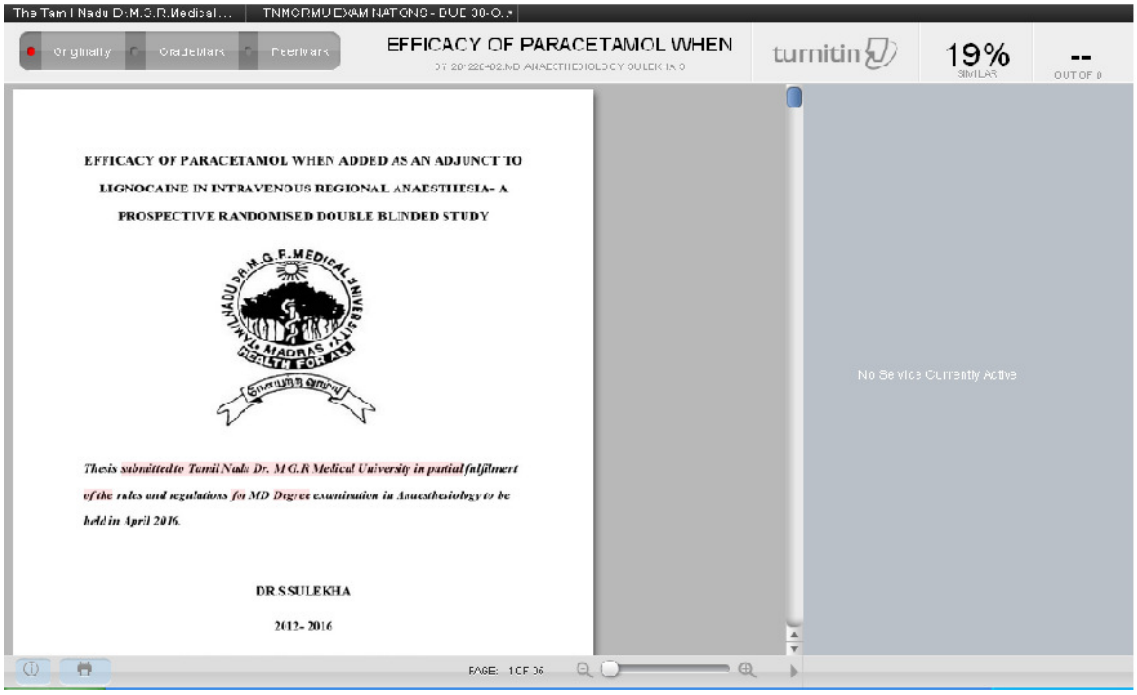
Kindly note this approval is subject to ratification in the forthcoming full board review meeting of the IHEC.

Yours truly,

SECRETARY PSG IMS&R COIMBATORE 641004 INSTITUTIONAL HUMAN ETHICS COMMITTEE

Dr S Bhuvaneshwari
Member – Secretary

Proposal No. 13/06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DR S SULEKHA
2012- 2016
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LIST OF ABBREVIATIONS

IVRA	– Intra Venous Regional Anaesthesia
ASA	– American Society of Anaesthesiologists
ECG	– Electrocardiogram
NIBP	– Non Invasive Blood Pressure
VAS	– Visual Analogue Scale
NSAID	– Non Steroidal Anti Inflammatory Drug
CB	– Cannabinoid receptors
Mg	– Milligrams
%	– Percentage
ml	– Millilitre
Kg	– Kilograms
mcg	– Micrograms
g	– Grams
Mol	– Molecules
l	– Litres

Mins	– Minutes
i.v	– Intravenous
i.m	– Intramuscular
POX	– Peroxidase
FAAH	– Fatty Acid Amide Hydrolase
AM404	– N-arachidonoylphenolamine
h	– Hour
cms	– Centimetres
G	– Gauge
Yrs	– Years
OR	– Operating Room
mmHg	– millimetres of mercury
MAP	– Mean Arterial Pressure
HR	– Heart rate
SpO_2	– Oxygen Saturation
PF	– Preservative Free

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ABSTRACT

BACKGROUND AND OBJECTIVES

Intravenous regional anaesthesia (IVRA) using Lignocaine is a safe, reliable, and cost-effective technique for providing anaesthesia as well as bloodless field during upper limb surgery. It has been postulated that the site of action in IVRA is probably by blockade of small nerves or possibly nerve endings and not the major nerve trunks. A disadvantage of this technique is the rapid return of sensation after tourniquet release resulting in subsequent pain.

The ideal IVRA solution should have rapid onset, require less dose of local anaesthetic (LA), reduce tourniquet pain, and prolong post-deflation analgesia.

In this study we evaluated the effects of Paracetamol on onset of sensory and motor block time, sensory and motor recovery time and the requirement of postoperative analgesia.

METHODS

Sixty patients undergoing upper limb extremity surgeries were randomised into two groups .IVRA was achieved by injecting 10 ml of 2% Lignocaine with 30 ml of Paracetamol to total of 40 ml in Group 1(n=30) and 10 ml of 2% Lignocaine with 30 ml of Normal saline to total of 40 ml in Group 2(n=30). Onset of sensory and motor block time noted, intraoperative pain assessed using VAS scores, intraoperative

analgesic use and sensory and motor recovery time were noted during the surgery. Postoperative analgesic requirement was noted after the tourniquet deflation. Vital parameters were monitored throughout the operative period.

RESULTS

Onset of sensory and motor block was shorter and sensory recovery time was longer in Group 1 ($p < 0.001$). Intraoperative VAS scores were significantly lower in Group 1 ($p< 0.05$). Intraoperative Fentanyl consumption was 8.33 ± 21.82 mcg in Group 1 and 38 ± 37.82 mcg in Group 2, the number of patients requiring Fentanyl were 4 and 17 respectively ($p< 0.001$). The postoperative analgesia requirement was lower in Group 1 with 9 patients and was 25 patients in Group 2 ($p< 0.001$).

CONCLUSION

The administration of Paracetamol as an adjunct to Lignocaine in IVRA was found to be efficacious and it provided significant shortening in the onset of sensory block, a decrease in the intraoperative analgesic requirement and an improvement in the post operative analgesia with a reduced need for analgesics in the post operative period.

KEYWORDS: IVRA, Paracetamol, Lignocaine, VAS scores, Fentanyl

1. INTRODUCTION

Intra Venous Regional Anaesthesia (IVRA) is a regional anaesthetic technique commonly used in forearm surgeries. It was first introduced by a German surgeon August Gustav Bier in 1908 by injecting Procaine intravenously between two tourniquets[1]. He found that there was a rapid onset of anaesthesia between the tourniquets and a slower onset beyond the distal tourniquet. This technique gained more importance in the late 1960s after its reintroduction by Holmes[2].

There have been many modifications to this technique over time, presently the use of double tourniquet with injection of drugs distal to the cuffs. Its use has been proved to have an advantage of faster recovery, shorter hospital stay, cost effectiveness and reduced nursing care requirements making it an ideal choice for Day care surgeries[3].

When IVRA is appropriately performed there is a 96 - 100% success rate[4-6]. This technique has the advantage of rapid return of sensory and motor power at the end of surgical procedure allowing normal functioning of the operated limb and the surgeons are able to assess neurological status after surgery. This rapid recovery facilitates early discharge of patients.

IVRA is advantageous being reliable, easy to administer and cost-effective for short operative procedures of the extremities performed on an ambulatory basis[3]. There are some disadvantages like delayed onset of action, poor muscle relaxation and rapid onset of pain at operative site after tourniquet is deflated[7].

Various additives like Opioids, Muscle relaxants, NSAIDs such as Ketorolac[8], Tenoxicam[9] and Aspirin[10] have been used to overcome these disadvantages to improve analgesia.

There is a risk of local anaesthetic toxicity due to sudden release of large amounts of local anaesthetic as a result of leakage due to high venous pressure or accidental tourniquet failure past the inflated tourniquet. Due to the above mentioned effects it is desirable to limit the amount of local anaesthetic to a minimum[11].

In previous studies, IVRA with Paracetamol was shown to improve overall quality of the block, early onset of motor block, reduced tourniquet pain, delayed recovery of motor and sensory block, low intraoperative pain scores and decreased analgesic requirements both during intraoperative and post operative period.

The ideal IVRA solution should have rapid onset of action, require less amount of local anaesthetic, reduce tourniquet pain and prolong post-deflation analgesia. This may be achieved by addition of adjuncts to local anaesthetic. Paracetamol added as an adjunct to Lignocaine has been shown to provide decreased tourniquet pain, increased anaesthesia quality and decreased postoperative analgesic consumption.

2. AIM AND OBJECTIVES OF THE STUDY

PRIMARY OBJECTIVES:

To determine the efficacy of Paracetamol when added as an adjuvant to Lignocaine for IVRA.

SECONDARY OBJECTIVES:

To compare the

1) Onset of sensory and motor block in both groups

2) Sensory and Motor recovery time in both groups

3) Requirement of post operative analgesia

3. REVIEW OF LITERATURE

Holmes et al[1] opined that Procaine produced patchy anaesthesia; so he replaced it with Lignocaine. In 1963 he conducted a study on 30 patients with 0.5% Lignocaine. He used 25 to 60 ml of 0.5% Lignocaine for 29 patients and 0.25% for 1 patient. The dose of 0.25% was found to be ineffective. Analgesia was complete in 21 cases with 0.5% Lignocaine. In 7 patients, surgery was performed satisfactorily but patients had discomfort and failure of technique in 2 cases. Motor power and sensation returned back within 5 to 10 minutes of the tourniquet release.

Chan VW et al[3] postulated that IVRA can offer a more favourable patient recovery, shorter post operative care and early discharge than an Isoflurane based general anaesthesia or brachial plexus block technique for hand surgery.

Perlas A et al[7] observed the use of forearm tourniquet as a rescue cuff when there was tourniquet pain. Inflation of the proximal cuff was common to both the groups and IVRA with 0.5% Lignocaine at 0.6 ml/kg was given. When there was tourniquet pain, the distal cuff in the double cuff tourniquet was inflated in the first group and a single forearm cuff as rescue cuff in the second group. From the study, it was concluded that there was better tolerance with forearm rescue cuff with lower pain scores, longer tourniquet tolerance and less side effects.

Reuben SS et al[8] conducted a study using the parenterally available NSAIDs - Ketorolac as a component of IVRA which suppressed intraoperative tourniquet pain and enhanced post operative analgesia. It was concluded that Ketorolac improves IVRA with 0.5% Lignocaine both in terms of controlling intraoperative tourniquet pain and by decreased post operative pain.

Vishala G et al[11] compared the analgesic effects of IVRA between Lignocaine and Paracetamol with Lignocaine. In their study, one group received 40 ml of 0.5% Lignocaine and another group received 10 ml of 2% Lignocaine with 30 ml Paracetamol. From their study, it was inferred that onset of motor block, intraoperative rescue analgesia, recovery of sensory block and postoperative analgesia were statistically significant in the group which received Paracetamol.

Turan A et al[12] evaluated the effects of Neostigmine when added to Prilocaine for IVRA. Onset and recovery of sensory and motor block, and anaesthesia quality was determined by an anaesthesiologist. The operating field dryness and anaesthesia quality was noted during the study by the surgeon. It was concluded that Neostigmine as an adjunct to Prilocaine improved the quality of anaesthesia and is beneficial in IVRA.

Choyce A et al[13] reviewed the use of adjuncts in IVRA for surgical procedures in terms of their intraoperative effects, efficacy of block, tourniquet pain and post operative analgesia. Using NSAIDs or Clonidine as adjuncts to IVRA improved motor block and post operative analgesia.

Sen H et al[14] evaluated the effect of Paracetamol on onset of sensory and motor block, tourniquet pain and post operative analgesia when added to Lignocaine in IVRA. The addition of Paracetamol during IVRA with Lignocaine was shown to decrease tourniquet pain, increase anaesthesia quality and decrease post operative analgesic consumption.

Bertolini and colleagues[15] observed that Paracetamol had a peculiar analgesic and antipyretic property which neither caused anti-inflammatory response nor any gastric side effects but characterized by a sense of relaxation and tranquility. It led to the discovery that Paracetamol acts as a prodrug (Cannabinomimetic) triggered by the CB_1 receptors of the Cannabinoid system proving the peculiar action of paracetamol.

Blond L and Madesan J L[16] in their study had evaluated the exsanguination of the upper limb by elevation alone, or by use of Esmarch or gauze bandages, squeeze methods and using the Urias bag. By the above procedures, the reduction in blood volume with elevation alone during 5,15,30,60 seconds & 4 minutes was 44%,

45%, 46%, 46% and 42% respectively; whereas the reduction was 63 % with Esmarch bandage, 53% by squeeze method and 57% by Urias bag method. From this study, it was inferred that Esmarch bandage was the most effective exsanguination method but its sterilization and application was time consuming. Urias bag takes time to apply in exsanguination making its use ineffective. Squeeze method was found to be practical as it was fast and inexpensive but not effective as the external applicators.

Boas R A et al[17] conducted a study to evaluate the analgesic effect of intravenous Lignocaine. They had selected five patients and produced ischemic pain of equal intensity to their clinical pain by applying and inflating tourniquet on upper arm. At that point they gave Lignocaine 3mg/kg intravenously and observed initial decline in both ischemic and clinical pain when arterial Lignocaine level was above 3 microgram/ml. As the Lignocaine concentration decreased below 3 microgram/ml the severity of ischemic pain increased.

Jagger K.S et al[18] mentioned that for IVRA, agents like Chlorprocaine, Prilocaine, Mepivacaine and Lignocaine were used, with each drug having its own disadvantage. Chlorprocaine produced an incidence of 37.5% central nervous system effects and thrombophlebitis. Prilocaine caused methaemoglobinemia and Mepivacaine had an inconvenient dosage scheme. Lignocaine remained as the popular agent for the technique. However the dosage found to produce desirable effect had several side effects like dizziness, tinnitus and cardiac dysarrhythmias.

Reuben S.S et al[19] in another study compared wound infiltration of Ketorolac versus IVRA with Ketorolac for postoperative analgesia following ambulatory hand surgery. This study consisted of 60 patients who were divided into three groups of 20 each. All patients received IVRA with 40ml 0.5% Lignocaine and 5ml 1% Lignocaine infiltrated into the surgical site. Group 1, the control group received no additional medications. Group 2 had 60mg Ketorolac added to Lignocaine for IVRA and Group 3 had 60mg Ketorolac added to Lignocaine for wound infiltration. Post operative pain was assessed by a Visual Analogue Scale (VAS) 1 hour and 2 hours after IVRA. They were assessed for additional requirement of narcotics and Acetaminophen with Codeine tablets. The conclusion was Ketorolac provides similar post operative analgesia after ambulatory hand surgery when administered with Lignocaine either by IVRA or by wound infiltration.

Arregui-martinez-de-hejarza LM et al[20] studied the analgesic effectiveness of Ketorolac in IVRA induced by Lignocaine. They conducted a double blinded placebo controlled clinical trial on 26 patients undergoing elective surgery on the upper extremities who were divided into two groups. They received 3mg/kg of 0.5% Lignocaine either with 1 ml of 0.9% saline solution for control group or 1 ml with 30 mg of Ketorolac for the treatment group. They were assessed for postoperative pain on a VAS over the first 24 hours. The data were compared using student t test for parametric variables and Mann-Whitney test and Fisher's exact test for non-parametric

variables. They found 10 out of 13 patients in control group required analgesia within first two hours whereas none in the treatment group required analgesia.

Geoffrey T. Tucker et al[21] studied the kinetics of deposition of Lignocaine after IVRA of the arm and direct intravenous infusions. They found that peak plasma levels of Lignocaine after the release of cuff were 20 to 80% lower than those found when the same dose was given directly into a vein over 3 minutes. Peak levels after release of cuff were inversely proportional to duration of tourniquet application. They also tend to be lower when the same dose was given in 0.5% instead of 1% solution. Following the first few minutes after release of tourniquet cuff, there was distribution of Lignocaine within pulmonary system buffering the vital organs against high levels of the drug.

Raj et al[22] studied the site of action of local anaesthetic agents in intravenous regional anaesthesia. According to them local analgesic agent can block the nerves at the elbow by

1. Central axis system
2. Peripheral venous plexus in neural sheath
3. Anastamosing channels between central axis system and peripheral venous plexus
4. Direct perfusion

Since the fibres to the distal part of the extremity are in the core of the nerve trunk, while those to the proximal part are in the outer layers, the fibres of the distal extremity are blocked first. Their anaesthesia develops from the finger tips upwards when the solution is deposited in this region.

Merryfield A.J et al[23] studied the blood levels of Lignocaine in IVRA. They used 4 mg/kg of 0.5% Lignocaine solution, subjective symptoms appeared at a blood level approximately 5 mcg/ml. They stated that even below the dose 2 mg/kg can produce subjective symptoms and this amount will not often produce adequate analgesia. They suggested that the dose 4 mg/kg found necessary for good analgesia was safe, provided the release into the circulation is delayed.

Sorbie C et al[24] reported the use of IVRA in 128 patients. In his study 15 patients out of 128 had discomfort at operative site and were classified as having unsuccessful anaesthetics. They used 0.5% Lignocaine and the maximum dose was 200 mg for the arm, no serious effects were found during surgery or tourniquet release.

Steinberg RB et al[25] studied the dose response relationship of Ketorolac as a component of IVRA with Lignocaine. They added 0, 5, 10, 15, 20, 30 and 60 mg of Ketorolac to 0.5% Lignocaine IVRA for either carpal tunnel release or tenolysis.

There were no significant differences among the groups who received 20, 30 or 60 mg of Ketorolac. They concluded that 20 mg of Ketorolac was the optimal dose for inclusion with 0.5% Lignocaine for IVRA under the conditions of their study.

Niemi T.T et al[26] studied the haemostatic changes caused by IVRA when used with Lignocaine. This study was performed on 10 healthy volunteers to examine the role of Lignocaine in IVRA to detect haemostatic changes particularly the fibrinolytic pathway and platelet function. It was concluded that there was activation of fibrinolysis and no alteration of platelet function when there was high concentrations of Lignocaine in the limb where tourniquet was applied.

HISTORY

AUGUST KARL GUSTAV BIER (1861- 1949)

August Bier was born in Bad Arolsen in Waldeck-Frankenberg in Germany on 24th November 1861. He graduated from the University of Kiel in 1889 where he later became an assistant to Friedrich Von Esmarch, professor of surgery. He familiarised the work done in a medical college in Kiel by Heinrich Irenaeus Quincke who established lumbar puncture as safe investigation in routine neurological examination.

FIGURE 1. AUGUST BIER

On August 16th 1898, Bier performed the first surgery under spinal anaesthesia at Royal surgical hospital under the University of Kiel. Later in the same year Bier received spinal anaesthetic by his assistant August Hilderbrandt to prove the anaesthetic effects which was successful.

In addition to this discovery he invented the method of treating chronic inflammation by the method of passive hyperaemia with Esmarch's bandage and pioneered intravenous Procaine analgesia in 1908. He was a great figure of German surgery as a teacher, a lecturer and a surgeon. He introduced the tin helmet into the German army in the First World War. He died at the age of 88 years on 12th March 1949.

ANATOMY:

The relevant anatomy in IVRA is the location and distribution of peripheral veins in the extremity to be blocked. A vein as distal as possible is chosen. Cannulation at the surgical site is best avoided.

The superficial veins of the upper limb form many patterns. The dorsal venous arch lies on the dorsum of the hand and receives many digital branches. It ends medially as Basilic vein and laterally as Cephalic vein.

The Cephalic vein is the preaxial vein of the upper limb; it crosses the anatomical snuff box superficial to the radial nerve. It ascends on the radial border of the forearm in the lateral bicipital furrow of the arm and runs in between the deltoid and pectoralis major muscles at the shoulder. It pierces the Clavipectoral fascia and ends in the Axillary vein.

The Basilic vein is the postaxial vein of the upperlimb, it ascends on the ulnar side of the forearm to the elbow and runs in the medial bicipital furrow to the middle of the arm where it pierces the deep fascia. It then accompanies the Brachial artery to the axilla and becomes the Axillary vein.

The Median Cubital vein lies in front of the elbow which joins the cephalic to the Basilic vein. The bicipital aponeurosis separates the Median Cubital vein from the Brachial artery and Median vein.

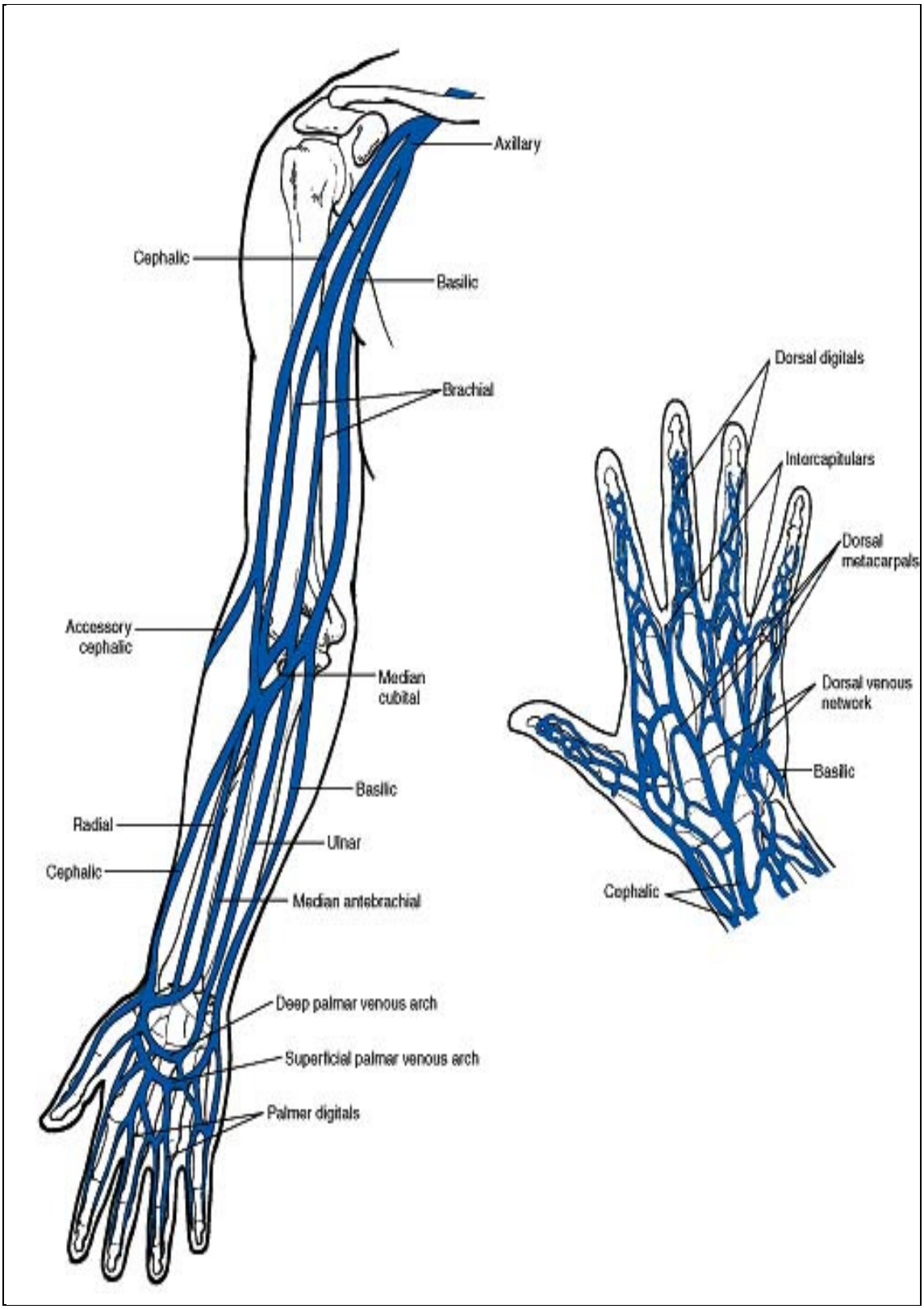

FIGURE 2. VENOUS SYSTEM OF THE UPPER LIMB

MECHANISM OF ACTION:

Mechanisms of IVRA are multiple, depending primarily on ischemia and on the transport of local anaesthetic solution through venous network into veins near the nerve trunks. Nerve trunks in the extremities are composed of a connective tissue layer called epineurium containing blood vessels supplying the nerves. The endoneurium encloses individual nerve fibers containing capillary plexuses extending intraneurally as vasae nervorum. There is diffusion of local anaesthetic into small veins surrounding the nerves, the vasae nervorum and capillary plexus leading to a centrifugal neural blockade. There is diffusion into smaller nerves in skin blocking the conduction. It is said that tourniquet inflation causes ischaemia which contributes to analgesic action of the local anaesthetic by blocking conduction and motor endplate function[27].

Initial effect - Blockage of small peripheral nerves and nerve endings

↓

Diffusion – Blockage of large nerves at proximal sites and intraneural venous distribution of local anaesthetic

↓

Ischemia - Blockage of nerve conduction and motor end-plate function

↓

Compression – Nerves under the tourniquet cuff gets compressed

INDICATIONS:

1) Duration of procedure not exceeding more than 1 hour
2) Surgeries on forearm and hand which includes
    a) Manipulation of forearm fractures
    b) Excision of wrist ganglia
    c) Tendon grafting or tendon repair
    d) Suturing of major lacerations in forearm or hand
    e) Debridement of burn areas in forearm or hand

CONTRAINDICATIONS:

ABSOLUTE:

1) Patient refusal
2) Allergy to local anaesthetics
3) Uncontrolled hypertension hindering tourniquet inflation.

RELATIVE:

1) Patient uncooperative during procedure
2) Raynaud's disease
3) Buerger's disease
4) Sickle cell disease
5) Crushed extremities causing transient ischaemia due to hypoxia

6) Continuous cardiac or blood pressure monitoring required

7) Inability to assess peripheral veins

8) Skin infection or cellulitis

9) Disruptions in the integrity of venous system

10) Skeletal muscle disorders

11) Paget's disease – local anaesthetics may spread to systemic circulation via venous channels in bone.

PHARMACOLOGY:

LIGNOCAINE HYDROCHLORIDE

- Local anaesthetic
- Class – 1b antiarrhythmic drug

History:

In 1860 Albert Nieman purified the alkaloid extracted from Coca leaves and named it Cocaine. In 1884 Karl Koller used Cocaine as a topical ophthalmic anaesthetic. Nils Lofgren in 1943 a Swedish chemist synthesised first amino amide local anaesthetic. His colleague Bengt Lundqvist injected the drug himself to prove its anaesthetic properties. It was first marketed in 1949.

Trade names	**:**	Xylocaine Xylocard (preservative free) used intravenously
Routes of administration	**:**	Intravenous, subcutaneous, topical, oral solutions and epidural
Bioavailability	**:**	Oral - 35% Topical – 3%
Half life	**:**	1.5 – 2 hours
Metabolism	**:**	Hepatic 90% by CYP1A2

Excretion : Renal system

IUPAC name : 2-(diethylamino)-N-(2, 6-dimethylphenyl)acetamide

Formula : $C_{14}H_{22}N_2O$

Molecular mass : 234.34 g/mol

Melting point : 68^0C

Therapeutic range : 1.5 – 5 mcg/ml

Structure :

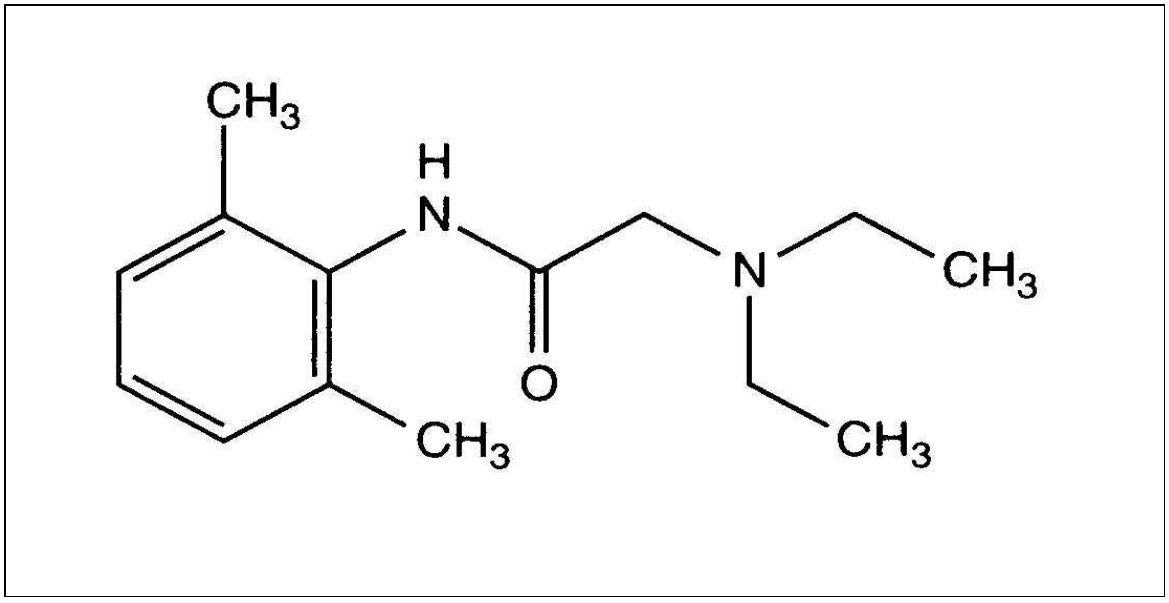

FIGURE 3. STRUCTURE OF LIGNOCAINE HYDROCHLORIDE

Mechanism of action of Lignocaine:

The primary action of Lignocaine is on the cell membrane of the axon, on which it produces electrical stabilisation. The large transient increase in permeability to sodium ions necessary for propagation of the impulse is prevented, thus the resting potential is maintained and depolarisation in response to stimulation is inhibited. Initially the threshold for electrical excitation is raised, the rate of rise of action potential is reduced and conduction slowed, eventually propagation of the impulse fails[28].

It has a dual effect on the cell membrane to produce these effects

1) Action on the axoplasmic opening of the sodium channels
2) Non-specific physiochemical effect within cell membrane

1) Action on the axoplasmic opening of the sodium channels :

It is hypothesised that it acts on specific receptors. This is shared by quartenary derivatives of Lignocaine being fully ionised, that cannot penetrate the cell membrane which produce nerve blockade only if applied to its inner surface. Similarly amide local anaesthetics act principally in the cationic form and on the axoplasmic surface of the membrane. This suggests that local anaesthetics impair sodium permeability by an action blocking the internal openings of sodium channels. This action accounts for 90% of the nerve conduction blocking effect of Lignocaine.

2) Non-specific physiochemical effect within cell membrane:

This is a non-specific action in contrast to a more specific drug receptor interaction and is analogous to the electrical stabilisation produced by a number of non-polar, purely lipid substance such as non-ionised Barbiturates, general anaesthetics and Benzocaine.

The production of nerve conduction blockade is associated with about 3-5 % expansion of membrane volume. The actual volume of anaesthetic occupying the membrane however is only 0.3 % or less. Since the volume occupied by the anaesthetics accounts for 10 % of this membrane expansion, a number of mechanisms have been suggested to account for further 90 %.

The most likely explanation is that there is unfolding of membrane protein, together with a disordering of the liquid component of the cell membrane, with consequent obstruction of the sodium channels. Displacement of membrane bound calcium ions may also be involved. Calcium is known to condense lipid layers and local anaesthetics to displace it. The mechanism may account for the lesser part of the effect of Lignocaine.

It stabilises the neuronal membrane by inhibiting the ionic fluxes required for initiation and conduction of impulses effecting local anaesthetic action. Efficacy of Lignocaine is characterised by its rapid onset of action and intermediate duration of action so used for infiltration, blocks and surface anaesthesia.

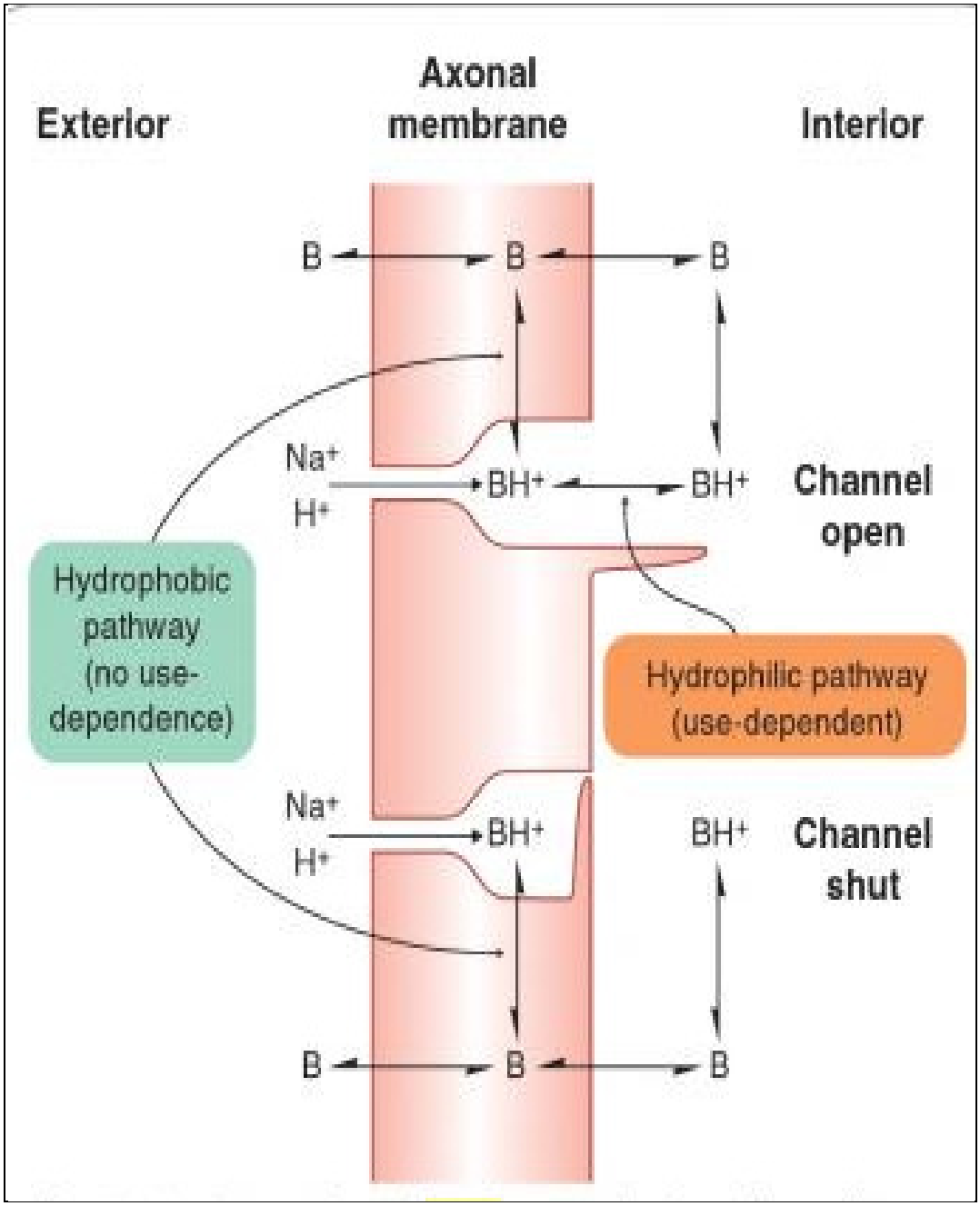

FIGURE 4. INTERACTION OF LOCAL ANAESTHETICS WITH

SODIUM CHANNELS

The blocking site within the channel can be reached either through the open channel gate on the inner surface of the membrane by the charged species BH^+ (hydrophilic pathway) or directly from the membrane by the uncharged species B (hydrophobic pathway)[29].

Analysis of local anaesthetic action has shown many drugs exhibit the property of 'use dependent' block of sodium channels and to some extent the gating of the channels[28]. Use dependence means more the channels are open the greater the block. This occurs because the blocking molecule enters the channel more readily when opened than when closed[29].

Channels can exist in three functional states: resting, open and inactivated. Many local anaesthetics bind strongly to the channels in inactivated state, therefore at any given membrane potential the equilibrium between the resting and inactivated channels will be in favour of the inactivated channels. This contributes to the overall blocking effect, by reducing the number of channels available for opening and by prolonging refractory period following an action potential[29].

When a painful stimulus is applied to a sensory nerve it causes the channels to cycle through open and inactivated states, both of which are more likely to bind the local anaesthetic than the resting state. These mechanisms contribute to use-dependence which explains why transmission may be blocked more effectively than other sensory modalities[29].

Impulse blockade by local anaesthetics[29]:

1. By deposition of local anaesthetic near the nerves, most of the free drug molecules are removed by tissue binding, circulation and hydrolysis of aminoester anaesthetics and the remaining free drug is penetrated into the nerve sheath.

2. Penetration into nerve's axon and axoplasm depends on the drug's pK_a and lipophilicity.

3. Binding to voltage-gated Sodium channels prevents the opening of these channels as local anaesthetic binds to the channel's pore occluding the path of the Sodium channels.

4. Impulse blockade is incomplete during onset and recovery from local anaesthetics. Repeated stimulation produces dose dependent binding to Sodium channels.

5. Binding site on Sodium channel which produces drug's resting and dose dependent action is accessed through hydrophobic approach from within the axon membrane.

6. The rate of onset and recovery from blockade are regulated by the slow diffusion of local anaesthetics in and out of the nerves, not by their fast binding and dissociation from ion channels.

Insensitivity:

Relative insensitivity is genetic and is commonly seen in hypokalemic sensory overstimulation and attention deficit hyperactivity disorder. Ehlers-Danlos syndrome patients are also insensitive to Lignocaine.

Contraindications:

Absolute

1. Heart block – second or third degree not on pacemaker
2. Sinoatrial block not on pacemaker
3. Adverse drug reactions to Lignocaine or other amide local anaesthetics.
4. Hypersensitivity to corn or corn related products as dextrose used is derived from corn
5. Class 1 antiarrthymic drugs used concurrently
6. Prior use of Amiodarone hydrochloride
7. Adams- stokes syndrome[30]
8. Wolff – Parkinson – White syndrome[30]

Relative

1. Hypotension not related to arrhythmia
2. Bradycardia
3. Accelerated idioventricular rhythm

4. Elderly patients
5. Pseudocholinesterase deficiency
6. Porphyria
7. Impaired liver function

Adverse Effects

1) **Central Nervous System:**

Nervousness, agitation, anxiety, apprehension, circumoral paraesthesia-tingling sensation around mouth, tremors, dizziness, papillary changes, hallucinations, euphoria, psychosis and seizures[31].

2) **Cardiovascular System:**

Bradycardia, hypotension, arrhythmias, flushing, venous insufficiency, increased defibrillator threshold and cardiac arrest[31], may be due to hypoxaemia secondary to respiratory depression[32].

3) **Respiratory System:**

Bronchospasm , dyspnoea , respiratory depression and respiratory arrest[31].

4) **Gastrointestinal System:**

Nausea, vomiting and metallic taste[31]

5) **Others:**

Tinnitus, allergy, conjunctival hyperaemia, corneal epithelial opacification or ulceration, urticaria, itching, methemoglobinemia and hypersensitivity reactions[31]. Inflammation of veins can occur at the site of drug injection in IVRA techniques.

Pharmacokinetics:

Onset	**:**	45 to 90 seconds
Duration	:	10 to 20 minutes
Metabolism	**:**	Dealkylation in liver by CYP3A4
		Metabolites :
		1.Active – Monoethylglycinexylidide
		2.Inactive – Glycine Xylidide
Volume of Distribution	**:**	1.1 to 2.1 L/Kg
Elimination Half-Life	:	90 to 120 Minutes
Excretion	:	Urine - 90% Metabolites
		10% Unchanged drug

Drug interactions[33]:

Factors altering protein binding will alter the availability of the drug in a free state. Renal and hepatic diseases are associated with high circulating levels of Lignocaine.

Drugs like Isoproterenol and Adrenaline increase the hepatic blood flow.

Concomitant administration of Phenytoin and Propranolol are associated with increase in free drug level in plasma.

Phenobarbitone produces enzyme induction enhancing elimination of the drug from the body.

Inhalational agents like Halothane, Fluroxene, Methoxyflurane enhance the lethal effects of the local anaesthetics with their cardiovascular system depressant action.

Administration during Ether anaesthesia causes respiratory depression in spontaneously breathing patients.

There is prolongation of Suxamethonium and non-depolarising muscle relaxant action.

PARACETAMOL (ACETAMINOPHEN)

History:

Paracetamol was first synthesised in the year 1878 by Morse and later it was introduced for usage in 1883. In 1887 Von Mering used it clinically but discontinued after introduction of Phenacetin. In 1948 Brodie and Axelrod demonstrated the analgesic property of Paracetamol leading to its rediscovery and marketed since 1950′s.

Intravenous route of administration started in the last decade and it was found to overcome the issue of bioavailability which limits speed of onset. Onset of analgesia occurs within 5 minutes with peak effect in 40-50 minutes and lasting for 4 to 5 hours.

Trade name	**:**	Perfalgan (Intravenous route)
Routes of administration	**:**	Oral, rectal and intravenous
Bioavailability	**:**	63 to 89 % orally
		24 to 98% rectally
Half-life	**:**	1-4 hours
Metabolism	**:**	Hepatic system
Excretion	**:**	Renal system

IUPAC name	**:**	N (4-hydroxyphenyl) ethanamide
		N (4-hydroxyphenyl) acetamide
Formula	**:**	$C_8H_9NO_2$
Molecular mass	**:**	151.163 g/mol
Melting point	**:**	169^0 C
Density	**:**	1.263 g/ cm^3
Solubility in water	**:**	12.78 mg/ml
Structure	**:**	

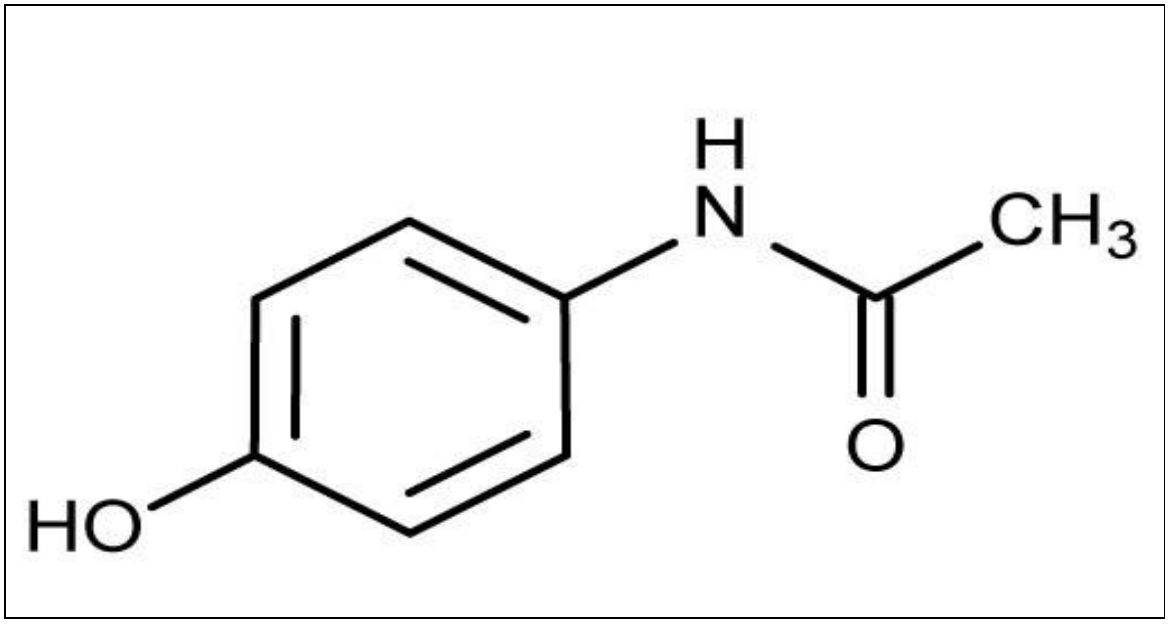

FIGURE 5. STRUCTURE OF PARACETAMOL

Mechanism of action of Paracetamol:

Paracetamol acts by the inhibition of Cyclooxygenase (COX) mediated production of Prostaglandin unlike the non steroidal anti inflammatory agents, so it was found that tissue inflammation was not reduced[34, 35].

In intact cells levels of arachidonic acid were found to be low so the potent inhibitory action of Paracetamol on Prostaglandin synthesis blocks the physiological regeneration of Peroxidase (POX) [34, 35].

In broken cells concentration of Hydroperoxidase was found to be high; hence Prostaglandin synthesis inhibited weakly. This explains the differential activity of Paracetamol in the brain where peroxide concentrations are low and in peripheral sites of inflammation the levels were high. Hence at the site of injured or inflamed tissue it provides highly effective analgesia and antipyretic effects; but there is lack of antiinflammatory and anti platelet activity[34, 35].

Another pathway of action is by the activation of descending serotonergic pathway. Paracetamol also has an endocannabinoid enhancement activity which explains the experience of relaxation, tranquility and euphoria reported in many users apart from the analgesic effects[15].

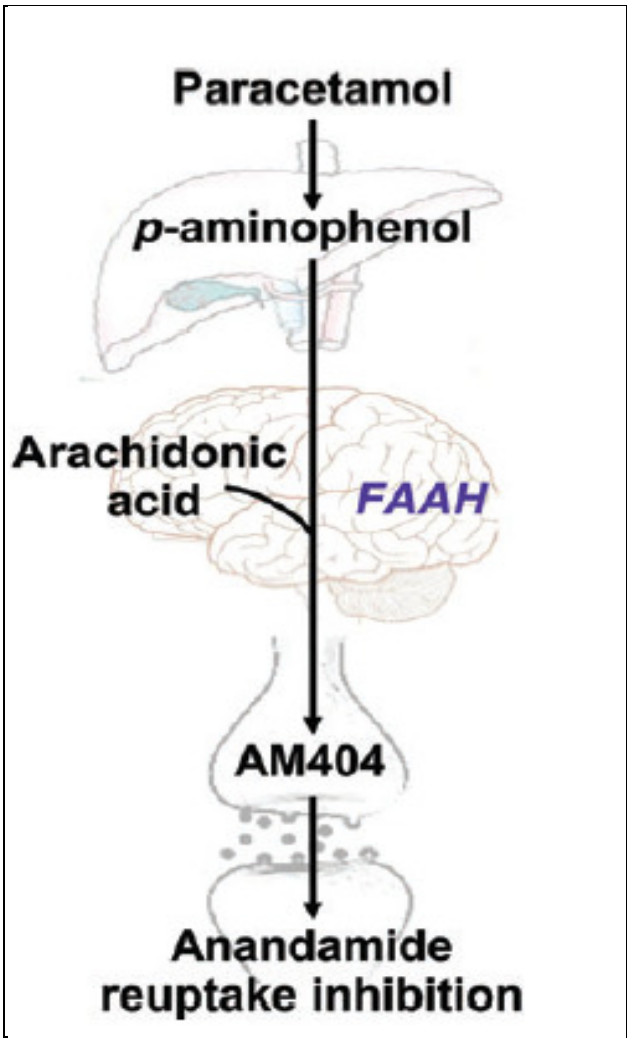

FIGURE 6. CONVERSION OF PARACETAMOL TO AM404, AN ENDOCANNABINOID REUPTAKE INHIBITOR

Paracetamol is conjugated with Arachidonic acid in the presence of Fatty acid amide hydrolase(FAAH) to form the active metabolite N-arachidonoylphenolamine (AM404). This inhibits the reuptake of the endocannabinoid, anandamide from synaptic clefts, increasing the cannabinoid receptor activation on post synaptic membrane[15].

Onset of action[36]**:**

Oral and rectal – 40 minutes; peak effect – 1 hour

Intravenous – 5 minutes; peak effect – 40 to 60 minutes.

Adverse Effects:

1. Overdosage can cause liver damage
2. Upper gastrointestinal bleeding
3. Stevens – Johnson syndrome
4. Toxic epidermal necrolysis
5. Asthma
6. Renal failure

Overdosage:

Nausea, vomiting, sweating and pain when acute liver failure starts.

Toxicity is believed to be due to the accumulation of the Quinone metabolite. Untreated overdosage can lead to liver failure and death.

Treatment is to remove Paracetamol from the body by replacing the Glutathione stores. It is either by using Activated charcoal (to decrease absorption of Paracetamol when a person presents with overdose) or using an antidote (N-acetylcysteine or acetylcysteine). It acts as a precursor for Glutathione helping the body regenerate enough to prevent further damage to liver.

PHARMACOKINETICS:

Absorption **:** Oral administration is rapidly absorbed in the gastrointestinal tract by passive transport

Volume Of Distribution **:** Approximately 50 litres (1 to 2 L/Kg)

Metabolism **:** Occurs in liver into toxic and non-toxic products

Three pathways

1. Glucuronidation accounts 45 to 55 %
2. Sulfation – sulphate conjugation accounts for 20 to 30 %
3. N-Hydroxylation and Dehydration accounts 15%

The cytochrome P450 enzyme metabolises Paracetamol forming a metabolite N-acetyl-p-benzoquinone imine (NAPQI) also called as N-acetylimidoquinone which is irreversibly conjugated with sulfhydryl groups of Gluthathione. NAPQI production is primarily from isoenzymes of cytochrome P450 which are CYP2E1 and CYP3A4.

The three pathways produce final products which are inactive and non-toxic excreted by kidneys. NAPQI is toxic which is responsible for toxic effects of paracetamol. At normal dose it is detoxified by conjugation with Glutathione[76, 77, 78, 79].

Elimination:

1 to 4% is excreted unchanged in urine. Metabolic products are mainly excreted through the kidneys. Rate of urinary clearance is 13.5L/h.

Drug interactions[15]:

Paracetamol potentiates the anticoagulant effects of acenocoumarol and warfarin, increasing the risk of bleeding. There is said to be an inhibition of the hepatic synthesis of coagulation factors 2, 7, 9 and 10 but not yet proved.

Carbamazepine increases risk of hepatotoxicity by inducing the formation of toxic metabolites. There is lower bioavailability of Paracetamol when given with Phenytoin and Fosphenytoin.

Coadministration with Zidovudine results in neutropenia and hepatotoxicity.

Major concern is the interaction with alcohol. Alchohol- paracetamol syndrome is the development of acute toxic hepatic symptoms in long term alcoholics who consume Paracetamol at non-toxic doses. There is a worse prognosis than non-alcoholics overdosed with Paracetamol. With this syndrome the mortality is 20% and exceeds 75% if accompanied with acute liver failure.

EQUIPMENT – TOURNIQUET DEVICES:

1) PNEUMATIC TOURNIQUET

History:

Jean Louis Petit coined the term from French word "tourner" (to turn) in 1718.

FIGURE 7. JEAN LOUIS PETIT

Mechanism:

It consists of inflatable cuff connected to compressed gas supply. This is connected to an instrument which monitors and controls cuff pressure. Pressure is exerted on the limb by compressed gas which is introduced into the cuff by a microprocessor source through connection tubings[37].

When sufficient pressure is exerted the vessels beneath tourniquet are occluded, preventing blood flow past the cuff. While cuff is inflated, tourniquet system automatically monitors the pressure chosen by the user. High pressures

generated can be measured allowing controlled arterial compression. Audiovisual alarm alerts the user when there is cuff leak.

Indications[37]:

1) Surgeries on extremities – To reduce blood loss and provide good operative field
2) Bier's block – IVRA
3) Management of complex regional pain syndrome – Intravenous regional sympathectomy
4) Management of localised malignancy – Isolation of limb perfusion

Pathophysiology:

Effects on Cardiovascular system

Cardiac arrest and circulatory overload commonly occur. It is believed that there is shift of blood volume into central circulation causing an increase in systemic vascular resistance and this leads to a transient rise in systolic blood pressure and central venous pressure[38].

Tourniquet pain is detected 30 – 60 minutes post inflation by gradual rise in arterial blood pressure and heart rate. Tourniquet deflation causes redistribution of circulating volume back into the limb and causes post ischemic reactive hyperaemia. Accumulated circulating metabolites are released back into systemic circulation and leads to a transient fall in arterial blood pressure and central venous pressure[39, 40].

Effects on Respiratory system

Tourniquet inflation has minimal effects where as deflation leads to increase in end tidal concentration of carbon dioxide which peaks in 1 minute. There are two mechanisms to explain these effects, the first being increase in mixed venous P_{CO_2} caused by release of hypercapnic blood from ischemic area distal to tourniquet into systemic circulation. Secondly increase in cardiac output after deflation in response to decreased arterial pressure. This effect is more pronounced in lower limb tourniquet than upper limb tourniquet[41, 42].

Effects on Central nervous system

Rapid increase in end tidal carbon dioxide after deflation causes increase in cerebral blood flow which peaks at 2 – 4 minutes and returns to baseline within 8 – 10 minutes[43, 44]. This effect may cause secondary brain injury in patients with raised intracranial pressure. Normocapnia by hyperventilation after tourniquet deflation can prevent increase in cerebral blood flow and intracranial pressure[45, 46, 47].

Effects on Haematological system

Inflation is associated with hypercoagulability towards the later stage of inflation and after deflation there is an increased thrombolytic effect. Pain due to tourniquet inflation and surgery causes release of catecholamines which promote platelet aggregation creating a hypercoaguble state[48]. Tissue ischemia after tourniquet

inflation causes release of tissue plasminogen activator producing systemic thrombolysis on tourniquet deflation. After deflation there is a brief period of increased fibrinolysis peaking at 15 minutes and returning to preoperative levels within 30 minutes of deflation[49].

Temperature effects

Core body temperature is increased during inflation due to reduced heat transfer and decreased heat loss from affected limb. Deflation causes fall in core temperature because of redistribution of body heat, in addition there is small amount of hypothermic blood from ischemic limb returned to systemic circulation[50, 51].

Metabolic changes

After 1 to 2 hours of ischemia is increase in plasma potassium and lactate concentration after tourniquet release. Lactate and carbon dioxide from ischemic limb entering systemic circulation causes a reduction in arterial pH. Reperfusion of ischemic limb and other hemodynamic changes causes increase in oxygen consumption and carbon dioxide production post tourniquet release. All these effects are reversed within 30 minutes of release[52].

Tourniquet pain mechanism

When tourniquet is inflated there is a vague dull pain in the limb associated with an increase in blood pressure, prolonged inflation causes increase in heart rate and further increase in blood pressure requiring interventions this is reffered to as tourniquet pain. Tourniquet pain is thought to be mediated by unmyelinated, slow C-fibres that are normally inhibited by large, fast, myelinated A-delta fibres. Mechanical compression causes loss of conduction in nerve fibres blocking the large A-delta fibres before small C fibres[53, 54,55,56,57].

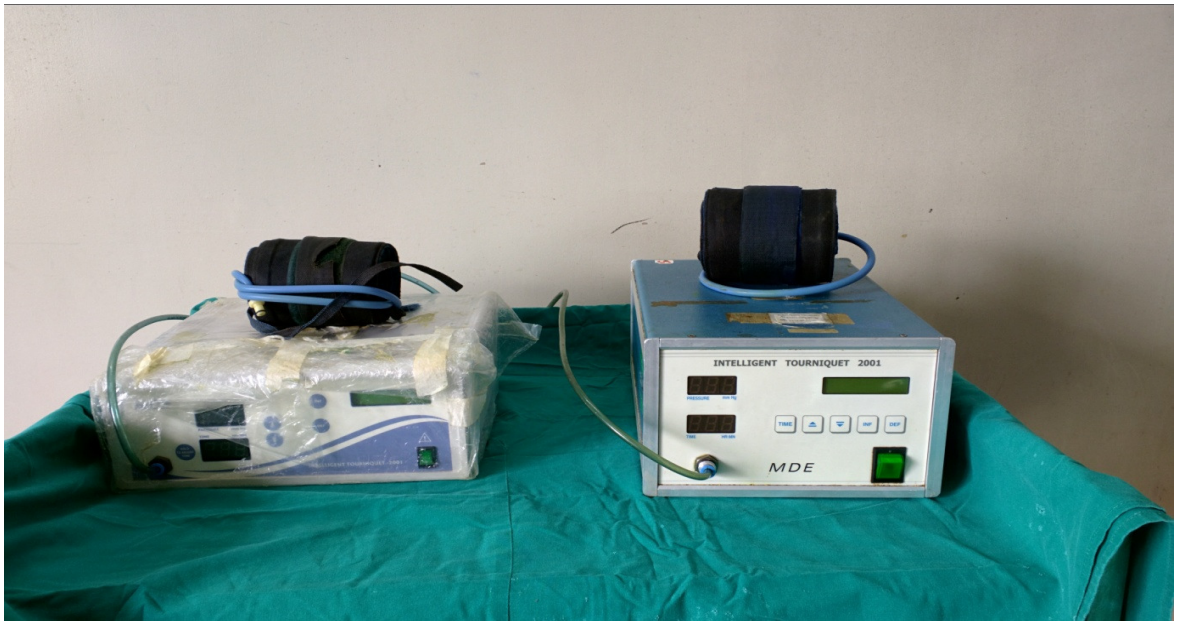

FIGURE 8. TOURNIQUET APPARATUS

Tourniquet pressures

Two common practises regarding inflation pressures are using fixed pressure 250 mmHg for upper limb and 300 mmHg for lower limb or by increasing cuff pressures 100 mmHg above systolic blood pressure for upper limbs and 100-150 mmHg for lower limbs[58].

Contraindications

1. Severe crush injuries to extremities
2. Peripheral neuropathy in diabetic patients
3. Sickle cell disease[59]
4. History of deep vein thrombosis and pulmonary embolism
5. Peripheral vascular disease

Complications:

1) Muscle injury:

Swelling and oedema can occur along with reperfusion hyperaemia. Muscle ischaemia, oedema and microvascular congestion leads to post tourniquet syndrome producing swollen, stiff and weak limbs. Rhabdomyolysis rarely occurs[60].

2) Nerve injury:

Complications range from paraesthesia to paralysis. High tourniquet pressures are implicated in cases of nerve damage. Using esmarch bandage increases likelihood of nerve injuries[61].

3) Skin injury:

Pressure necrosis and friction burns can occur due to badly applied tourniquets. Chemical burns are also quite common due seepage of alcohol based solutions during skin preparation beneath the tourniquet, held against the skin under pressure[62, 63].

4) Vascular injury:

Arterial injury is uncommon. Rush et al[65] suggested mechanical pressure can traumatise atheromatous vessel causing plaques to rupture and the lack of blood flow as a result of tourniquet may cause thrombosis in atherosclerotic vesels[64, 65].

5) Intraoperative bleeding:

Incomplete exsanguination can use intraoperative bleeding.

Tourniquet safety[66, 67, 68]:

(i) Tourniquets should undergo regular maintenance checks like checking the aneroid gauge against suitable calibration device.

(ii) Must be leak proof with no change in pressure over time

(iii) Visually inspected prior to use with attention to rubber tubing, connections and cuff.

(iv) Cuff circumference should exceed 7 – 15 cms more than the limb circumference and width appropriate to the size of the patient.

(v) Avoid folding of tourniquet to protect skin from mechanical injuries

(vi) Pressure gauge monitored continuously during use.

(vii) Arm adequately padded before applying tourniquet

(viii) Surgeons should be informed about the inflation time and alerted at frequent intervals when nearing deflation time

(ix) Avoid seeping of bactericidal solutions beneath the tourniquet

(x) Cautiously used in high risk patients like morbid obesity and previous peripheral vascular surgery.

2) ESMARCH BANDAGE:

History:

Johann Friedrich August Von Esmarch (1823-1908) was a German surgeon who designed a two component device consisting of a rubber bandage attached with a strap to exsanguinate and occlude an arm or leg in battlefield injuries to combat the blood loss and limb injuries.

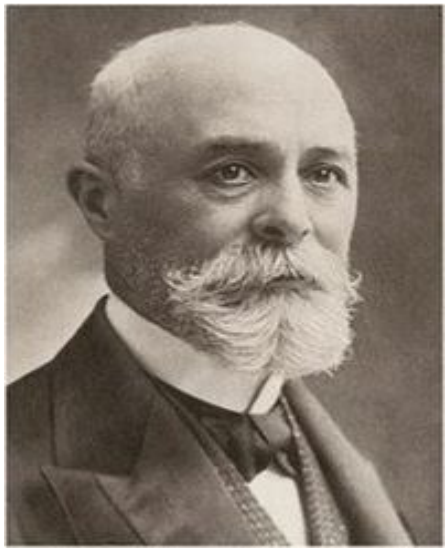

FIGURE 9. JOHANN VON ESMARCH

August Bier was the first to use this bandage in IVRA, but previously Johannes Von Esmarch and Henry A Martin used this bandage in the lower limb for treatment of static ulcers and in preventing recurrence of effusion in knee after aspiration.

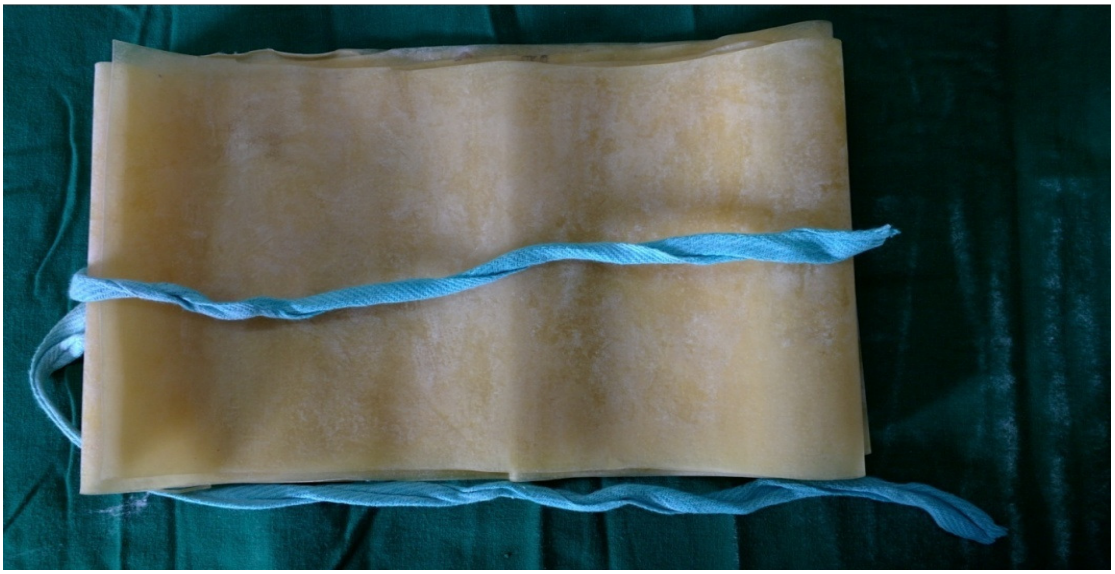

FIGURE 10. ESMARCH BANDAGE

Mechanism:

In patients with traumatised arm or forearm, elevation or arterial compression by exsanguination techniques will sufficiently empty the veins. The degree of emptying the veins is related to the evenness and distribution of the local anaesthetic injected in the limb that does not affect the success of anaesthesia.

If there is overfilling and distension of the veins, it causes swelling of adjoining tissue structures leading to oozing of blood obscuring the operating field during surgery. This problem can be overcome by using Esmarch bandage.

Blond L et al[16] observed 69% reduction in the blood volume of the arm when Esmarch bandage was used for exsanguinations, where as reduction of blood volume while elevating the arm alone causes only 44% reduction in the first 5 seconds, 46% reduction at 60 seconds and 42% reduction at 240 seconds.

4. MATERIALS AND METHODOLOGY

The materials used in this study include:

1) Pneumatic double tourniquet
2) Esmarch bandage
3) Intravenous cannulas – 20 G and 22G
4) Disposable syringes
5) Intravenous solutions
6) Infusion sets
7) Local anaesthetic agents – 2% Plain Lignocaine (Xylocard)
8) Additive agents - Paracetamol or Normal saline

FIGURE 11. MATERIALS USED IN THE STUDY

METHODOLOGY:

Study design : Prospective Randomised double blinded study

Study population : ASA I &II patients posted for upper limb surgeries

Sample size : 60 patients

Study period : August 2013 – March 2015

Study conducted : PSG Institute of Medical Sciences, Coimbatore

Ethical committee approval (August 2013) obtained prior to the start of study.

60 patients of American Society of Anaesthesiologists (ASA) physical status belonging to I or II who were scheduled for upper limb extremity surgeries were included in the study after obtaining informed written consent.

The study group patients were assigned into two groups as Group 1 and Group 2, comprising of 30 patients each. IVRA was performed using 10 ml of 2% Lignocaine with 30 ml of Paracetamol in Group 1 patients and 10 ml of 2% Lignocaine with 30 ml of Normal saline in Group 2.

INCLUSION CRITERIA:

1. ASA I and II patients
2. Age between 20-60 yrs
3. Upper limb extremity surgeries of duration not exceeding 60 minutes

EXCLUSION CRITERIA:

1. History of allergy to local anaesthetics
2. Expected duration of surgery more than 60 minutes
3. Raynaud's disease
4. Sickle cell anaemia
5. Coagulation disorders

PROCEDURE:

Simple randomization was done and assigned into two groups (with 30 patients in each group as Group -1 and Group - 2).

According to ASA starvation guidelines patients were kept nil per oral status overnight and pre-medicated with Tablet Ranitidine 150 mg and Tablet Diazepam 5 mg the night prior to surgery and on the morning of surgery.

Anaesthesia machine safety checklist including resuscitation equipments, emergency drugs and tourniquet equipments were kept ready before the patient arrived in the operating room (OR). Starvation status and surgical consent confirmed in the preoperative room before the patient was shifted inside the operating room.

Preinduction monitors like ECG leads, Non invasive blood pressure (NIBP) cuff and pulseoximeter were connected and baseline readings noted. All the patients were explained about the Visual Analogue Scale (VAS) prior to the start of the procedure.

The syringes were loaded by the principal investigator in the study.

Two intravenous cannulas were secured according to the universal aseptic precautions – one on the dorsum of operative hand as distal as possible to field of surgery for IVRA (22 G) and another on the non operative hand for crystalloid infusion (20 G).

The double pneumatic tourniquet a proximal cuff and distal cuff, were applied to the operative limb after padding the limb. Blood pressure cuff and pulse oximeter were applied to the opposite limb.

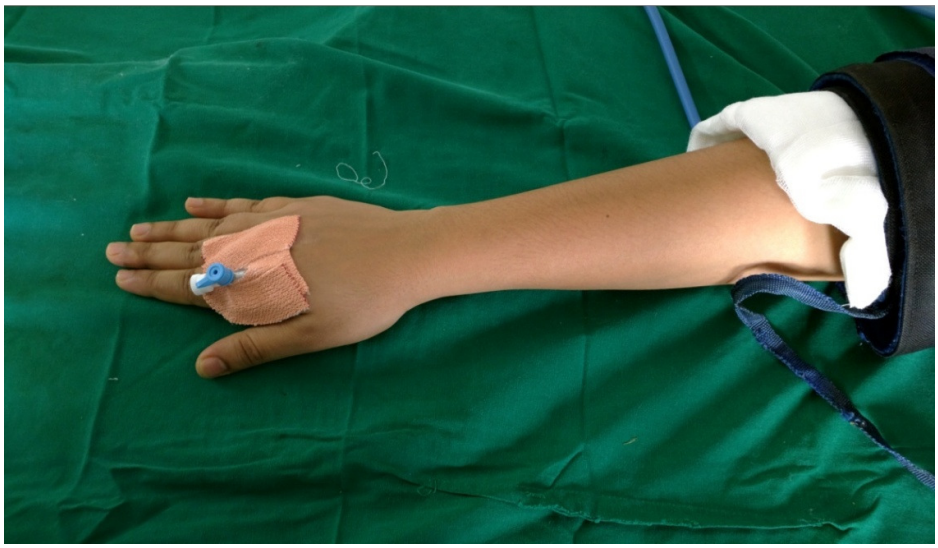

FIGURE 12. INTRAVENOUS CANNULATION WITH TOURNIQUET ON THE OPERATIVE LIMB

The operative arm was elevated for 2 minutes and exsanguination was aided with an Esmarch bandage.

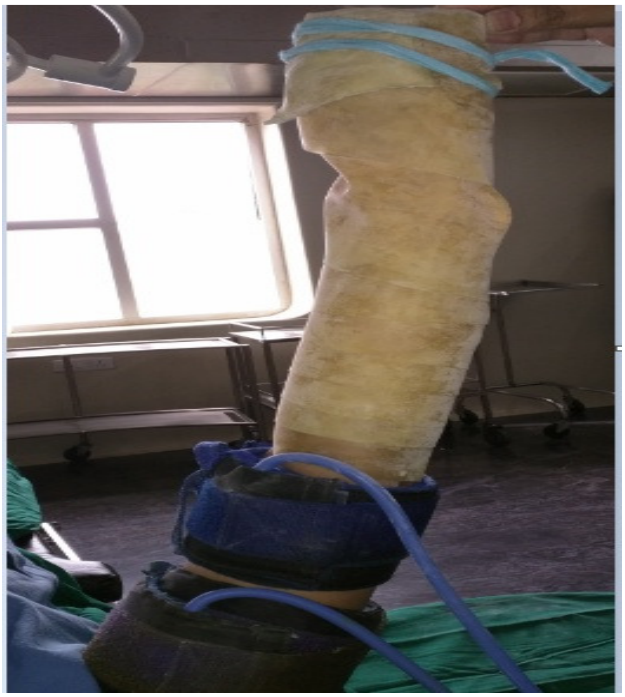

FIGURE 13. LIMB EXSANGUINATION

The proximal cuff was inflated to 100 mmHg above patient's systolic blood pressure. Circulatory isolation of arm was verified by inspection, absence of radial pulse, and a loss of the pulse oximetry tracing.

The solutions were injected by an anaesthesiologist blinded to the study drugs. After injecting the study drug, the sensory block was evaluated by pinprick test every 30 seconds until start of surgery with 22-guage needle in median, ulnar and radial nerve innervated areas of the hand and forearm.

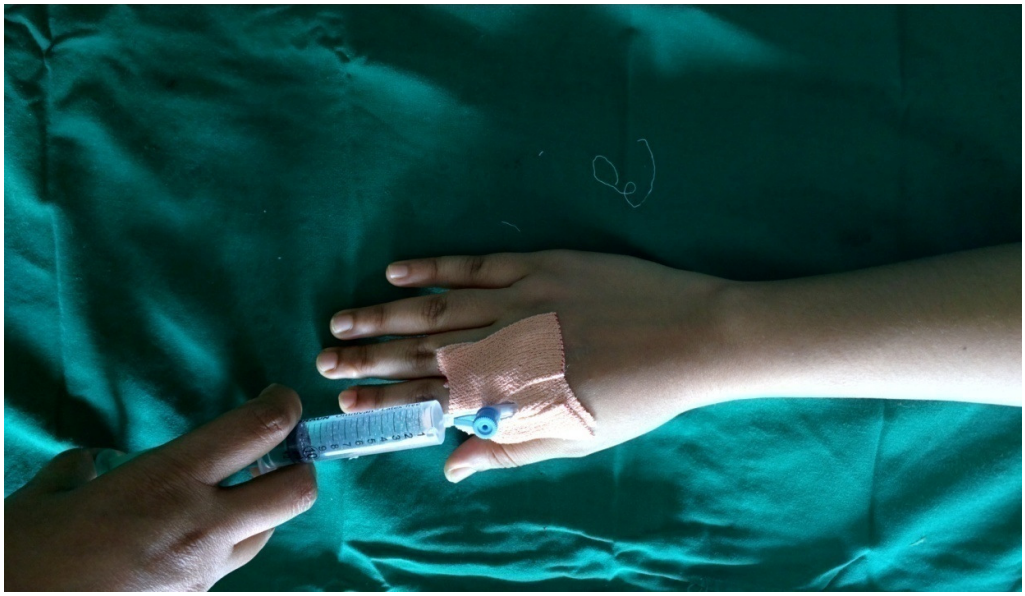

FIGURE 14. IVRA ADMINISTRATION

Motor nerve functions were assessed by asking patients to flex and extend their wrist and fingers, complete block was achieved when no voluntary movement was possible. After complete sensory and motor blocks were achieved, the distal tourniquet was inflated to 100 mmHg, approximately 15 minutes later the proximal tourniquet was released, and surgery was started.

Vital signs like MAP, HR, and SpO_2 were recorded before and after application of tourniquet and monitored continuously during the procedure at 5, 10, 15, 20, 30, 40, 50 minutes interval till the release of tourniquet.

Pain was assessed using a 10cm visual analogue scale. If the patient reported a VAS > 4, rescue analgesic of 1 mcg/kg Fentanyl was intravenously given and the requirement for analgesics was recorded.

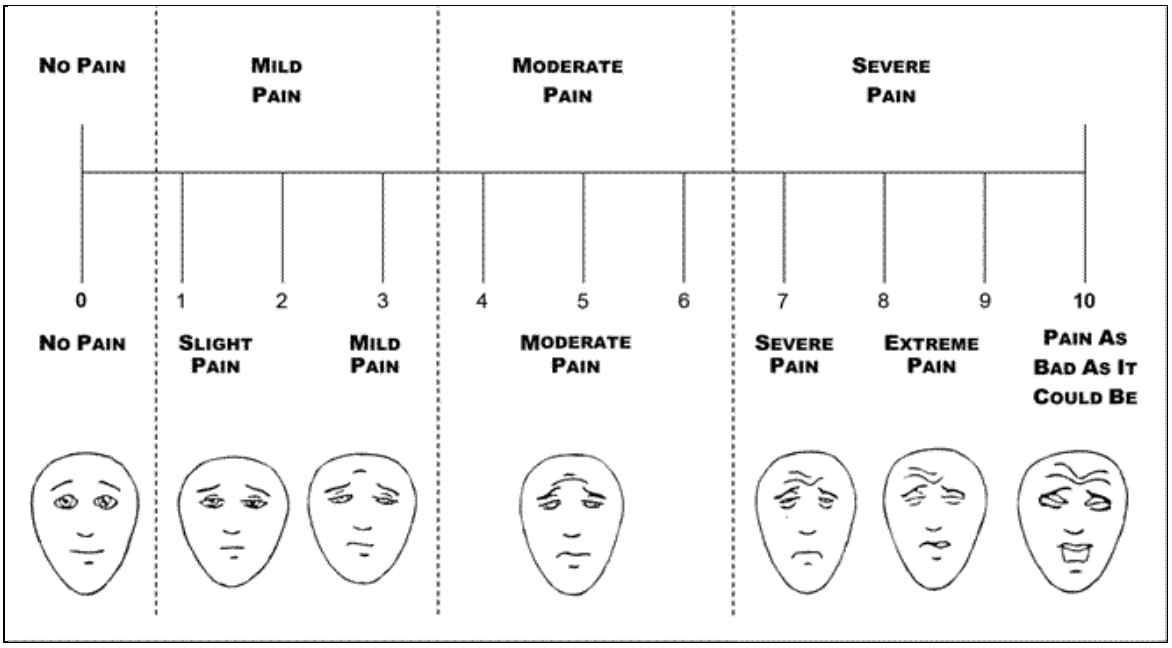

FIGURE 15. VISUAL ANALOGUE SCALE

The tourniquet should not be deflated till 30 minutes after the start of the procedure and not to be inflated more than 2 hours. At the end of the surgery, sensory and motor recovery time was noted.

Patient satisfaction was graded as excellent, good, moderate and poor.

Surgeons blinded to the study were asked to grade the procedure based on the operative conditions and dryness of the field of surgery. The grading was scored as perfect, acceptable, poor and unsuccessful.

The first analgesic requirement after the deflation of tourniquet was noted.

5. OBSERVATION AND RESULTS

STATISTICAL ANALYSIS:

In this study, 60 patients were selected after considering the inclusion and exclusion criteria. Consent was obtained from all the 60 patients and were divided into 2 groups with 30 patients in each group.

Group 1 received 30 ml of Paracetamol and 10 ml of 2% Lignocaine (preservative free (PF))

Group 2 received 30 ml of Normal Saline and 10 ml of 2% Lignocaine (preservative free (PF))

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 19.

Chi-square test and paired 't' test was used for analysis.

"p value of <0.05" was considered to be statistically significant in this study and "p value of <0.001" was considered to be statistically highly significant.

MEAN AGE DISTRIBUTION OF STUDY GROUPS

GROUP	MEAN AGE	SD	x^2	p
1	42.87	11.578	1.099	0.276
2	39.37	13.040		

TABLE 1: MEAN AGE DISTRIBUTION

The average mean age distribution in group 1 and group 2 were 42.87 and 39.37 respectively. The Chi square test and p value is 0.276 which is > 0.05 shows that there is no statistically significant difference in mean age between two groups.

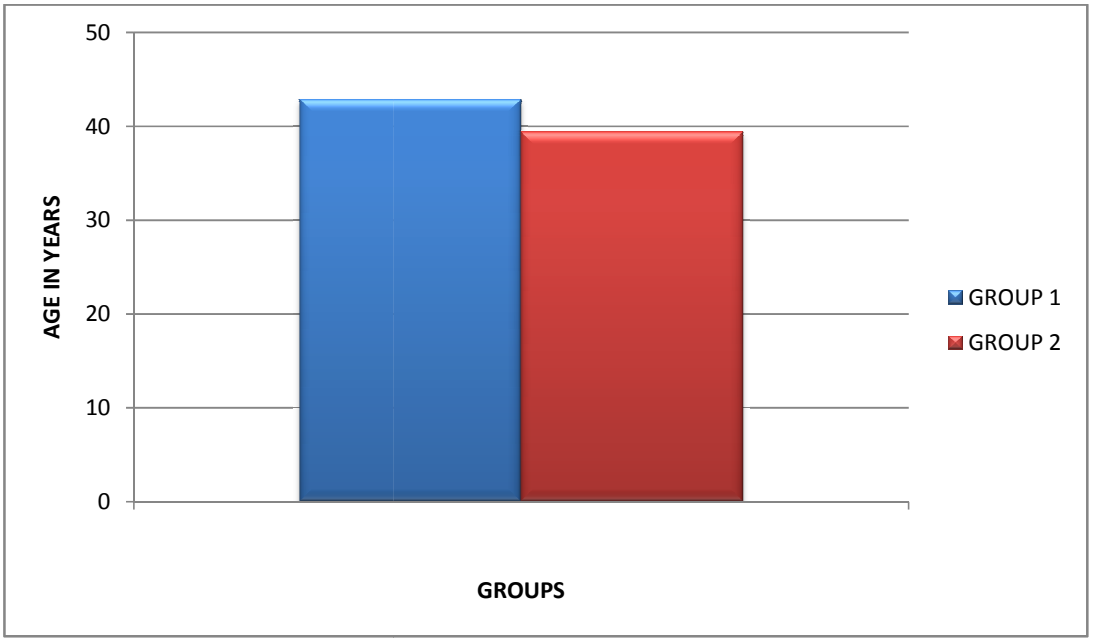

FIGURE 16: MEAN AGE DISTRIBUTION

AGE GROUP DISTRIBUTION

AGE IN YEARS	GROUP - 1		GROUP – 2	
	No. of Patients	Percentage	No. of Patients	Percentage
20 - 30	6	20	10	33.3
31 – 40	8	26.7	6	20
41 – 50	7	23.3	8	26.7
51 - 60	9	30	6	20
Total	30	100	30	100
Mean Age in years ± S.D	42.87±11.578		39.37±13.040	
x^2	1.099			
p value	0.276			

TABLE 2: AGE GROUP DISTRIBUTION

There is no statistically significant difference in age group distribution between two groups as 'p' value is 0.276 which is >0.05.

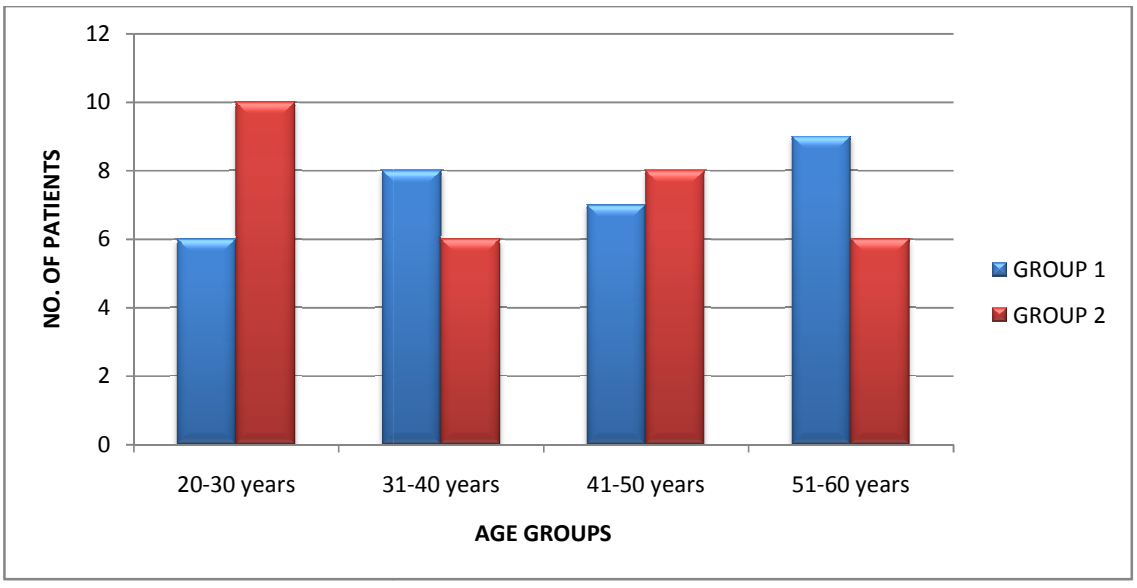

FIGURE 17 : AGE GROUP DISTRIBUTION

SEX DISTRIBUTION

SEX	GROUP 1	GROUP 2	TOTAL	x^2	P
Males	18 (60%)	16 (53.3%)	34 (56.7%)	0.271	0.602
Females	12 (40%)	14 (46.7%)	26 (43.3%)		
Total	30 (100%)	30 (100%)	60 (100%)		

TABLE 3: SEX DISTRIBUTION

The p value is 0.602 which is > 0.05 and this shows that there is no statistically significant difference in sex distribution between two groups.

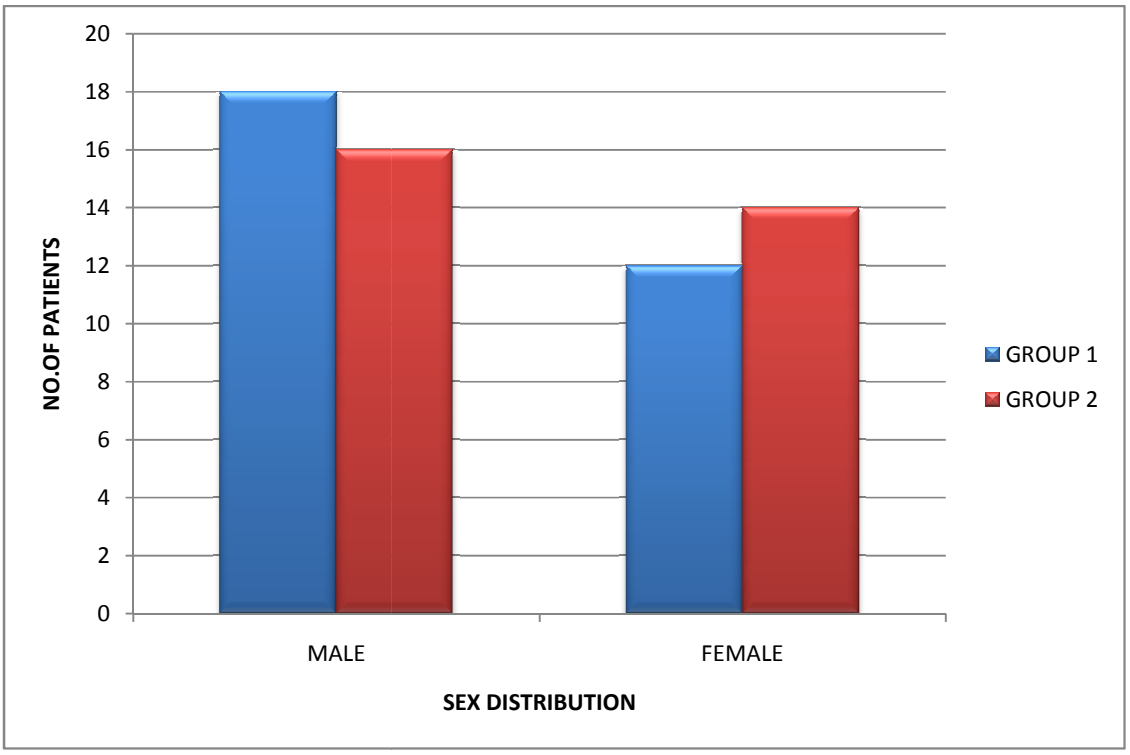

FIGURE 18 : SEX DISTRIBUTION

ASA GRADING DISTRIBUTION

ASA	GROUP 1	GROUP 2	TOTAL	x^2	P
1	20 (66.7%)	22 (73.3%)	42 (70%)	0.317	0.573
2	10 (33.3%)	8 (26.7%)	18 (30%)		
Total	30 (100%)	30 (100%)	60 (100%)		

TABLE 4: ASA GRADING DISTRIBUTION

The p value is 0.573 which is > 0.05 showing no statistically significant difference in ASA grading distribution between two groups.

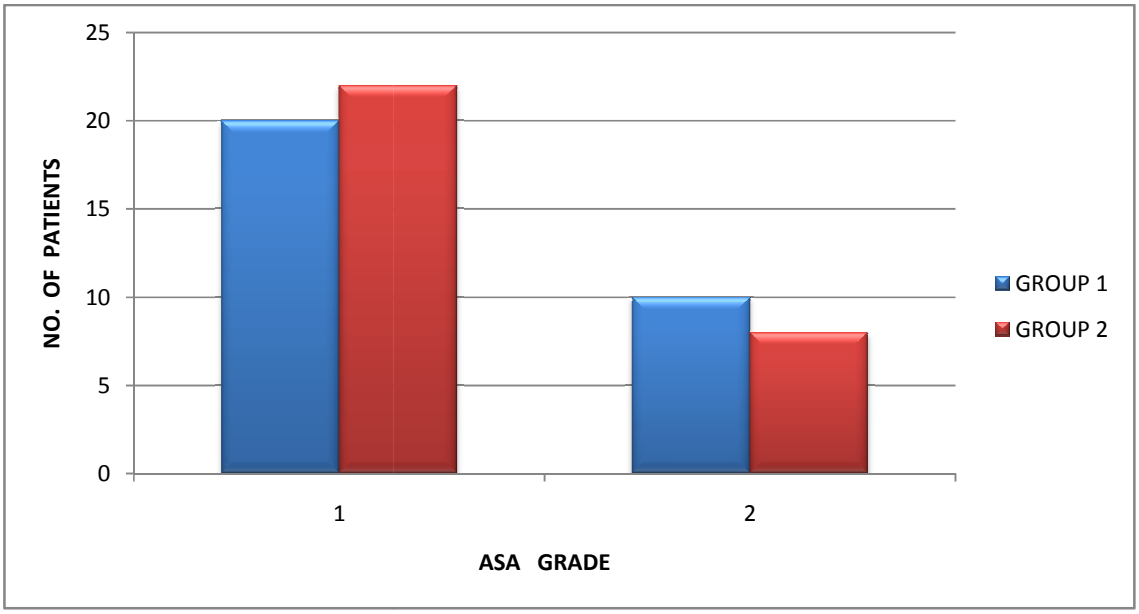

FIGURE 19 : ASA GRADING DISTRIBUTION

TYPE OF SURGERY

GROUP	Carpal tunnel release	Ganglion Excision	K wire fixation	Suturing	x^2	P
1	7	3	19	1	4.929	0.177
2	4	9	17	0		
Total	11	12	36	1		

TABLE 5: TYPE OF SURGERY PERFORMED

By Chi square test, x^2 is 4.929 and value is 0.177 this shows there is no statistically significant difference in terms of type of surgery performed between two groups.

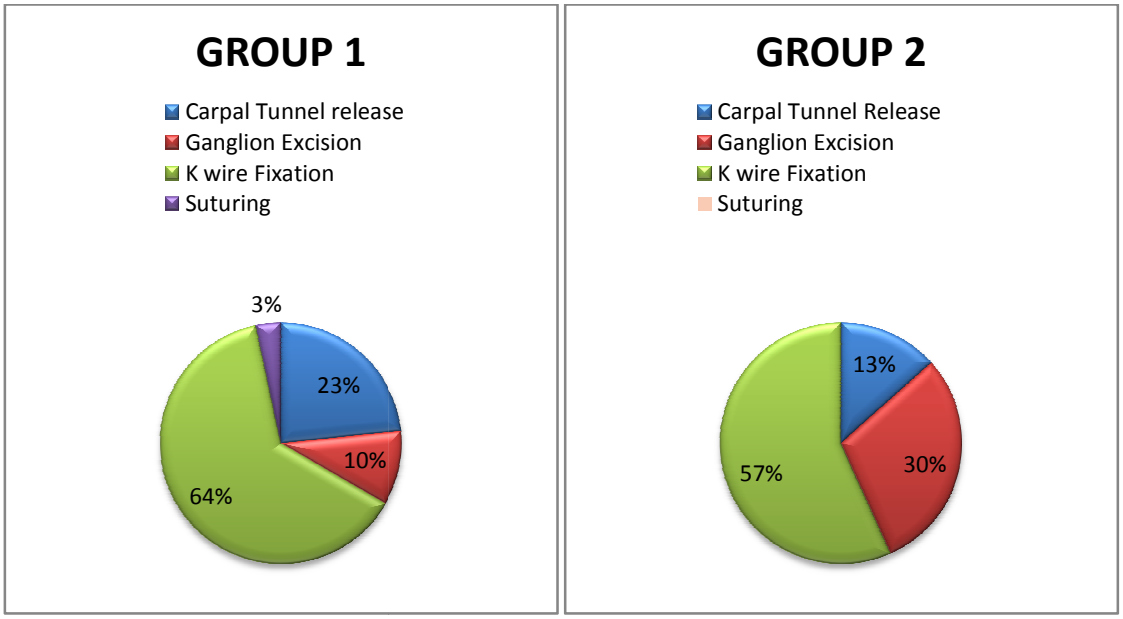

FIGURE 20 : TYPE OF SURGERY PERFORMED IN EACH GROUP

ONSET OF SENSORY AND MOTOR BLOCK TIME

GROUP		N	MEAN	SD	t	p
Onset of Sensory Block (mins)	1	30	5.60	1.589	3.734	**0.001**
	2	30	7.13	1.592		
Onset of Motor Block (mins)	1	30	8.70	2.521	5.194	**0.001**
	2	30	12.27	2.791		

TABLE 6: ONSET OF SENSORY AND MOTOR BLOCK TIME

The paired t test value was 3.734 and **p < 0.001 which shows that there is statistically highly significant difference in between two groups in terms of the onset of sensory block time.**

The paired t test value was 5.194 and **p < 0.001 which shows that there is statistically highly significant difference in between two groups in terms of the onset of motor block time.**

SENSORY AND MOTOR RECOVERY TIME

GROUP		N	MEAN	SD	t	P
Sensory Recovery Time (mins)	1	30	7.60	1.102	5.614	**0.001**
	2	30	5.60	1.610		
Motor Recovery Time (mins)	1	30	8.90	2.139	2.443	**0.018**
	2	30	10.37	2.498		

TABLE 7: SENSORY AND MOTOR RECOVERY TIME

The paired t test value was 5.614 and **p value < 0.001 which shows that there is statistically highly significant difference in between the groups in terms of the sensory recovery time**.

The paired t test value was 2.443 and **p value 0.018 which shows that there is statistically significant difference between the groups in terms of the motor recovery time**.

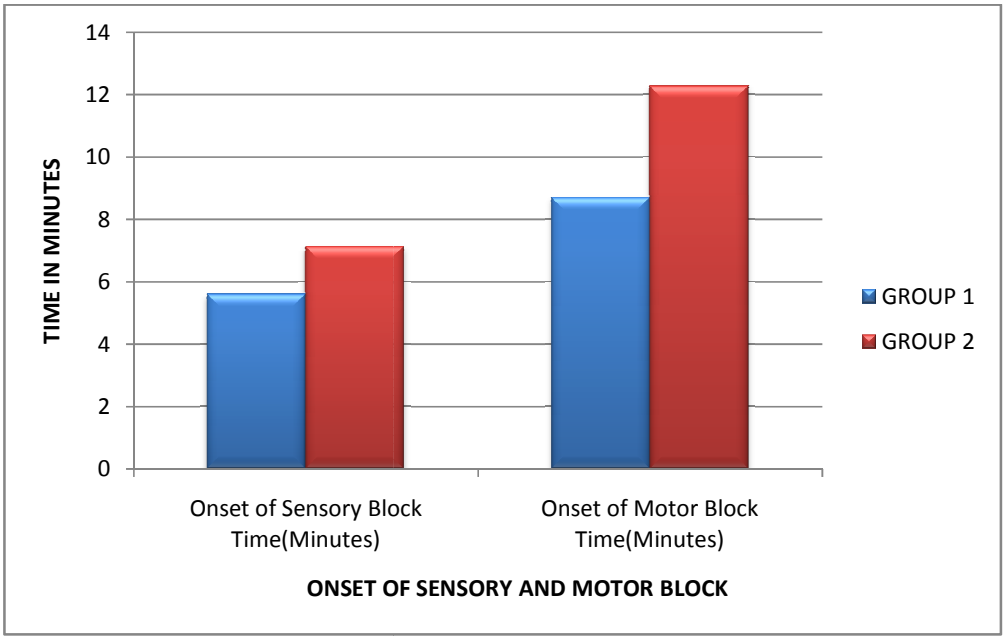

FIGURE 21 : ONSET OF SENSORY AND MOTOR BLOCK TIME

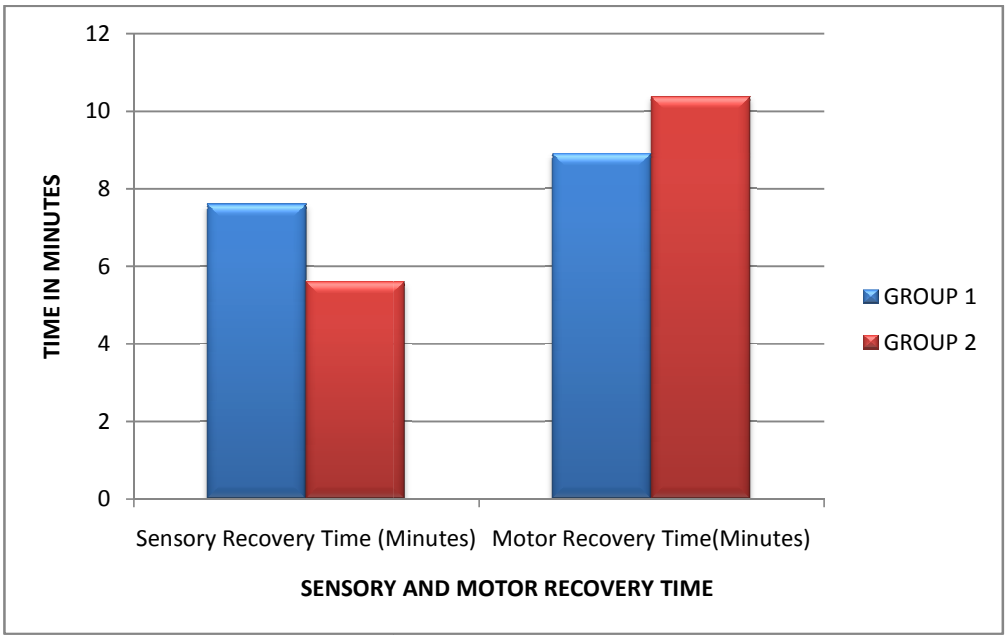

FIGURE 22 : SENSORY AND MOTOR RECOVERY TIME

INTRAOPERATIVE VAS SCORE

GROUP	N	MEAN	SD	t	p
1	30	2.17	1.621	3.116	**0.003**
2	30	3.80	2.369		

TABLE 8: INTRAOPERATIVE VAS SCORE

The paired t test is 3.116 and **p value is 0.003 which shows there is a statistically significant difference in the intraoperative VAS score between two groups**.

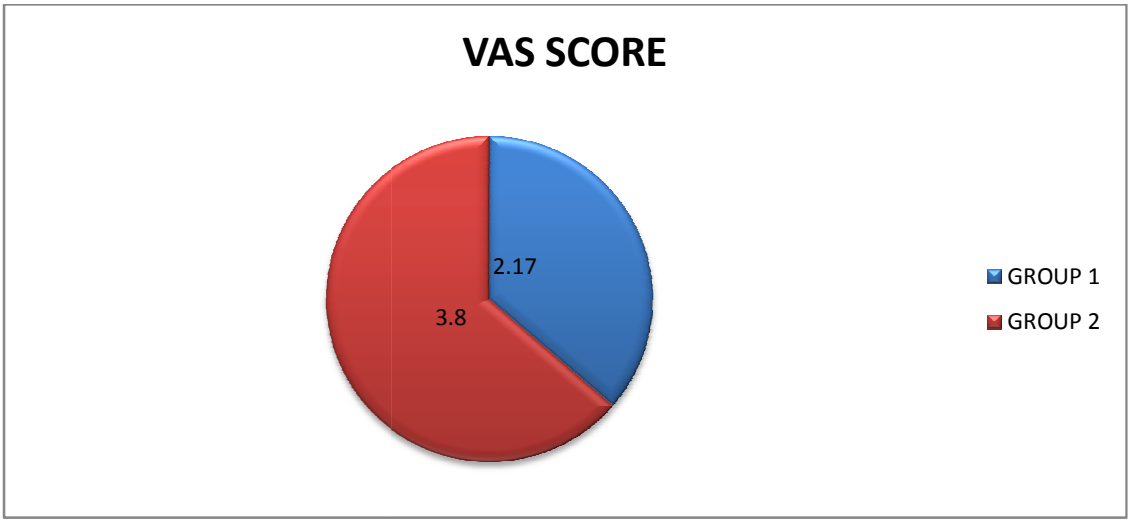

FIGURE 23: INTRAOPERATIVE VAS SCORE

SURGEON SATISFACTION GRADING

Surgeon Satisfaction Grading	Group 1	Group 2	Total	x^2	p
1	14 (46.7%)	6 (20%)	20 (33.3%)	4.800	**0.028**
2	16 (53.3%)	24 (80%)	40 (66.7%)		
3	0	0	0		
4	0	0	0		
Total	30 (100%)	30 (100%)	60 (100%)		

TABLE 9: SURGEON SATISFACTION GRADING

The p value is 0.028 which is < 0.05 shows there is statistically significant difference between two groups with regard to surgeon satisfaction.

PATIENT SATISFACTION GRADING

PATIENT SATISFACTION GRADING	GROUP 1	GROUP 2	TOTAL	X^2	p
1	7 (23.3%)	2 (6.7%)	9 (15%)	7.541	**0.023**
2	18 (60%)	14 (46.7%)	32 (53.3%)		
3	5 (16.7%)	14 (46.7%)	19 (31.7%)		
4	0	0	0		
TOTAL	30 (100%)	30 (100%)	60 (100%)		

TABLE 10: PATIENT SATISFACTION GRADING

The p value is 0.023 which is < 0.05 which shows there is a statistically significant difference between two groups in terms of patient satisfaction.

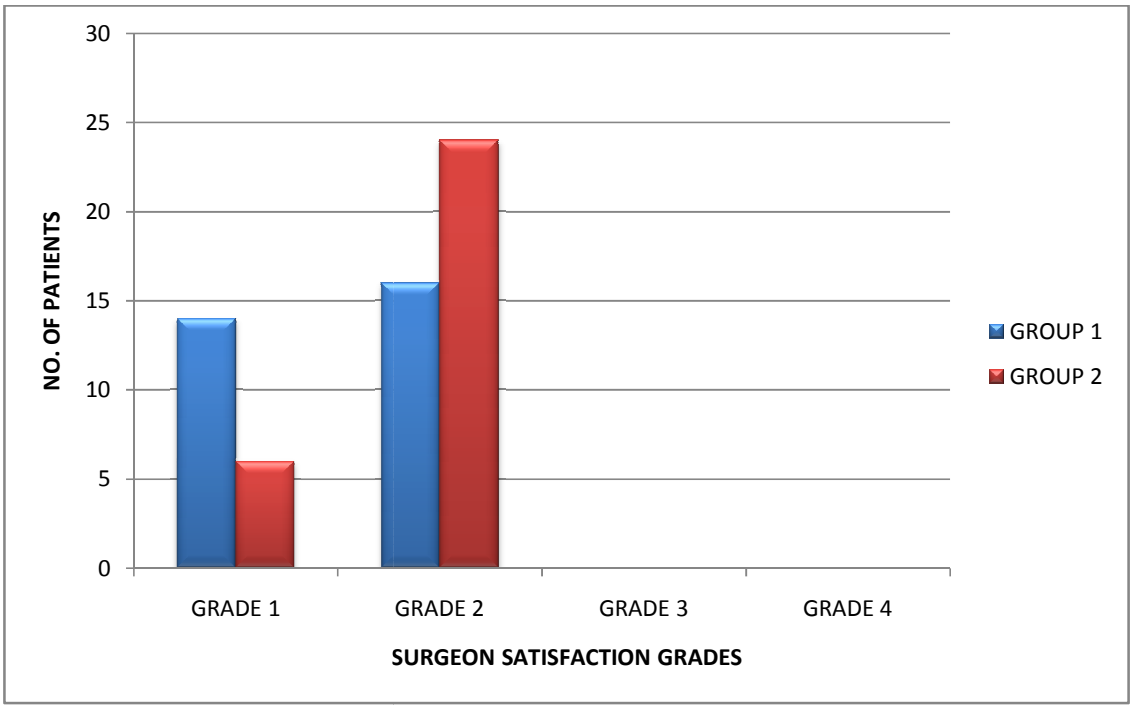

FIGURE 24 : SURGEON SATISFACTION GRADING

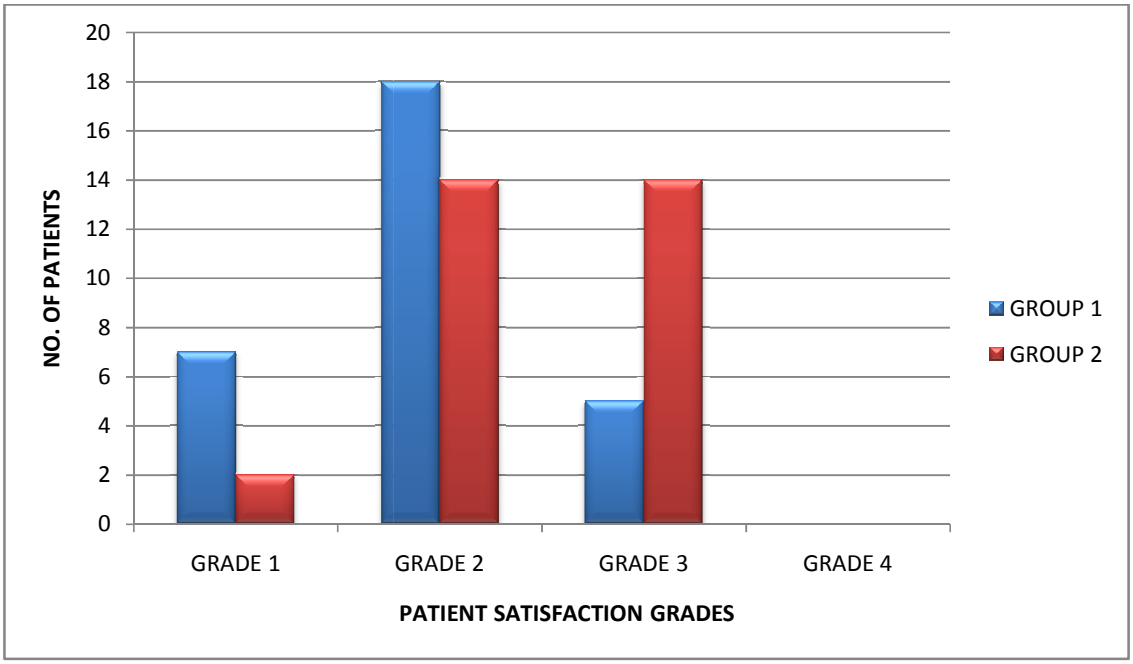

FIGURE 25 : PATIENT SATISFACTION GRADING

FENTANYL REQUIREMENT

FENTANYL REQUIREMENT	GROUP 1	GROUP 2	TOTAL	x^2	p
YES	4 (13.3%)	17 (56.7%)	21 (35%)	12.381	**0.001**
NO	26 (86.7%)	13 (43.3%)	39 (65%)		
TOTAL	30 (100%)	30 (100%)	60 (100%)		

TABLE 11: FENTANYL REQUIREMENT INTRAOPERATIVELY

The Chi-square test value is 12.381. The p value is 0.001 which shows there is a statistically highly significant difference between two groups in terms of Fentanyl requirement intraoperatively.

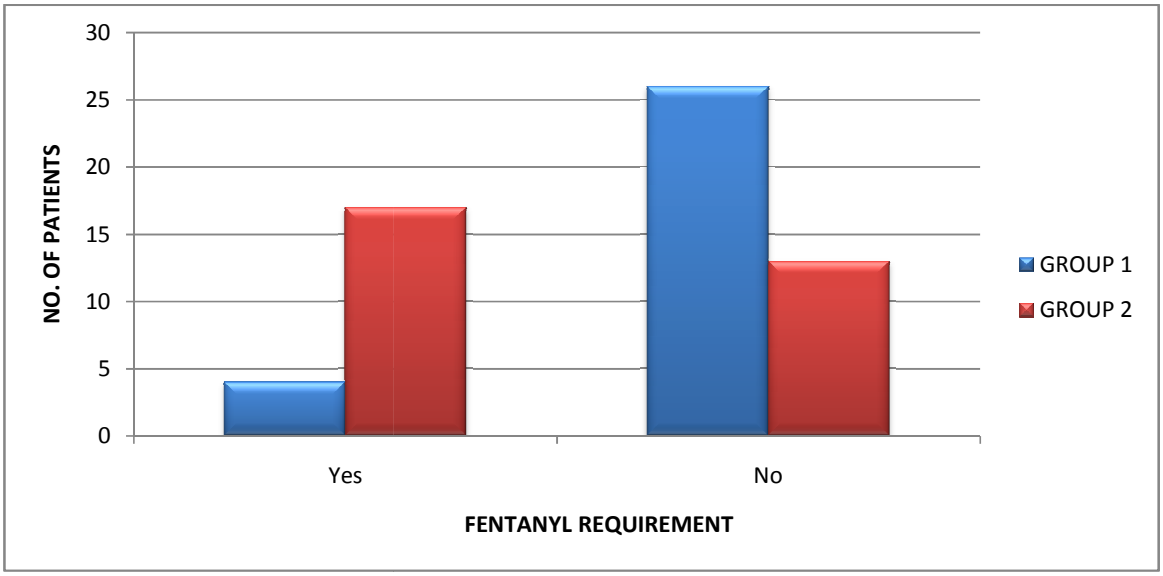

FIGURE 26 : FENTANYL REQUIREMENT INTRAOPERATIVELY

FENTANYL CONSUMPTION IN MICROGRAMS (mcg)

GROUP	N	MEAN (mcg)	SD	t	p
1	30	8.33	21.827	3.721	**0.001**
2	30	38.00	37.820		

TABLE 12: FENTANYL CONSUMPTION INTRAOPERATIVELY

The p value is 0.001 which shows there is a statistically highly significant difference in between the groups in terms of Fentanyl consumption as rescue analgesic intraoperatively.

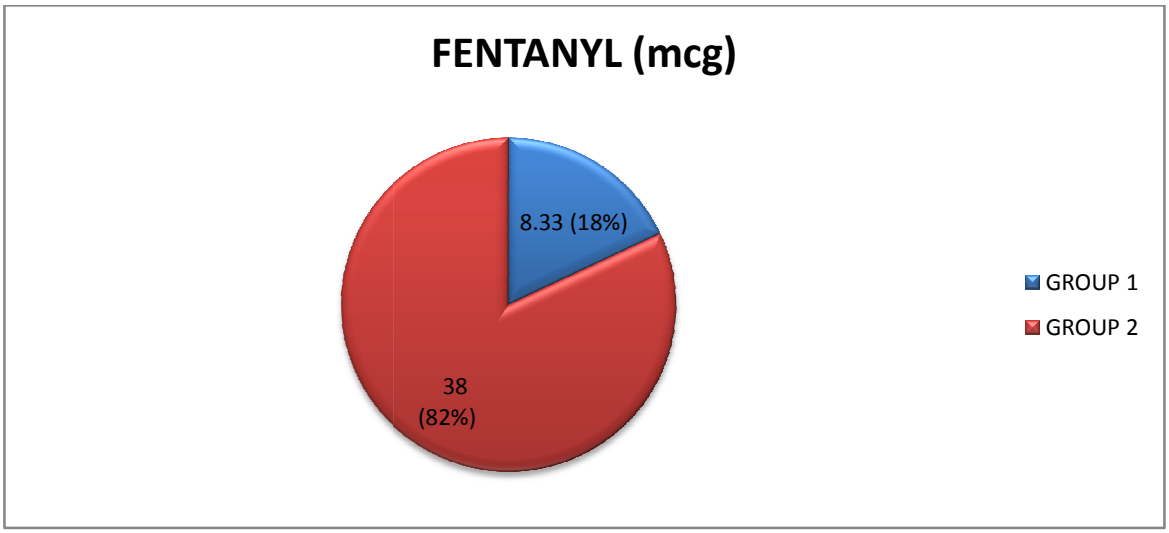

FIGURE 27: FENTANYL CONSUMPTION INTRAOPERATIVELY

POST OPERATIVE ANALGESIC REQUIREMENT

POST OPERATIVE ANALGESIA	GROUP 1	GROUP 2	TOTAL	x^2	p
YES	9 (30%)	25 (83.3%)	34 (56.7%)	17.376	**0.001**
NO	21 (70%)	5 (16.7%)	26 (43.3%)		
TOTAL	30 (100%)	30 (100%)	60 (100%)		

TABLE 13: POSTOPERATIVE ANALGESIC REQUIREMENT

The Chi-square value is 17.376. The p value is <0.001 which shows there is a statistically highly significant difference between two groups in terms of post operative analgesic requirement following tourniquet deflation.

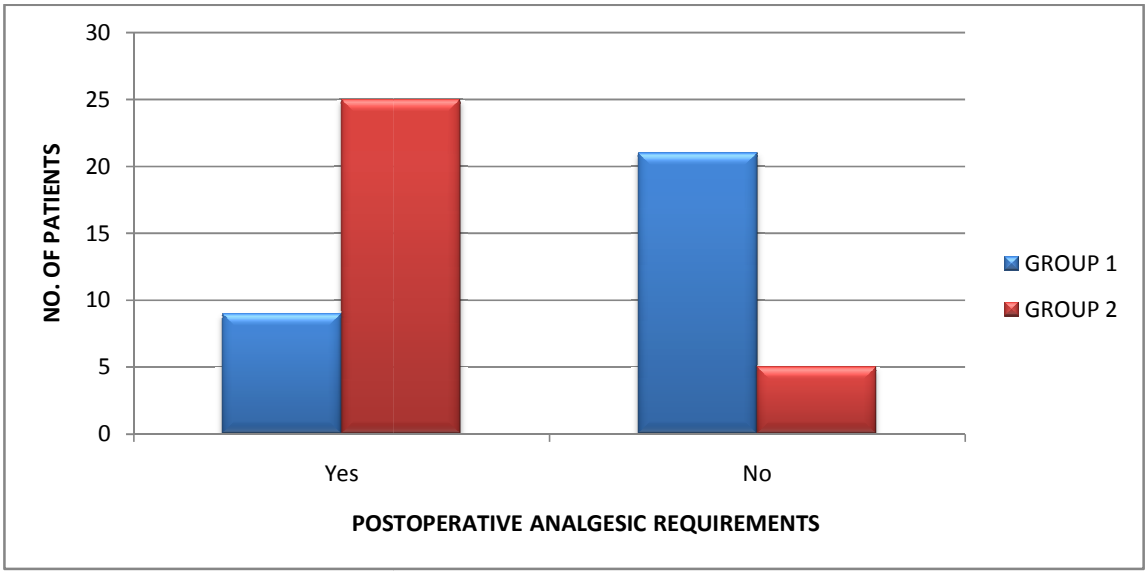

FIGURE 28: POSTOPERATIVE ANALGESIA REQUIREMENT

6. DISCUSSION

IVRA was first introduced by August Bier in the year 1908. This technique is commonly known as Bier's block in commemoration of its founder. IVRA is a simple technique, easy to perform, providing adequate analgesia intraoperatively and decreased postoperative analgesic requirements, while the circulation is occluded. It can be performed in extremities requiring surgical intervention where general anaesthesia may be contraindicated either due to their comorbid conditions or inadequate fasting status.

IVRA technique provides a simple, easy application, cost effective and time saving anaesthesia which makes it as a day care procedure resulting in early discharge allowing them to resume normal activities at the earliest.

Many local anaesthetic agents like Procaine, Mepivacaine, Bupivacaine, Ropivacaine and Prilocaine have been used, but Lignocaine has been popularised as it was found to have less complications when compared with other agents. This technique has the disadvantages of local anaesthetic toxicity, tourniquet pain and inadequate post operative analgesia. These factors have been overcome by changing the local anaesthetics used, modifying the technique and adding additives to local anaesthetics[11].

In our study, we investigated whether the addition of Paracetamol to IVRA solution decreased tourniquet pain, decreased intraoperative use (Fentanyl) and enhanced the sensory and motor block duration by increasing the quality of IVRA.

However, in our study we also demonstrated a decrease in postoperative pain score and analgesic requirement.

SELECTION OF DRUGS AND DOSAGE:

Lignocaine was the local anaesthetic chosen as it is the least toxic agent among the others. Usually 1-2 mg/kg is given for attenuating cardiovascular response during endotracheal intubation or for ventricular arrhythmias.

In IVRA, there is a tourniquet placed over the upper arm requiring adequate analgesia to prevent intraoperative tourniquet pain, hence a dose of 3mg/kg 2% Lignocaine was required[13]. In this study, a fixed dose of 10 ml of 2% Lignocaine (Xylocard-preservative free) was used and made to a total of 40 ml making it as 0.5% Lignocaine which produced adequate analgesia without serious adverse effects[69, 70].

In our study, we used Paracetamol as an additive to confirm whether there was a decrease in intraoperative pain, minimal or decreased opioid usage intraoperatively, along with reduced postoperative analgesic requirement and favourable effects on sensory and motor block.

The dose of Paracetamol was fixed to 30 ml amounting to 300 mg, as total volume required was 40 ml for each group. If a dose more than 300 mg of Paracetamol was used, there would be more volume requiring the local anaesthetic dose to be reduced, that would lead to inadequate sensory and motor blockade[14].

Myoung JK et al[69] used Fentanyl 1 microgram /kg for tourniquet pain and 50 mg Tramadol for postoperative pain. Sen H et al[14] used Fentanyl 1 microgram/ kg if patient had VAS> 4 and 75 mg Diclofenac for post operative pain.

In our study, we used Fentanyl 1 microgram/kg for intraoperative / tourniquet pain or if VAS > 4 requiring analgesia and it was found to be statistically significant which was in concordance with Sen H et al[14].

We also noted post tourniquet deflation analgesic request time along with analgesic supplementation time as per the treating physician orders and found it to be statistically significant. Sen H et al[14] used Diclofenac in his study and noted the decreased Diclofenac requirement in post tourniquet deflation period which was statistically significant.

AGE DISTRIBUTION:

Elhakim M and Sadek RA[71] carried out IVRA on patients between 25 – 55 years. Palecha S et al[73] used IVRA on patients above 20 years of age. Sanjay Kherde et al[72] used age group of 15 – 55 years in his study.

In our study, after reviewing the literature we selected the study group in the age between 20 – 60 years. The mean age distribution in our study was 42.87 ± 11.57 in Group 1 and 39.37 ± 13.04 in Group 2 which was found to be statistically insignificant in coherence with the studies.

SEX DISTRIBUTION:

Out of 60 patients in our study, the sex distribution was 18:12 (Male: Female) in Group 1 and 16:14 (Male: Female) in Group 2. Statistical analysis was insignificant with regard to sex distribution in both the groups in our study, which was in accordance with Vishala et al[11].

ASA GRADING:

In our study, we included patients belonging to ASA I and ASA II in both the groups and found to be statistically insignificant. This study correlates with the Sen et al[14] demographic studies on similar ASA distribution.

PREMEDICATION:

Sen H et al[14] premedicated patients with 0.07 mg/kg of Midazolam i.m and 0.01 mg/kg of Atropine i.v 45 minutes before surgical procedures.

Supplementation of premedication to the patients preoperatively ensured allaying anxiety and for better assessment of the quality of analgesia. In this study, we premedicated the patients preoperatively with Tablet Ranitidine 150 mg and Tablet Diazepam 5 mg on the day prior to surgery in the night and 2 hours prior to surgery on the day of surgery.

We believed that premedicating the patients with an anxiolytic agent would help in improving the patients co operation for the procedure.

INTRAOPERATIVE PAIN:

Tourniquets are used in IVRA to restrict the drugs from entering beyond the cuff into systemic circulation causing untoward consequences. It is also used to provide analgesia and motor blockade distal to the tourniquet.

Chandrashekara PM et al[74] used single rubber latex bandage as a tourniquet above the site of surgery. He noted the tourniquet pain and discomfort in surgeries that prolonged for more than 40-50 minutes.

Holmes C et al[1], Sorbie C and Chancha P[24] and Janardhan et al[75] used double tourniquet with the second tourniquet placed on the anaesthetised portion of the extremity distal to the proximal one to prevent tourniquet pain and discomfort.

In our study, we used a double pneumatic tourniquet placing the first tourniquet on the proximal portion of the extremity to be operated and the second tourniquet distal to the proximal one. Group 1 patients in our study had very negligible intraoperative pain / discomfort during procedure, but Group 2 patients reported with pain intraoperatively, presumably tourniquet pain.

EXSANGUINATION:

IVRA technique is successful when there is proper tourniquet placement and adequate exsanguination[1].

Holmes C et al[1] and Chandrashekara PM et al[74] achieved exsanguination either by simple gravity draining method or by using Esmarch bandage and combined both in some cases.

Blond L et al[16] showed there was 69% reduction in blood volume in the limb after exsanguination using Esmarch bandage.

In our study, we used the combination of limb elevation and Esmarch bandage for exsanguination.

ONSET OF SENSORY BLOCK TIME:

In our study, the mean time of onset of sensory block was 5.60 ± 1.589 minutes in Group 1 and 7.13 ± 1.592 minutes in Group 2 patients. The p value < 0.001 shows there is statistically highly significant difference between two groups in terms of time of onset of sensory block.

The observation of the present study is in accordance with regards to the mean time of onset of sensory block by Myoung Jin Ko and Jeong Han Lee et al[69]. He reported a similar statistically significant difference in his IVRA study, in patients who received 40 ml of 0.5% Lignocaine in one group and 0.5% Lignocaine diluted with Acetaminophen 300 mg to a total volume of 40ml.

ONSET OF MOTOR BLOCK TIME:

In our study amongst patients in Group 1, the average onset of motor block time was 8.70 ± 2.521 minutes and in Group 2 it was 12.27 ± 2.791 minutes. The p value < 0.001 shows that there is statistically highly significant difference among two groups in terms of time of onset of motor block.

The observation of the present study is in accordance with the observations of Sen H, Kulahci Y et al[14] who stated similar statistically significant difference in their

study population with the mean time motor block onset 12 ± 4 minutes in patients who received 40 ml of 0.5% Lignocaine and 8 ± 4 minutes in patients who received 0.5% Lignocaine diluted with Acetaminophen 300 mg to a total volume of 40 ml. .

SENSORY BLOCK RECOVERY TIME:

In our study, the sensory recovery time was 7.60 ± 1.102 minutes in Group 1 and 5.60 ± 1.610 minutes in Group 2. The p value < 0.001 showed that there is statistically highly significant difference with regard to the onset of the sensory recovery time between two groups.

The observations of the present study are in accordance with the statistical observation of Sen H, Kulahci et al[14], who reported the mean time of sensory block recovery time was 5 ± 3 minutes in patients who received 40 ml of 0.5% Lignocaine and 8 ± 2 minutes in patients who received 0.5 % Lignocaine diluted with the Acetaminophen 300 mg to a total volume of 40 ml.

MOTOR BLOCK RECOVERY TIME:

In our study, the motor recovery time was 8.90 ± 2.139 minutes in Group 1 and 10.37 ± 2.498 minutes in Group 2. The p value 0.018 showed that there is statistically significant difference between two groups in terms of motor recovery time.

The observations of the present study are in accordance with the statistical observation of Sen H, Kulahci et al[14], who reported the mean time of motor block recovery time was 6 ± 2 minutes in patients who received 40 ml of 0.5% Lignocaine

and 8 ± 4 minutes in patients who received 0.5 % Lignocaine diluted with the Acetaminophen 300 mg to a total volume of 40 ml.

INTRAOPERATIVE ANALGESIC REQUIREMENT:

In our study, 4 patients out of 30 required Fentanyl consumption intraoperatively in Group 1 and 17 patients out of 30 in Group 2 and proved to be statistically significant with a p value of 0.003. This observation was concurrent with that of Sen H et al[14].

In our study, the mean Fentanyl consumed was 8.33 ± 21.827 micrograms in Group 1 and 38 ± 37.820 micrograms in Group 2, p value < 0.001 showed that there is statistically highly significant difference between two groups in terms of Fentanyl consumption as rescue analgesic intraoperatively.

INTRAOPERATIVE VAS SCORE:

The mean VAS pain score intraoperatively was 2.17 ± 1.621 in Group 1 and 3.80 ± 2.369 in Group 2. The p value 0.003 showed that there is statistically significant difference in the intraoperative VAS score between two groups.

This observation was in accordance with observation obtained in Sen H et al[14] where intraoperative VAS scores seen at 20 and 30 minutes were significantly lower in Group 2 which was 10 ml 3mg/kg Lignocaine with 300mg Paracetamol similar to the present study.

POST DEFLATION ANALGESIC REQUIREMENT:

Out of 30 patients in each group in our study, 9 patients required analgesia following tourniquet deflation in Group 1 and 25 patients in Group 2; which was statistically significant between two groups with p value < 0.05

This observation coincides with Sen H et al[14] and Myoung Jin Ko et al[69] where they showed a statistically significant difference between two groups with a p value <0.05 using Diclofenac and Tramadol respectively.

SURGEON SATISFACTION:

Out of 30 patients in each group in our study, surgeon satisfaction grade was excellent in 14 patients in Group 1 and 6 patients in Group 2. The grade was good in 16 patients of Group 1 and 24 patients of Group 2.

There was a statistically significant difference between two groups as the p value is 0.028 (which is < 0.05) with regard to surgeon satisfaction in our study.

PATIENT SATISFACTION:

Out of 60 patients in our study, 7 patients from Group 1 and 2 patients from Group 2 gave excellent grading (Grade 1), 18 patients from Group 1 and 14 patients from Group 2 gave good grading (Grade 2) and 5 patients from Group 1 and 14 patients from Group 2 gave moderate grade (Grade 3).

There was a statistically significant difference between two groups as p is 0.023 (< 0.05) with regard to patient satisfaction in our study.

7. SUMMARY

The IVRA study entitled "Efficacy of Paracetamol when added as an adjunct to Lignocaine in Intravenous Regional Anaesthesia" was undertaken at PSG IMSR, Coimbatore from 8th August 2013 to 31st March 2015. The study population consisted of 60 patients belonging to ASA class I and II who were allocated into two groups as

Group 1 – 10 ml 2 % Lignocaine (PF) with 30 ml Paracetamol and

Group 2 – 10 ml 2 % Lignocaine (PF) with 30 ml Normal Saline

The following parameters were studied in our IVRA study

1. Demographic details like age and sex distribution
2. ASA distribution and type of surgery performed
3. Intraoperative tourniquet pain assessed by VAS
4. Onset of sensory and motor block
5. Sensory and Motor block recovery time
6. Fentanyl requirement intraoperatively
7. Surgeon and Patient satisfaction in IVRA technique
8. Postoperative analgesic requirement

PARAMETERS	GROUP - 1	GROUP -2	p VALUE
Age (Years)	42.87 ± 11.58	39.37 ± 13.04	> 0.05
Sex (Male / Female)	18 / 12	16 / 14	0.602
ASA (I / II)	20 / 10	22 / 8	0.573
Onset of Sensory Block (Mins)	5.60 ± 1.58	7.13 ± 1.59	**< 0.001**
Onset of Motor Block (Mins)	8.70 ± 2.52	12.27 ± 2.79	**< 0.001**
Sensory Block Recovery Time (Mins)	7.60 ± 1.10	5.60 ± 1.6	**< 0.001**
Motor Block Recovery Time (Mins)	8.90 ± 2.13	10.37 ± 2.49	**0.018**
Intraoperative VAS	2.17 ± 1.62	3.80 ± 2.36	**0.003**
Fentanyl Consumption (mcg)	8.33 ± 21.82	38 ± 37.82	**< 0.001**
Fentanyl required intraoperatively	4	17	**< 0.001**
Surgeon Satisfaction (Grade 1:2:3:4)	14:16:0:0	6:24:0:0	**0.028**
Patient Satisfaction (Grade 1:2:3:4)	7:18:5:0	2:14:14:0	**0.023**
Postoperative Analgesic Requirement (Yes / No)	9 / 21	25 / 5	**< 0.001**

TABLE 14: SUMMARY OF THE STUDY

8. CONCLUSION

To conclude from our study, that the administration of Paracetamol as an adjunct to Lignocaine in IVRA, was found to be efficacious and it provided significant shortening in the onset of sensory block, a decrease in the intraoperative analgesic requirement and an improvement in the post operative analgesia with a reduced need for analgesics in the post operative period.

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10. ANNEXURES

Proforma

Name: Age/Sex: IP no:

OP no: Dept/Unit: ASA:

Group:

Time of injection of solution:

Onset of sensory block :

Onset of motor block :

Monitoring chart:

TIME(min)	PR	MAP	SpO_2
Baseline			
5			
10			
15			
20			
30			
40			
50			

After release			
10 min after release			

Tourniquet pain : VAS :

Rescue Analgesic :

Excellent ☐ Good ☐ Moderate ☐ Poor ☐

Surgeon Satisfaction:

Perfect ☐ Acceptable ☐ Poor ☐ Unsuccessful ☐

Sensory Recovery time :

Motor Recovery time :

First Analgesic Time :

Patient Satisfaction :

Excellent ☐ Good ☐ Moderate ☐ Poor ☐

PSG Institute of Medical Science and Research, Coimbatore
Institutional Human Ethics Committee
INFORMED CONSENT FORMAT FOR RESEARCH PROJECTS

(strike off items that are not applicable)

I / We (write name of the investigator(s) here), DR.S.SULEKHA , am / are carrying out a study on the topic: EFFICACY OF PARACETAMOL WHEN ADDED AS AN ADJUNCT TO LIGNOCAINE IN INTRAVENOUS REGIONAL ANAESTHESIA

As part of my / our research project being carried out under the aegis of the Department of: ANAESTHESIOLOGY

(*Applicable to students only*): My / our research guide is: DR.S.MUSHAHIDA

The justification for this study is: Paracetamol added as an adjunct to lignocaine has been shown to provide decreased tourniquet pain ,increased anaesthesia quality and decreased postoperative analgesic consumption.

The objectives of this study are:

Primary Objective: To determine the efficacy of paracetamol when added as adjuvant to lignocaine for intravenous regional anaesthesia.

Secondary Objective: to compare the

1) Onset of sensory and motor block in both groups.
2) Recovery time in both groups.
3) Requirement of post operative analgesia.

Sample size: __60 convenient sample size__.

Study volunteers / participants are (specify population group & age group): ASA 1-2,AGE GROUP-20-60 yrs .

Location: _PSGIMSR.

We request you to kindly cooperate with us in this study. We propose collect background information and other relevant details related to this study. We will be carrying out:

Initial interview (specify approximate duration):20 minutes.

Data collected will be stored for a period of fifteen years. We will / will not use the data as part of another study.

Health education sessions: Number of sessions: __1_. Approximate **duration** of each session:

___20__minutes.

Clinical examination (Specify details and purpose):

Blood sample collection: Specify quantity of blood being drawn: _____ml.

No. of times it will be collected: _____.

Whether blood sample collection is part of routine procedure or for research (study) purpose:

1. Routine procedure 2. Research purpose

Specify **purpose**, discomfort likely to be felt and side effects, if any: _____

Whether blood sample collected will be stored after study period: Yes / No, it will be destroyed

Whether blood sample collected will be sold: Yes / No

Whether blood sample collected will be shared with persons from another institution: Yes / No

Medication given, if any, duration, side effects, purpose, benefits:

Whether medication given is part of routine procedure: Yes / No (If not, state reasons for giving this medication)

Whether alternatives are available for medication given: Yes / No (If not, state reasons for giving this particular medication)

Final interview (specify approximate duration):_____ mts. If **photograph** is taken, purpose:

Benefits from this study:

Easy to administer
Low incidence of block failure
Safe technique when used appropriately
Rapid onset and recovery
Muscle relaxation for the surgeon

Risks involved by participating in this study:

Tourniquet discomfort- tourniquet pain may occur 20-30 minutes after inflation.
Rapid return of sensation after tourniquet release resulting in subsequent pain
Toxic reactions from malfunctioning tourniquets or deflating the tourniquets prior to 20-25 minutes.
Sudden cardiovascular collapse or seizures may occur if local anaesthetic is released into the circulation too early.

How the **results** will be used:

If you are uncomfortable in answering any of our questions during the course of the interview / biological sample collection, **you have the right to withdraw from the interview / study at anytime.** You have the freedom to withdraw from the study at any point of time. Kindly be assured that your refusal to participate or withdrawal at any stage, if you so decide, will not result in any form of compromise or discrimination in the services offered nor would it attract any penalty. You will continue to have access to the regular services offered to a patient. You will **NOT** be paid any remuneration for the time you spend with us for this interview / study. The information provided by you will be kept in strict confidence. Under no circumstances shall we reveal the identity of the respondent or their families to anyone. The information that we collect shall be used for approved research purposes only. You will be informed about any significant new findings - including adverse events, if any, – whether directly related to you or to other participants of this study, developed during the course of this research which may relate to your willingness to continue participation.

Consent: The above information regarding the study, has been read by me/ read to me, and has been explained to me by the investigator/s. Having understood the same, I hereby give my consent to them to interview me. I am affixing my signature / left

thumb impression to indicate my consent and willingness to participate in this study (i.e., willingly abide by the project requirements).

Signature / Left thumb impression of the Study Volunteer / Legal Representative:

Signature of the Interviewer with date: Witness: