Regional and Local Anesthesia of the Wrist and Hand Aided by a Forearm Sterile Elastic Exsanguination Tourniquet - A Review

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Abstract

Hand and wrist procedures range in various lengths of time and are performed under bleeding-free conditions achieved by some sort of exsanguination and tourniquet. The purpose of this paper is to describe regional and local anesthesia options facilitated by the use of forearm tourniquet, in particular the forearm sterile elastic exsanguination tourniquet (FA-SET). The paper will focus on two main strategies: (i) Local incision site infiltration while the FA-SET is tolerated by the patient without or with additional topical anesthesia at the site of the tourniquet; and (ii) Intravenous regional anesthesia (IVRA – Bier Block) performed with the FA-SET in place. The conclusion from our experience is that the use of the FA-SET for IVRA is superior and safer over the traditional methods.
Introduction

Hand and wrist surgical procedures range from very short, such as carpal tunnel release (CTR), to medium (e.g. distal radius internal fixation), to long (e.g. multiple digital joint replacements). These procedures do have in common the need for effective anesthesia and in the majority of cases are performed under bleeding-free conditions achieved by some sort of exsanguination and tourniquet. The purpose of this paper is to describe regional and local anesthesia options facilitated by the use of the forearm tourniquet, in particular the forearm sterile elastic exsanguination tourniquet (FA-SET).

Our focus is on two main strategies: (i) Local incision site infiltration while the FA-SET is tolerated by the patient without or with additional topical anesthesia at the site of the tourniquet; and (ii) Intravenous regional anesthesia (IVRA – Bier Block) performed with the FA-SET in place. We hereby describe our experience with the FA-SET in both categories.

The Forearm Sterile Elastic Exsanguination Tourniquet

The FA-SET (HemaClear®, OHK Medical Devices Ltd. Haifa Israel) consists of an elastic silicone ring, wrapped around a tubular stockinet and four straps terminated by two handles (App. Figure 1a). The FA-SET is placed on a conical application cup that helps in its placement on the fingers and the initiation of its rolling up the hand. The FA-SET is sterile (Ethylene Oxide treatment) and comes double wrapped in individual packs. When the straps are pulled proximally along the axis of the arm, the ring rolls over the hand, wrist and forearm and the stockinet is released to cover the skin (App. Figure 1b). The final position of the FA-SET is 10-12 cm above the root of the palm. The rolling applies uniform circumferential force on the tissues, translated into radial pressure that effectively squeezes the blood out (exsanguination) and blocks the arterial flow into the hand. The application of the FA-SET is quick and smooth, taking 3-5 seconds.

Short procedures

Hand procedures that take no more than 15 minutes (e.g. Carpal Tunnel Release) may be performed with the FA-SET and local infiltration without any additional sedation or anesthesia. The patient should be alerted in advance about the discomfort associated with the compression of the FA-SET and should be verbally coached during the short duration of discomfort. For patients who are not in complete control of their faculties (i.e. cognitive dysfunction) or patients who seem very apprehensive, an alternative should be offered (see below). Studies conducted with both pneumatic tourniquets and with the SET show significantly better tolerance of a tourniquet on the forearm as compared to the upper arm (1).

When the patient, the surgeon, or the anesthesiologist determine that supplemental analgesia is needed to obviate tourniquet discomfort and pain, there are two techniques that are readily available:
1. Ring anesthesia – infiltration of the subcutaneous tissue in the area where the FA-SET will be placed with a local anesthetic (e.g. 50% diluted Citanest solution using 22 G × 3 1/2" size spinal needle (Sujia®)); or
2. Circumferential spreading of a cream composed of 5% lidocaine and 5% prilocaine (Emla® Astra) on the skin over the area where the FA-SET will be placed.

In a prospective randomized study using a forearm pneumatic tourniquet, Inal, et al.(2009) found that anesthesia using Emla cream is equally effective and less disturbing than using the injection technique (subcutaneous ring anesthesia). They also commented that a tourniquet placed at the distal forearm is effective, safe, and a useful technique for hand surgery.

**Longer procedures**

Intravenous regional anesthesia (IVRA) or Bier Block becomes safer and more efficient when the FA-SET is used. This is primarily due to the smaller dose of lidocaine needed to effect surgical anesthesia of the hand. The following is a step-by-step annotated description of FA-SET – assisted IVRA:

1. An IV cannula is inserted and secured (App. Figure 1a). It is preferred to use a cannula with no side port (not as shown) which is flatter, but not a “butterfly”. The hand and forearm are disinfected. Securing the catheter in place can be done with a sterile bandage to prevent dislodgement when the FA-SET is applied.

2. The FA-SET is applied as usual (see description above) using the sterile technique. The optimal position is about 10-13 cm (4-5") proximal to the root of the palm (App. Figure 1b).

3. The IV cannula is exposed (App. Figure 1c) and lidocaine 0.5% or another local anesthetic commonly used for IVRA is injected into the cannula (Figure 1d). We use 20 ml of the solution (100-125 mg). Given the fact that the veins are emptied, the intra-vascular pressure associated with the injection of such small volume is low, certainly under arterial pressure, thereby avoiding leakage of anesthetics into the central circulation.

4. In our experience, the hand is fully under surgical anesthesia in 5-7 minutes, verified by pricking the skin with a sterile needle. The level of exsanguination is very good as seen by the minimal stain on the pad and the surgeon’s gloves (App. Figure 1e). In case the patient complains about tourniquet discomfort and pain, the FA-SET is simply moved distally by manually rolling it in the distal direction to a position that has already been anesthetized.

5. Suturing (App. Figure 1f) and compression dressing (App. Figure 1g) can be done before or after release of the FA-SET. Note that in view of the fact that the overall dose is kept low (e.g. 1.5 mg/kg) and within the therapeutic dose typically used for multiple PVCs, there is no risk associated with early release of the occlusion.
6. The removal of the FA-SET is done by cutting the ring with a scalpel (App. Figure 1h) and the fabric with scissors. App. Figure 1i shows the compression marks on the skin after the removal of the FA-SET ring.

7. The “dissected” FA-SET is shown in App. Figure 1j. The blue silicone ring is the elastic mechanism which applies calibrated pressure on the forearm.

It should be noted that performing IVRA with the FA-SET is tolerated well by the patients. It saves a few minutes of tourniquet time as the FA-SET can be removed as soon as the surgical procedure is completed, and it increases significantly the overall OR throughput. The fact that the FA-SET is sterile, as compared with the non-sterile and often dirty (App. Figure 2) pneumatic cuff, enhances this margin of safety.

The main differences from the traditional IVRA are the forearm placement of the FA-SET, its sterility, and the elimination of the pneumatic system from the process, notwithstanding the concern about sudden pressure loss or confusion between distal vs. proximal cuff inflation. In addition, while the IV cannula can be placed by the anesthesiologist or anesthesia nurse, the injection of the anesthetics is typically done by the surgeon, necessitating the drawing of the liquid into a sterile syringe.

Summary and conclusions

- The FA-SET is sterile and tolerated well by the patient. The forearm placement limits the volume of ischemic tissue to the minimum.

- Using the FA-SET for small hand/fingers procedures is logistically straight forward. It does not require capital equipment and calibration and the preparations for the case are simple (single item). As such, these cases can be performed in a procedure room with minimal support personnel, freeing the anesthesiologist for more complex cases.

- Subcutaneous infiltration of local anesthetics combined with the FA-SET is a safe, efficient and cost-effective way of optimizing the surgical field for short hand/fingers procedures. The addition of topical Emla® type cream can be applied in those patients where discomfort tolerance is low or unpredictable.

- Intravenous Regional Anesthesia with the FA-SET is safer than the traditional upper arm double cuff pneumatic tourniquet due to the fact that a much lower dose of local anesthetics is required in order to obtain surgical anesthesia. It is also safer because there is no risk of sudden loss of tourniquet pressure.

The use of the FA-SET for IVRA is also logistically superior over the traditional methods. The elimination of the pneumatic system with only a single item needed for the blocking of blood flow
into the hand and seepage of anesthetics into central circulation. The early release of the tourniquet allows for a more efficient use of OR facility and personnel. The FA-SET presents a useful option for effecting wrist, hand and finger surgical anesthesia. In our experience, the safety margin is better than the traditional use of upper-arm pneumatic tourniquet and should be considered as first choice in most hand cases.

Bibliography

Appendix – Figures

Figure 1a

Figure 1b

Figure 1c

Figure 1d

Figure 1e

Figure 1f