INTRODUCTION

Intravenous regional anesthesia (IVRA) is a technique involving administration of local Anesthetic into a region where venous return is mechanically impeded. It is easily learned and requires minimal personnel.

IV regional anesthesia was introduced in1908 by the German surgeon August Gustav Bier, hence the more common term "Bier's block" for this technique, The technique regained popularity by Holmos in 1963 **(Casey, 1992).**

Advantages include being one of the safest and most reliable forms of regional anesthesia for short procedures on the upper extremity. It is also associated with a more favorable patient recovery profile than general anesthesia .Patients undergoing regional anesthesia for outpatient hand surgery are less likely to require analgesic and anesthetic medication during the recovery period than those receiving general anesthesia .IVRA also offers reduced nursing time demand in the post anesthesia care unit and earlier hospital discharge, resulting in decreased hospital costs **(Chen and Pan, 2001)**

Disadvantages include **c**oncerns about local anesthetic toxicity, slow onset, poor muscle relaxation, tourniquet pain and minimal postoperative pain relief **(Johnson, 2000**)

The ideal IVRA solution should have the following features: rapid onset, reduced dose of local anesthetic, reduced tourniquet pain, and prolonged post deflation analgesia to improve the quality of block and to prolong the post tourniquet release analgesia. **(Choyce and Peng, 2002)**

Some drugs could be added to lidocaine as an analgesic adjuvant, in this work we are going to study the effect of two drugs when added each to lidocaine compared to lidocaine when used alone.

These drugs are magnesium and neostigmine parenteral magnesium has been used for many years on an empirical basis as an antidysrhythmic, treatment for eclampsia and for intra operative and post operative analgesia. The mechanism of the analgesic effect of magnesium is not clear, but interference with calcium channels and N-methyl-D aspartate receptors (NMDA) seems to play an important role.

Studies have reported that magnesium has an endothelium derived nitric oxide induced vasodilator effect that protects vascular endothelium from ischemia induced by the pneumatic tourniquet **(Mallet, *et al* .1996)** It was demonstrated that the addition of magnesium to Lidocaine improved the quality of the block, extended the analgesia, and reduced the overall failure rate(**Tramer and Glynn, 2002)**

Side effects of systemic magnesium include loss of deep tendon reflexes, heart block, respiratory paralysis and cardiac arrest in toxic plasma levels (**Tramer and Glynn, 2002)**

Neostigmine is a drug that has been used to antagonize muscle relaxants, Admnistration of neostigmine in animals and humans caused analgesia by inhibition of the breakdown of acetylcholine in the spinal cord and the peripheral nerves. Side effects of neostigmine include sinus bradycardia and bronchospasm **(Naguib and Yaksh, 1994)**

One of the drawbacks of IVRA being not suitable for procedures that extend for more than one and half hours and development of tourniquet pain .The aim of adding magnesium or neostigmine to IVRA in this study is to increase the duration of the block and delay the tourniquet pain.

AIM OF THE WORK

The aim of this study is to compare the analgesic efficiency, onset and duration of both sensory and motor blockade of neostigmine versus magnesium when incorporated with lidocaine in local intravenous anesthesia introperatively and postoperatively.

CHAPTER ONE

Intravenous Regional Anesthesia

Bier's block

Intravenous (IV). regional anesthesia is a technique involving administration of a local anesthetic into a region where venous return is mechanically impeded **(Roberts et al., 1991).** Intravenous regional anesthesia was introduced in 1908 by the German surgeon August Gustav Bier, hence the more common term "Bier's block" for this technique. Although used commonly when it was first introduced, Bier's block fell in popularity before being reintroduced by Holmes in 1963 ***(Casey, 1992).***

Most experience with Bier's block has been in operating rooms, where it is considered a safe and effective alternative to general anesthesia in selected cases involving the upper and lower limbs. Bier block can also be used in the emergency department to provide rapid and complete anesthesia, as well as muscle relaxation and a bloodless operating field. Bier's block has been shown to be effective when used by pediatric orthopedic surgeons in the management of children's upper-extremity fractures (***Blasier and White, 1996).***

History of the block

The currently familiar technique of intravenous regional anesthesia (IVRA). first advocated by Holmes in 1963 is basically different from the original method introduced by Bier in 1908 . (**Holmes C,1989).**

Bier (1861 -1949). used the rubber bandages invented by his former teacher von Esmarch to exsanguinate the limb and to form two tourniquets, one above and one below the elbow or the knee. The purpose of his block was to facilitate palliative surgery on the elbow or knee, consequently Bier needed to anesthetize the segment of limb between the tourniquets . (**Holmes C,1989).**

Bier had the good fortune to have at his disposal the first safe injectable local anesthetic, procaine *(Synthesized by Einhorn in 1904)* nevertheless it was with innovative flair that he hit upon the idea of delivering the procaine directly to the core of the major nerves in the region of the elbow or knee through the vasa nervous. In this way the drug would not have to penetrate the thick connective tissue surrounding the nerves before producing its effect. Bier felt that he did not have the technical resources to cannulate peripheral arteries safely, hence he had to settle for the venous approach to the vasa nervorum Bier designed a special wide bore cannula with a proximal stop-cock, the whole being attached to a 100 ml syringe by a tough flexible hose. He had to perform a cut-down, after local infiltration with procaine, to expose a sufficiently large vein in the region of the elbow or knee isolated between the two tourniquets. The cannula came in three diameters: 1.5 mm for children; 1.75 mm for general use; and2.0 mm for larger vessels such as varicose saphenous veins. Two circumferential grooves near the distal end of the cannula enabled him to secure it in place with a constricting ligature around the vein**.** (**Holmes C,1989).**

Bier dissolved procaine crystals in physiological saline to make a 0.5% solution and he used 50-80 ml in the elbow region and 100 ml in the knee region. As an added refinement Bier mentioned that he favored warming the solution to body heat before use, because he had observed that veins are sensitive to cold. Bier tried eliminating the distal tourniquet and injecting procaine solution into veins just proximal to the wrist or ankle (much as in the modern technique of IVRA). but he was not enthusiastic because of the difficulties he experienced cannulating these smaller peripheral veins. **(Holmes C,1989).**

Bier noted that whilst rapid anesthesia developed in the area between the tourniquets (where the tissues were in direct contact with the procaine solution)., the extremity beyond the distal tourniquet also became anesthetic after a delay of several minutes because the nerve trunks were blocked by the procaine to which they were exposed in the inter-tourniquet zone. Hence he referred to direct anesthesia between the two tourniquets and indirect anesthesia in the extremity. Bier realized that surgery could be performed in the extremity under this indirect anesthesia but he was more interested in the prime purpose of his block which was to provide anesthesia for surgery on the elbow and knee joints (**Holmes C,1989).**

Technique of the block
Preblockade requirements

1- Appropriate selection of the patient.
2- Minimum monitoring: ECG–blood pressure–pulse oximetry.
3- Venipuncture in contralateral arm with hydration plan for premedication and necessary adjuvant drugs.
4- Checking of the double hemostatic tourniquet:
   A- padded enough
   B- connections without leakages
   C- perfect functioning
5- Emergency drugs available.
6- Dorsal decubitus position with both upper extremities free.
7- The patient should be comfortable in the operating table.(**Henderson et al., 1997)**

Premeditation

- Patient's sedation and cooperation are fundamental.
- The use of 0.1 mg/kg of diazepam with the purpose of increasing the threshold in the face of possible convulsions is advisable. However, 0.05

mg/kg of midazolam can also be used since this is an ambulatory surgery procedure.

- The use of 0.2 mg/kg of metoclorpramide, 2 mg/kg of ranitidine is administered for prevention of vomiting
- The use of 0.5 ug/kg to 1ug/kg fentanil is used for analgesia and sedation.
- 5 mL of subcutaneous infiltration of local anesthetic for blockade of the intercostobrachial nerve is done. .(**Henderson et al., 1997)**

Tourniquet placement

The selection of tourniquets is closely related to the diameter and length of the arm. They must be 40% bigger than the diameter of the arm and from 5 cm to 6 cm wide each. The narrower the tourniquet, the smaller the surface to press on the underlying tissues. When this happens, there is great discomfort and intolerance to the tourniquet.

In the market, there are numerous models of pneumatic tourniquets, such as simple, double, or of a single piece but with two inflatable bands. The electronic apparatuses with permanent evaluation of insufflating pressure and alarms are highly safe and reliable. If electronic apparatuses are not available, tourniquets with aneroid clocks can be used.

It is fundamental to be sure about their correct functioning. It is advisable not to clamp them to be able to constantly measure the pressure and tightness of the system.

To be safe and effective enough, this technique always requires either two tourniquets or a double one. (**Holmes,1996)**

The skin should be protected with soft bandages which, in turn, will be used for better adaptation of the tourniquets to the arm.

Insufflation pressure of pneumatic tourniquets is debatable. Some works advocate a standard figure of 100 mm Hg above systolic pressure. It has been proved that 50 mm Hg is enough in pediatric patients. Generally, we suggest 250 mm Hg for the upper extremity, 300 mm Hg for the lower extremity and 230 mm Hg in pediatrics. Tourniquets should be placed next to the axilla (**Holmes,1996)**

Figure (1): Tourniquets placed close to the axila. (Holmes,1996)

If there are two tourniquets, one must make sure that there is no space between them. Otherwise, in the change from one tourniquet to the other, there might be hematic leakage in the surgical field. One way to avoid this is insufflation of the second tourniquet 20 mm Hg to 25 mm Hg over the first one before release. Special care must be taken so as not to place the tourniquet on the articulation of the elbow, since due to vicinity of the nerves and bone, the nerves could be compressed and damaged. Insufflation time, from around 1.5 hours to 2 hours, is given by the time of ischemia and the possible damage it causes. The use of this technique is not recommended in patients whose arms are bigger than 35 cm in diameter. **(Holmes,1996)**

Insertion of the catheter

After asepsis of the area, a 20-gauge or 22-gauge disposable catheter is used for intravenous injection. The site should be the most distal possible from the tourniquet; however, it must not coincide with the area of incision. Proximity to the tourniquet can favor the anesthetic agent’s permeability toward circulation due to increase of pressure by the injected solution and volume of the venous system.

The use of large antecubital vessels would not make sense because of evolution of the blockade from distal to proximal and of small nervous endings to big trunks. We have used such vessels to carry out comparative clinical studies. We noted that the surgical time of onset is delayed with the pinprick method, which gives no advantage and favors appearance of adverse effects (passage of the anesthetic to bloodstream and congestive field for the surgeon). The choice of a distal vein increases correctness of the procedure from 4.1% to 22.7%, compared with the selection of an antecubital vein.(**Laura et al., 2006)**

The catheter must always be fixed before release of the stainless steel needle. Either an extension can be attached or the syringes directly adapted. For continuous blockade, the intravenous cannula should remain properly fixed. All these procedures must be performed under strict asepsis .

Figure (**2): ** Insertion of the catheter
(most distal from the tourniquet) **(Laura et al., 2006)**

Exsanguination

It is advisable to lift the extremity to 90° during 2 or 3 minutes and then proceed to exsanguinate from distal to proximal with the bandage of Esmarch. If, due to the own effect of the pathology, the passage of the bandage of Esmarch was impossible, the exsanguinations can only be made either with the arm or leg elevated or with a smooth passage of the bandage over the aching area. Then, exsanguination must be done with energy. Bad exsanguination can cause partial failure of the technique

Figure **(3):** Lift the extremity to 90° for 2 or 3 minutes
(Laura et al., 2006)

After that, the proximal tourniquet (the one closer to the patient's head) is inflated first. Then the bandage is withdrawn, which exposes the exsanguinated extremity ready to be blocked. .(**Laura et al., 2006)**

Figure (**4): **Esmarch bandage in position
(Laura et al., 2006)

Injection of the anesthetic solution

Once verified insufflation stability of the first proximal tourniquet, the chosen anesthetic solution is injected in volumes ranging from 40 mL to 50 mL for the upper extremity and from 60 mL to 80 mL for the lower extremity. Infiltration must always be done with the arm in horizontal position and at a speed of 3 mL/seconds if the point is distal and of 2 mL/seconds if it is close to the tourniquet. The injection speed must not be less than 90 seconds and at 0.5 mL/seconds to assure limitation of the pressure generated by the injection

Figure (**5**)**:** Local anesthesia injection
(Laura et al., 2006)

Venous pressure during injection depends on the volume of the anesthetic, the injection speed and the bypass between superficial and deep venous systems. .(**Laura et al., 2006)**

Local anesthetic

The ideal anesthetic agent is the one that allows use of large volumes at low concentrations without undesirable adverse effects. Besides, it must have a quick onset and few homodynamic effects after tourniquet release.

There is no “ideal” drug. Therefore, we will provide a possible list of very good options **(Chan et al., 1999)**