Surgical Technique

Surgical technique: placement of a totally implantable venous access port (TIVAP) through a cephalic vein cutdown in pediatric patients

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Abstract: The placement of totally implantable venous access ports (TIVAPs) is a critical step in the overall care of pediatric oncohematologic patients. These devices constitute a significant technical challenge and are not free of complications during their placement and use. There is extensive literature concerning placement techniques, including venous cut-down (mainly from the external jugular vein) and venous access through ultrasound-guided puncture (Seldinger technique), usually performed in jugular or subclavian veins. Considering that in chronic patients, especially oncology patients, the preservation of quality central venous accesses is essential, alternatives for peripherally inserted central venous catheters have been proposed. The cephalic vein is a peripheral accessory vein located at the deltopectoral groove and characterized by well-defined surgical landmarks. Although scarce and focused on adult populations, the preceding literature concerning using the cephalic vein for TIVAP placement shows promising results. In this manuscript, I present my experience using this technique in pediatric populations, detailing the necessary preoperative preparation to perform the procedure safely, the technical aspects of its implantation, and the most relevant postoperative considerations. Critical knowledge gaps concerning this technique that warrant further study, such as the role of ultrasound as a predictor of success for cephalic vein cut-down TIVAP placement in pediatric populations, are also discussed.

Keywords: Totally implantable venous access port (TIVAP); cephalic vein; venous cutdown; pediatric; peripherally inserted central catheter

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Introduction

Background

The placement of totally implantable venous access ports (TIVAPs) is a critical step in the overall care of pediatric oncohematologic patients. These devices constitute a significant technical challenge and are not free of complications during their placement and use. There is extensive literature concerning placement techniques, including venous cut-down (mainly from the external jugular vein) and venous access through ultrasound-guided puncture (Seldinger technique), usually performed in jugular or subclavian veins. Considering that in chronic patients, especially oncology patients, the preservation of

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quality central venous access is essential, alternatives for peripherally inserted central venous catheters have been proposed. The cephalic vein is located in the deltopectoral confluent. It is a superficial vein with direct drainage to the axillary vein, emptying into the right atrium through the subclavian vein. It is a secondary and accessory vein that can be ligated when necessary and is characterized by well-defined surgical landmarks (*Figure 1*).

Rationale

The current techniques (both venipuncture by Seldinger technique of the jugular or subclavian veins and jugular venotomy) are well-established and safe in clinical practice. However, they have disadvantages: (I) they involve obtaining central venous access with subsequent risk of bleeding, thrombosis, and infection; (II) they involve, in most technical variants, at least two skin incisions. The literature regarding using the cephalic vein for TIVAP implantation is minimal but growing (1-3). In some specific contexts, it has shown better results than other central venous accesses in the long term (4). In children, the literature concerning this technique is exceptional (5).

Highlight box

Surgical highlights
- Placing a totally implantable venous access port (TIVAP) through a cephalic vein cutdown in pediatric patients is a safe and effective alternative to classical techniques.

What is conventional, and what is novel/modified?
- Pediatric TIVAP placement is performed by ultrasound-guided subclavian/jugular puncture or jugular venous cut-down.
- This manuscript presents a scarcely described approach in the pediatric population through a cephalic vein cut-down.

What is the implication, and what should change now?
- Its main advantages are the preservation of central venous access, the use of a single incision, and the possibility of avoiding the cervical region in patients where this area is compromised (e.g., by lymphoproliferative processes).
- There are critical knowledge gaps concerning this technique that warrant further study, such as the role of ultrasound as a predictor of success for cephalic vein cut-down TIVAP placement in pediatric populations.
- The report of prospective multicentric pediatric series will contribute to a better understanding of the differential characteristics of this population about this technique and will help to understand areas of improvement on which to work.

Objective

Describe the preoperative, surgical, and postoperative aspects of TIVAP implantation through a cephalic venous cut-down. I present this article in accordance with the SUPER reporting checklist (6) (available at https://tp.amegroups.com/article/view/10.21037/tp-24-305/rc).

Preoperative preparations and requirements

This technique should be framed in the open surgery techniques, and it can be both curative and palliative. Pre-surgical preparation standards for TIVAP placement include ensuring hemodynamic stability and adequate hemoglobin, platelet count, and coagulation function. Pre-surgical blood cross-matching and antibiotic prophylaxis are recommended. The cephalic vein shows significant anatomical variability between individuals. Given that it is a vein of moderate caliber, this procedure is more feasible as the patient ages, with a reasonable lower limit of 1 year of age. Performing the technique in infants is not recommended due to the limited possibilities of success in catheterization. Likewise, cephalic vein development is usually more significant in the dominant arm, and given that the placement of the TIVAP does not condition any functional limitation, I recommend its placement in that arm. Recent studies show a preference for the right cephalic vein (7), which may be related to this concept. If the patients are right-handed (as is the majority of the general population), they will use the right arm more. They, therefore, will have more significant development in this vein. Lastly, concerning the preoperative use of ultrasound to assess the cephalic vein, Staszewicz *et al.* reported ultrasound predictive factors for successful catheterization (8). The main factor identified as a predictor of successful TIVAP placement by cephalic-vein cutdown was the visualization of the vein ultrasonographically. Vein depth was also shown to be a significant predictor of successful placement. Other factors, such as vein length, did not show statistical significance, although vein tortuosity reached marginal significance. If the center has experienced radiologists, the anatomy and caliber of the vein can be assessed to decide whether the approach is feasible.

This procedure can be performed in any hospital with a fully equipped operating theatre. Commercial TIVAPs suitable for the patient's size and weight are required. Generally, having at least two units is recommended in case of a manufacturing defect or accidental contamination. A

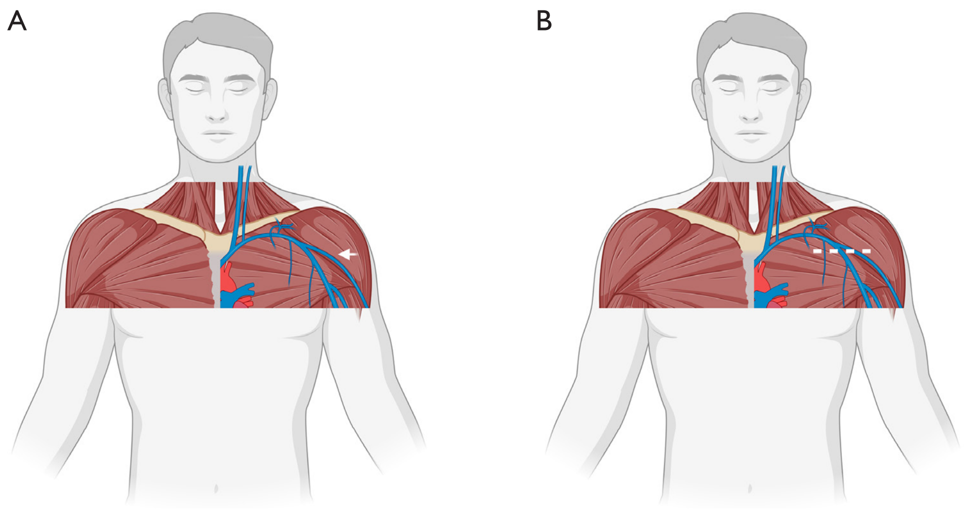

Figure 1 Schematic representation of the anatomy of the cephalic vein and its surgical approach. (A) The cephalic vein (white arrow) lies within the deltopectoral groove. (B) Proposed surgical incision (dashed white line). Created in BioRender. Arredondo Montero J [2024]; BioRender.com/p06l893.

commercial 5% heparin sodium solution for injection is needed to flush the catheter and reservoir during placement. It is recommended that two experienced pediatric surgeons perform this procedure.

This study was conducted in accordance with the Declaration of Helsinki (as revised in 2013) and was approved by the institutional review board of Complejo Asistencial Universitario de León under code 24129. Verbal and written informed consent was obtained from the patient's legal guardians, whose clinical photographs are included in this study.

Step-by-step description

Figure 2A-2F shows intraoperative images of the most relevant steps of the technique. *Figure 3* illustrates how the cephalic vein cutdown is performed.

The patient is placed in supine decubitus, with cephalic hyperextension, and with the arm to be operated on slightly abducted. A preoperative marking of the most relevant landmarks for the intervention (sternal notch, clavicle and deltopectoral groove) is performed (*Figure 2A*). It is recommended to reference an alternative vein in case the cephalic vein cannot be catheterized (e.g., the external jugular vein, in *Figure 2*). A transverse incision is made, spanning from the beginning of the deltopectoral groove to the infraclavicular region. This allows to use this single incision for both venous catheterization and subcutaneous placement of the TIVAP. The subcutaneous plane is bluntly dissected until the pectoralis major fascia is reached. The deltopectoral groove is explored until the cephalic vein is identified (*Figure 2B*). The vein presents significant variations concerning its depth within the deltopectoral groove: sometimes, it is relatively superficial, while in other cases, a deep dissection of the deltopectoral groove is required to identify it. The vein is carefully dissected with vascular instruments and gently tractioned with ligatures proximally and distally (*Figure 3*). I use 3/0 or 4/0 braided absorbable ligatures (polyglactin 910 with triclosan). It is essential to ensure adequate venous length exposure to be able to act in the event of a rupture and retraction of the vein ends. It must also be considered that sometimes, this vein presents anatomical variations (*Figure 2B*). Concerning these variations, the cephalic venous trunk with the most significant caliber should be identified for catheterization. Accessory branches can be preserved if they allow the procedure to be carried out correctly. If accessory branches make venotomy difficult or are at risk of bleeding during dissection, they can be ligated. Monopolar electrocautery should be avoided as diathermy transmission may damage the main vessel. In this regard, I recommend the use of bipolar electrocautery. If the vein becomes spasmolytic during dissection, the surgical site can be covered with lidocaine or papaverine to control this problem. At this point, the TIVAP is prepared and

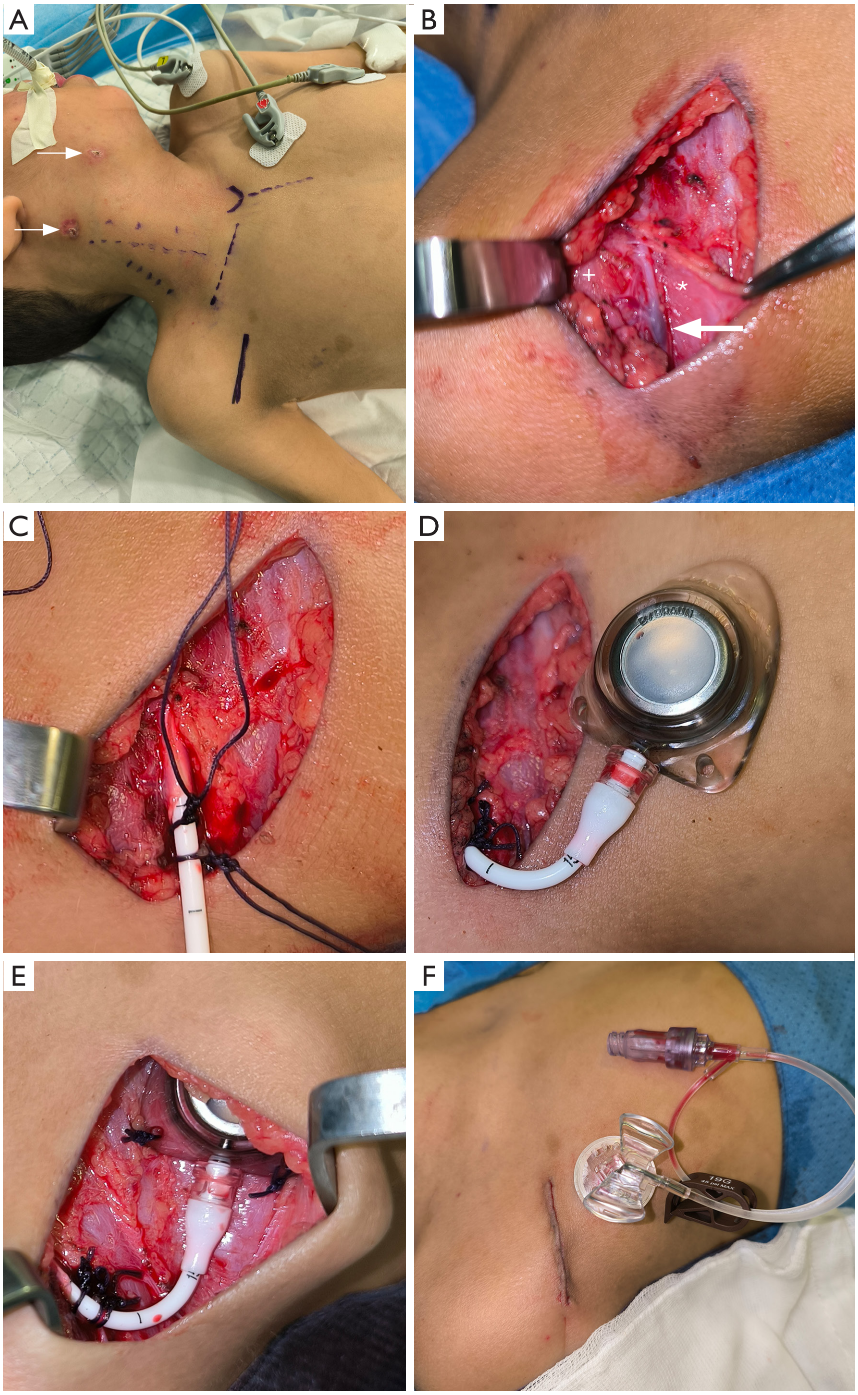

Figure 2 Surgical images of the procedure. (A) Surgical positioning of the patient and relevant landmarks. Note the presence of cervical lesions secondary to the underlying pathology (white arrows). (B) Surgical field. The cephalic vein (white arrow) which presents a small cranial branch (anatomical variation), lies in the deltopectoral groove. The pectoralis muscle fibers (asterisk) and deltoid muscle (plus symbol) are observed. (C) Cephalic vein catheterized and ligated. (D) TIVAP connected. (E) TIVAP implanted and fixed in the subcutaneous pocket above the pectoralis muscle fibers. (F) Final post-surgical image, with the incision closed and the TIVAP punctured. TIVAP, totally implantable venous access port.

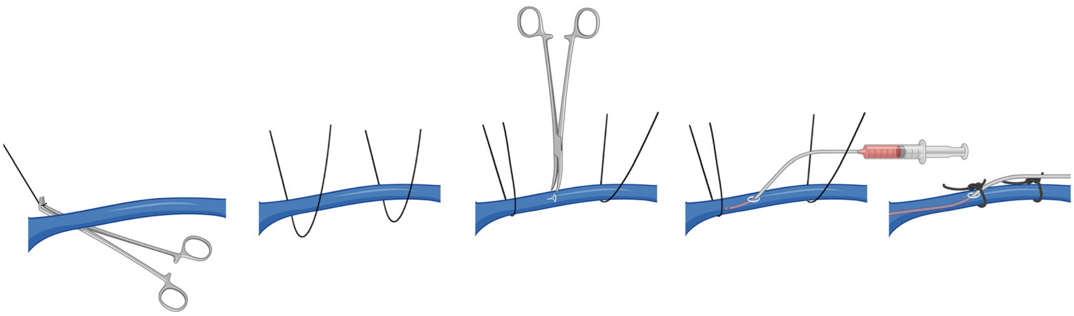

Figure 3 Schematic representation of the venous cut-down technique. Left, center left: dissection and reference of the venous structure with two ligatures. Center: venotomy. Central vertical cut and proximal longitudinal extension (spatulation). Center, right: catheter insertion. Right: knotting of the ligatures, with distal ligation of the vein and ligature securing the catheter. Created in BioRender. Arredondo Montero J [2024]; BioRender.com/g33w185.

flushed with a heparinized solution. A transverse central venotomy with Pott's scissors is performed. Then, the proximal segment of the vein is spatulated to allow for loose entry of the catheter; 4.5 Fr catheters can be used for small children and up to 6.5 Fr for larger children. To facilitate catheter insertion, the surgeon and assistant can grasp both edges of the venotomy with vascular clamps, momentarily increasing the caliber of the lumen. Proximal ligature can be gently tractioned to control bleeding if multiple catheterization attempts are required. After advancing the catheter and verifying its correct position ultrasonographically or fluoroscopically (and ensuring that it functions appropriately), the ligatures are knotted to fix the catheter and avoid accidental migration (*Figure 2C*). When deciding where to leave the catheter tip, the future growth of the patient should be considered. If the surgeon encounters difficulty in advancing the catheter, two technical resources can facilitate the process: (I) use a 0.035" angled hydrophilic guidewire and pass the catheter over this; (II) ask an assistant to mobilize the arm to rectify the anatomy of the cephalic vein and facilitate catheter entry. Subsequently, a subcutaneous pectoral pocket is made, and the TIVAP is connected (*Figure 2D*). It is important to ensure that the device has been properly purged before being implanted. Careful dissection of the subcutaneous pectoral pocket and careful hemostasis are mandatory as this is a prosthetic device, and post-surgical hematoma formation can lead to infection and loss of the TIVAP. It is recommended to perform this dissection with electrocautery, avoiding digital dissection. The subcutaneous pectoral pocket must be large enough for the TIVAP to fit loosely and not be under the skin incision (to reduce the risk of device extrusion). Still, it must not be excessive, as this increases the risk of seroma and migration/mobilization of the TIVAP. Likewise, if the subcutaneous pocket is excessive, there will be a longer catheter length at that level, with the subsequent risk of mechanical complications (rotation, kinking…). Progressive dissection with repeated checks of the pocket size with the TIVAP until it fits properly is recommended.

The TIVAP is introduced into the pocket and fixed with two or three 2/0 or 3/0 braided absorbable sutures (polyglactin 910 with triclosan) to the pectoralis major fascia (*Figure 2E*). It is essential to ensure fixation on at least two points to prevent accidental migration or rotation of the device after surgery. Finally, a conventional surgical closure is performed (*Figure 2F*). An advisable option is performing an intradermic suture using a 4/0 or 5/0 monofilament absorbable suture (such as poliglecaprone 25). The use of cutaneous cyanocrylates over the intradermic suture reduces the need for manipulation of the surgical wound. It is important to check during the procedure that the device infuses and refluxes, and a final radiological check is recommended after the completion of the procedure (*Figure 4*). Depending on whether TIVAP is needed to treat the patient immediately, a gripper can be left in place during surgery. It is essential to note the characteristics of the TIVAP in the patient's medical record and to provide parents with an implant document containing this information, as there is variability in technical parameters depending on the model and manufacturer (e.g., high flow *vs.* low flow). The duration of this procedure is highly variable and depends on multiple factors, such as the patient's vascular anatomy and the surgeon's experience.

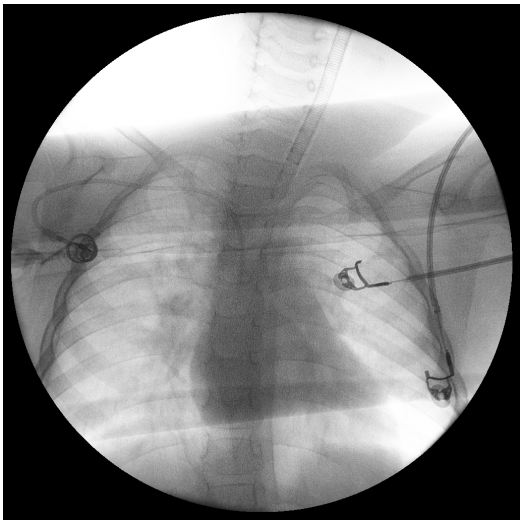

Figure 4 Radiological image of a TIVAP placed through a cephalic-vein cut-down technique. TIVAP, totally implantable venous access port.

Generally speaking, a time of between 1 and 3 hours should be considered.

Postoperative considerations and tasks

Post-surgical care and indications for a TIVAP placed in the cephalic vein using a cut-down technique do not differ from those placed using other techniques and routes. Depending on the center's and the patient's characteristics, this procedure can be performed on an outpatient or inpatient basis. It is recommended that the usual analgesics (acetaminophen, ibuprofen) be administered for the first 48 hours after the procedure. Patients usually report mild discomfort in the area and some sensation of pulling on the arm for the first few days. It is important to calm them about these sensations and encourage them to gently move their arm after surgery, given that sometimes they voluntarily limit the movement of the operated arm out of fear. It is essential to watch for bleeding or hematomas since, in many cases, patients who undergo this procedure have oncohaematological processes or active chronic diseases and may be prone to complications of this type. Likewise, and given that this is a prosthetic device, these complications can lead to the formation of an infectious biofilm that leads to the removal of the TIVAP.

Strenuous efforts must be avoided during the first two weeks after the surgery. TIVAPs implanted in the cephalic vein can be used as soon as patients leave the operating theatre.

Tips and pearls

- ❖ The needles required for puncturing a TIVAP have differential characteristics that prevent damage to the membrane despite continued use. These needles have a curved tip and are easily identifiable. It is essential not to puncture a TIVAP with an unsuitable needle.
- ❖ The discreetly lateral location of the TIVAPs implanted in the cephalic vein close to the axilla facilitates puncture in this area, which usually has less fatty tissue.
- ❖ Handling of a TIVAP by inexperienced personnel should be avoided.

Discussion

Surgical highlights

This paper presents a technical variant for the implantation of TIVAP using a peripheral venous cut-down. This variant safeguards central venous accesses and uses a single incision for implantation.

Strengths and limitations

The proposed approach presents multiple advantages: (I) using a single incision to perform the entire procedure; (II) reducing surgical manipulation of major central venous structures (jugular and subclavian); (III) although the preceding literature is limited, the cephalic vein cut-down technique has demonstrated similar or fewer catheter-related complications in adults compared to the Seldinger technique applied to subclavian or jugular venous access (9-11); (IV) in the presence of cervical pathology (as in the case of the patient from *Figure 1*), this approach constitutes a safe and effective alternative.

However, this approach has several limitations: (I) access to the cephalic vein is technically complex, requiring a deep anatomical knowledge of the deltopectoral region and a delicate surgical technique. This reaches its maximum expression in pediatric patients, where the vein often has limited development and is difficult to identify, dissect, and catheterize. (II) As mentioned, there is significant variability in the development of this vein among patients.

(III) Experience in pediatric populations, although positive, is so far limited. (IV) If a catheter-related thrombotic event occurs, other central veins (such as the jugular and subclavian veins) may also be affected, so although this technique minimizes surgical manipulation of these structures, it does not guarantee the preservation of these structures during the patient's clinical course. (V) This technique's surgical time is usually longer than for a Seldinger technique performed in skilled hands.

Implications and actions recommended

Placing a TIVAP through a cephalic vein cutdown in pediatric patients is a safe and effective alternative to classical techniques. Nevertheless, there are critical knowledge gaps concerning this technique that warrant further study, such as the role of ultrasound as a predictor of success for cephalic vein cut-down TIVAP placement in pediatric populations. The report of prospective pediatric multicentric series will contribute to a better understanding of the differential characteristics of this population regarding this technique. Also, it will help to identify areas for improvement.

Conclusions

Placing a TIVAP through a cephalic vein cutdown in pediatric patients is a safe and effective alternative to classical techniques.

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Footnote

Reporting Checklist: The author has completed the SUPER reporting checklist. Available at https://tp.amegroups.com/article/view/10.21037/tp-24-305/rc

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Conflicts of Interest: The author has completed the ICMJE uniform disclosure form (available at https://tp.amegroups.com/article/view/10.21037/tp-24-305/coif). The author has no conflicts of interest to declare.

Ethical Statement: The author is accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. This study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the institutional review board of Complejo Asistencial Universitario de León under code 24129. Verbal and written informed consent was obtained from the patient's legal guardians, whose clinical photographs are included in this study.

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