

Intravenous Regional Anesthesia: The Old and Recent Techniques? Review Article

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ABSTRACT

Background: A straightforward and efficient anesthetic approach for hand and forearm surgery is intravenous regional anesthesia (IVRA), often known as the Bier Block. Dr. August Bier developed this method in 1908, and it offers total anesthesia as well as a bloodless operating room. Historically, the local anesthetic has been contained and a bloodless surgical field has been created by using an upper arm tourniquet. Major issues following IVRA with an upper arm tourniquet are uncommon, although they typically arise from systemic toxicity of local anesthetics upon tourniquet relaxation. Convulsions, coma, respiratory depression and arrest, and cardiovascular depression are signs of significant systemic local anesthetic responses, which might be lethal. Because of this, some medical professionals favor general anesthesia or other loco-regional procedures for hand and forearm surgery.

Objective: The aim of this review was to compare the effects of early vs late distal tourniquet deflation during hand and forearm surgery under intravenous regional anesthetic with or without ketorolac.

Methods: A comprehensive search was conducted in PubMed, Google Scholar, and Science Direct, from August 2000 to July 2021, using the keywords “Deflation, Distal tourniquet, Intravenous Regional Anesthesia, Ketorolac, Hand and Forearm Surgery”. The reviewers evaluated relevant literature references as well. Only the most recent or complete study was taken into account. Examples of articles that weren't regarded as significant scientific research include unpublished manuscripts, oral presentations, conference abstracts, and dissertations. The lack of resources for translation has led to the ignoring of documents written in languages other than English.

Results: The reviewed literature showed that alternative adjustments in extremities surgery can improve IVRA. In short-term hand procedures, the forearm tourniquet may be chosen since it is simple to administer, has a minimal risk of toxicity, and offers an early block to healing. **Conclusion:** Depending on the patient's preferences, a Bier block with a forearm tourniquet can be utilized with or without further sedation or analgesics.

Keywords: Deflation, Distal tourniquet, Intravenous Regional Anesthesia, Ketorolac, Hand Surgery, Forearm Surgery.

INTRODUCTION

For limb procedures, IVRA is a tourniquet-related substitute for general anesthesia. With frequency varied depending on the type of operation and practice patterns, it is affordable and often utilized for both adult and pediatric patients ⁽¹⁾.

In IVRA, two single-bladed or two dual bladder cuffs are put close to the surgical site. After that, blood is exsanguinated from the limb by elevating it or by tying an elastic bandage over it, starting distally and working your way toward the heart. The elastic bandage is then taken off when the cuff is compressed ⁽²⁾.

Through an intravenous catheter, a local anesthetic drug is delivered into the affected limb. As long as the tourniquet is inflated, the local anesthetic is still in the affected limb. Most of the anesthetic agent has been absorbed into the tissues of the limbs around 20 minutes after infusion, therefore deflating the tourniquet cuff won't cause a large concentration of the substance to be released into the bloodstream ⁽³⁾.

The anesthesia practitioner may manage the inflation and deflation of each bladder individually using dual bladder cuffs and two single bladder cuffs, which increases patient safety and comfort during surgery ⁽⁴⁾.

When carried out correctly in accordance with established protocols and using instruments and cuffs for tourniquets that are accurate, dependable, and safe that have undergone extensive testing prior to use, IVRA has been successfully used on a large number of patients for a long time and has shown to be reasonably simple, safe, and helpful ⁽⁵⁾.

However, there are risks associated with IVRA. These dangers might be brought about by the inherent safety restrictions of tourniquet devices and cuffs not made particularly for IVRA, by tourniquet device and cuff failures while in use, and by inadequate testing of devices and cuffs before use. These dangers rise when using unconventional procedures and when using personnel with insufficient IVRA expertise ⁽⁶⁾.

The aim of this review was to compare the effects of early vs late distal tourniquet deflation during hand and forearm surgery under intravenous regional anesthetic with or without ketorolac.

METHODS

A comprehensive search was conducted in PubMed, Google Scholar, and Science Direct, from August 2000 to July 2021, using the keywords “Deflation, Distal tourniquet, Intravenous Regional Anesthesia, Ketorolac, Hand and Forearm Surgery”.

The reviewers evaluated relevant literature references as well. Only the most recent or complete study was taken into account. Examples of articles that weren't regarded as significant scientific research include unpublished manuscripts, oral presentations, conference abstracts, and dissertations. The lack of resources for translation has led to the ignoring of documents written in languages other than English.

The following considerations should be made when carrying out an IVRA process:

When utilizing a dual-blade cuff or two single-blade cuffs coupled for IVRA, tourniquet users must be experienced with a secure inflation-deflation procedure. There might be a serious risk to the patient if the incorrect bladder or cuff is unintentionally released as a consequence of operator mistake ⁽⁷⁾.

The tourniquet device and any auxiliary pneumatic valves attached to the cuffs must both be understood by the operator. The best tourniquet systems contain safety measures like IVRA interlocks to prevent accidental deflation during an IVRA process. Users must continuously be aware of which bladder or cuff is proximal, which bladder or cuff is distal, and how much each bladder or cuff is inflated or deflated in order to limit dangers ⁽⁸⁾.

The IVRA tourniquet technique is similar to other tourniquet techniques, with the following significant variations ⁽⁹⁾:

- It is crucial to record any allergies to local anesthetics while doing a preoperative examination before to IVRA.
- It is necessary to utilize a dual-bladed tourniquet cuff, which requires a larger placement site and a greater pressure because one bladder is thinner than the other. The ideal pressure should be determined using the Limb Occlusion Pressure (LOP) measurement.

Rouso *et al.* introduced the use of a forearm tourniquet in 1978, and it has the significant benefit of requiring less local anesthetic (non-toxic) dose to create an analgesic of high grade ⁽¹⁰⁾.

There is hence no required minimum time for tourniquet inflation following forearm IVRA. Additionally, it has been suggested that the sensory onset time following forearm IVRA may be quicker than that following upper arm IVRA ⁽¹¹⁾. Forearm IVRA may be the best anesthetic approach for quick ambulatory surgery of the hand and wrist because to these two characteristics. Last but not least, it has also been proposed that a forearm tourniquet causes less ischemia discomfort and may thus be sustained for a longer period of time with less need for extra analgesics or sedation and less likelihood that general anesthesia would be required.

Despite these benefits, forearm IVRA is still not often used since it was once believed that the interosseous arteries in the forearm would not be

completely sealed off during the treatment, raising the possibility of insufficient hemostasis and local anesthetic leakage into the bloodstream. However, several researches have disproved that notion and shown that forearm IVRA is safe and efficient ⁽¹²⁾.

The best anesthetic method for distal extremities surgery is still up for debate in clinical practice. Studies conducted recently on patients following distal extremity surgery compared the analgesic effectiveness and negative effects of IVRA with a forearm tourniquet to the traditional upper arm tourniquet ⁽¹³⁾.

Tourniquet application for IVRA ⁽¹⁴⁾:

- The operation was performed with the patient awake. Explain any unfamiliar equipment, alarms, or other elements of the process to allay any worries that the patient may have.
- Cannulating a vein in the limb's distal end. (Angiocaths are recommended over butterfly needles because they are less prone to slide out of place when the elastic bandage is being applied).
- Cover the limb with limb protection (if applicable). Choose a limb protection sleeve that matches the tourniquet cuff, if one is available.
- Smoothly and firmly apply the dual-blade tourniquet, adjusting each bladder to the patient's limb's form and size.
- Attach a tourniquet device to each bladder of the dual-bladder cuff. (For further details on this connection, consult the tourniquet instrument instruction manual. Make sure you know how to connect and utilize a dual-cuff control valve if one is used between the bandage tool and the cuff.
- Refold the distal end of the limb protection sleeve over the distal edge of the cuff. Wrap the protective plastic drape around the tourniquet and the affected limb.
- To exsanguinate the limb, elevate it and wrap it in an elastic bandage.
- Increase the proximal bladder's pressure to the appropriate level. (Normally, the distal bladder is inflated first to complete exsanguination, but this has happened on occasion as well.) Due to the significance of upholding occlusion and the typically higher pressures necessary as a result of the limited width of each bladder, Limb Occlusion Pressure (LOP) is particularly helpful in establishing the cuff pressure in IVRA operations.
- Take off the bandage's elastic.
- Use auscultation and/or palpation to confirm complete occlusion.

Induction of anesthesia

To induce IVRA, use the following procedures after applying a tourniquet. This process is offered as a general recommendation and may vary in your academy ⁽¹⁵⁾:

- Using a syringe or drip technique, a preset quantity of local anesthetic is gradually administered into the cannulated vein (usually the responsibility of the anesthesia professional). Be careful not to overextend the vein with a quick infusion.
- Start monitoring the patient's physiological condition right away for any indication that the local anesthetic is having a harmful effect. (In this case, the presence of an anesthesia specialist does not absolve the nurse from any negative or hazardous effects of the anesthetic medication.)
- The anesthetic medicine perfuses the sensory and motor nerve trunks and endings as it passes through the veins and venules distal to the tourniquet.
- The limb ought to be put to sleep in around three minutes. The limb could be prepared and dressed for surgery during this period.
- If the patient has cuff discomfort 20 to 30 minutes after the start of anesthetic, with a tourniquet that is inflated distally and deflated proximally, cross the damaged limb. Since the tissue under the distal bladder has been anaesthetized, the patient should feel more at ease. NOTE: When utilizing a dual-bladder cuff, users of tourniquets need to know the following secure inflation-deflation process.

Deflating the tourniquet

Tourniquet users must be aware of the proper inflation-deflation procedure whether using a dual-bladder cuff or two single-bladder cuffs together. Forcibly releasing the incorrect bladder or cuff might be dangerous for the patient. Whenever there is intermittent deflation, never leave the patient alone ⁽¹⁶⁾.

- It has been recommended in the published literature that, when IVRA is utilized, the tourniquet be left inflated for at least 20 minutes after the injection to guarantee that the majority of the anesthetic agent has been absorbed into the limb tissue. Too fast a release of anesthetic agent can be avoided for a brief operation by immediately deflating and re-inflating the cuff numerous times, or by gradually lowering the cuff pressure.
 - After the surgery is complete, completely deflate the tourniquet bladder while the doctor raises the limb to improve venous return and applies pressure to the wound to stop bleeding and the formation of hematomas. It's crucial to always deflate to zero pressure to avoid venous distention, which can cause bleeding and hematoma development. Anaerobic waste and local anesthetic can be flushed back into circulation during a quick (15-second) deflation phase, minimizing side effects.
 - Pay close attention to the patient's mental state and the heart monitor at this time since issues are most likely to arise.
 - Re-inflate for 30 to 45 seconds to allow oxygenated blood to feed the tissue and for the anesthetic agent and waste materials to diffuse back into the venous circulation.
- Dress the patient and transfer them to the recovery area.
 - Compared to other anesthetic procedures, the anesthetic effect subsides within 15–20 minutes, allowing patients to safely leave the post-anesthesia care unit sooner ⁽⁶⁾.

Modern tourniquet tools and cuffs for IVRA have undergone certain noteworthy and distinctive changes that have significantly increased their usefulness and safety, such as ⁽¹⁷⁾:

- Tourniquet devices with two wholly separate channels: A tourniquet cuff used for IVRA has two channels that allow independent, precise, and dependable regulation of the tourniquet pressure in each bladder. This is crucial when certain bladders are being inflated, depressurized, and controlled during IVRA.
- Variable-contour dual-bladder tourniquet cuffs: These cuffs adjust to patient-specific limb shapes beneath each of the dual bladders from the proximal edge to the distal edge, improving the reliable and constant distribution of tourniquet pressure from each bladder to the underlying limb. Additionally, these cuffs include enhanced gas passages within the cuffs and twin independent fasteners to assist avoid unexpected cuff detachment and release. These characteristics serve to increase safety in IVRA.
- IVRA safety lockout: Some contemporary tourniquets systems can assist reduce the likelihood of an abrupt and unexpected loss of IVRA by preventing the surgical team from accidentally or unintentionally inflating both bladders of a dual-bladder cuff during an operation ⁽⁸⁾.
- Automatic cuff testing capability: Some contemporary tourniquet devices come equipped with this feature, which enables the perioperative nurse to quickly, automatically, and thoroughly test tourniquet cuffs in accordance with advised procedures before, and especially after, cleaning and reprocessing.
- Automatic cuff leak detection: This feature is included into some tourniquet instruments and allows for the identification of leaking cuffs, connections, and tubing while in use. After each operation, the staff is notified, which helps to avoid their risky usage in subsequent IVRA procedures ⁽¹⁸⁾.
- Automatic LOP measurement: Some tourniquet devices have this feature, which enables precise calculation of tourniquet pressures for each bladder of a dual-bladder cuff for each therapy, limb location, limb form, and application technique that are patient-specific.

Evaluation of LOP for each patient is crucial before deciding on the tourniquet inflation pressure since limb obstruction pressure has been suggested as the best way for establishing the ideal tourniquet pressure⁽¹⁹⁾.

CONCLUSION

Alternative adjustments in extremities surgery can improve IVRA. In short-term hand procedures, the forearm tourniquet may be chosen since it is simple to administer, has a minimal risk of toxicity, and offers an early block to healing. Depending on the patient's preferences, a Bier block with a forearm tourniquet can be utilized with or without further sedation or analgesics. The preservation of local anatomy enhances patient safety and aids the surgeon in identifying abnormal structures.

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