Innovative Percutaneous 3-Stitch Suture Technique for Site Closure in Venoarterial Extracorporeal Membrane Oxygenation Decannulation Without Direct Artery Repair: A Case Series

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No previous studies have reported the use of a percutaneous suture technique performed by bedside intensivists for site closure during decannulation without direct artery repair in venoarterial extracorporeal membrane oxygenation (VA-ECMO) cases. Thus, the objective of this study was to evaluate the safety and effectiveness of this alternative approach. This retrospective study included 26 consecutive patients who underwent percutaneous VA-ECMO decannulation at Maoming People's Hospital. Bedside percutaneous suture technique performed by intensivists facilitated cannula site closure. Primary outcome was successful closure without additional interventions. Secondary outcomes included procedural time, surgical conversion rate, complications (bleeding, vascular/wound complications, neuropathy, lymphocele), procedure-related death. Follow-up ultrasound were conducted within 6 months after discharge. All patients achieved successful site hemostasis with a median procedural time of 28 minutes. Procedure-related complications included minor bleeding (7.7%), acute lower limb ischemia (15.4%), venous thrombus (11.5%), minor arterial stenosis (7.7%), wound infection (4.2%), delayed healing (15.4%), and wound secondary suturing (6.3%). No procedure-related deaths occurred. Follow-up vascular ultrasound revealed two cases (7.7%) of minor arterial stenosis. The perivascular suture technique may offer intensivists a safe and effective alternative method for access site closure without direct artery suture during ECMO decannulation. *ASAIO Journal* 2024; 70:787–794

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Extracorporeal membrane oxygenation (ECMO) is a highly effective extracorporeal life support for critically ill patients with severe cardiopulmonary failure.[1–6] Venoarterial ECMO (VA-ECMO) supports those with severe cardiac or respiratory failure, maintaining adequate oxygenation and perfusion.[7–12] It involves draining blood from the body, oxygenating it, and returning blood through venous and arterial cannulation.[13] Cannulation facilitates quick and effective implementation of VA-ECMO therapy, providing crucial support to critically ill patients. The preferred peripheral VA-ECMO cannulation site is the common femoral artery and vein due to their accessibility, and ability to provide sufficient blood flow.[7] Once the patient is stable and able to maintain adequate oxygenation and perfusion without ECMO, decannulation can be considered. Successful decannulation is crucial for patient recovery, involving careful removal of cannulas and

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This research was authorized by the Ethics Committee and executed, complying with the Declaration of Helsinki. The Maoming People's Hospital's Ethics committee supervised the study (No. PJKY2020MI-132-01), including the design, protocol, ethical issue, and data and sample collection. Additionally, written informed consent was obtained from each patient or the appropriate guardian.

The data used or analyzed during the current study are available from the corresponding author upon reasonable request.

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reliable vascular closure to minimize the risk of complications during or after the procedure.[14]

Proper selection of the decannulation approach and careful postoperative management are essential for successful VA-ECMO treatment and reducing complications. Surgical cutdowns[14–18] and vascular closure devices (VCDs)[19–25] are common methods for decannulation. Surgical cutdown involves making an incision to remove the cannula and repair the vessel wall with sutures, offering a direct view but with increased risks of bleeding, prolonged operational time, higher transfusion rates, and higher hospitalization costs.[18] Furthermore, surgical cutdowns are highly dependent on the availability of skilled cardiovascular surgeons or a specialized team trained in this technique. Vascular closure devices seal the puncture site with special devices avoiding open surgery,[25] offering rapid hemostasis, standardized technique, and reduced access site complications.[22] However, risks include thrombosis, technical challenges, and potential device failure requiring surgical intervention.[19,24] Moreover, closure device suitability varies based on cannula size, vessel fragility, and availability or cost across different clinical settings.[24,26]

As the use of ECMO technology becomes more prevalent in healthcare facilities, there is a growing need for a straightforward, secure, and effective decannulation technique. Our team has developed a percutaneous suture technique that streamlines the cannula removal process, reducing complications and enhancing the safety of ECMO for a wider patient population. Unlike traditional methods, our technique avoids the necessity for direct closure of the artery, offering a novel approach to site closure without the reliance on VCDs or surgical interventions. This article aims to describe our percutaneous suture in detail and showcase its efficacy in achieving reliable site closure without the necessity for direct VCDs or the use of closure devices.

Methods

Study Design and Patients

This retrospective single-center case series comprised consecutive patients undergoing percutaneous decannulation of femoral VA-ECMO using the percutaneous suture technique between January 2021 and March 2023 at the tertiary Maoming People's Hospital in Guangdong, China. Exclusions from this technique during decannulation included patients initially cannulated surgically, nonfemoral arterial access, or notable tissue necrosis, infection, or hematoma at the femoral cannulation site, or in cases of patient mortality. The study protocol received approval from the Institutional Review Board (IRB) of the Maoming People's Hospital (IRB Reference Number: PJKY2020MI-132-01). Due to the retrospective nature of the study, informed consent was waived as the data had been deidentified for privacy protection purposes.

Venoarterial Extracorporeal Membrane Oxygenation Protocol

The ECMO protocol used in our practice was based on the guidelines provided by the Extracorporeal Life Support Organization (ELSO).[7] We also followed specific local standard operating procedures to ensure appropriate adaptation to our facility, mainly described in our earlier study.[27] Cannula was inserted peripherally through the common femoral vein and artery by any intensivist well-trained in the insertion of large indwelling catheters, under certain circumstances with the guidance of ultrasound. The size of cannula was determined by selecting the smallest arterial cannula that could deliver the maximal required flow. A distal perfusion (backflow) cannula is also inserted in the superficial femoral artery before inserting the arterial return cannula and connected to it with a high-flow three-way tap.

Throughout the ECMO procedure, anticoagulation was maintained using continuous infusion of either unfractionated heparin (UFH) or nafamostat to target an activated clotting time (ACT) of 160–180 seconds. Limb perfusion was assessed regularly to ensure, and vascular ultrasound was used to assist in evaluation. The initial ECMO blood flow rate was set between 2 and 3 L/min, and adjusted to maintain a mean arterial pressure (MAP) above 60 mm Hg. Inotropes, vasopressors, and, when necessary, an intra-aortic balloon pump was administered to achieve the desired MAP. Decannulation readiness was based on cardiovascular stability, respiratory improvement, organ recovery, hemodynamic stability, and overall clinical progress, with decisions made by the medical team considering individual response to treatment.

3 Stitch Suture Technique

The 3 stitch suture technique entails the suturing of the skin and subcutaneous tissues surrounding the punctured blood vessel using three stitches: one each on the upper left, upper right, and upper mid positions, except for the distal perfusion tube site which requires two stitches. Importantly, it is noteworthy that our technique does not involve the suturing of the blood vessel itself. After ligation, it creates a subcutaneous soft tissue fold, which applies pressure to achieve homeostasis. Our suture technique promotes hemostasis to close the vessel opening, initiating the four stages of injury repair—hemostasis, inflammation, proliferation, and remodeling—for natural healing.[28] Figures 1 and 2, along with Supplementary Figure 1, Supplemental Digital Content, http://links.lww.com/ASAIO/B250, and Supplementary Video (Steps 1–9), Supplemental Digital Content, provide visual demonstrations of the process.

First Stitch

To start, grasp the suture needle with a surgical holder and insert it 0.5 cm from the ECMO catheter's right side, about 1.5 cm from the catheter's proximal skin-entry point. Keep the needle parallel to the blood vessel's direction, maintaining a depth of 0.8–1.0 cm to avoid adjacent vessel puncture. Withdraw the needle 1.5 cm from the skin-entry point, then secure both thread ends with forceps for further use. See Figure 1A for illustration and Supplementary Video (Steps 2–4), Supplemental Digital Content, for demonstration.

Second Stitch

For the second stitch, use a needle holder to grasp the suture needle threaded with size 1 filament. Position the entry and exit points on the opposite side of the ECMO catheter, mirroring the first stitch's location. Insert the needle in the same direction and depth as the first stitch. Secure both ends of the

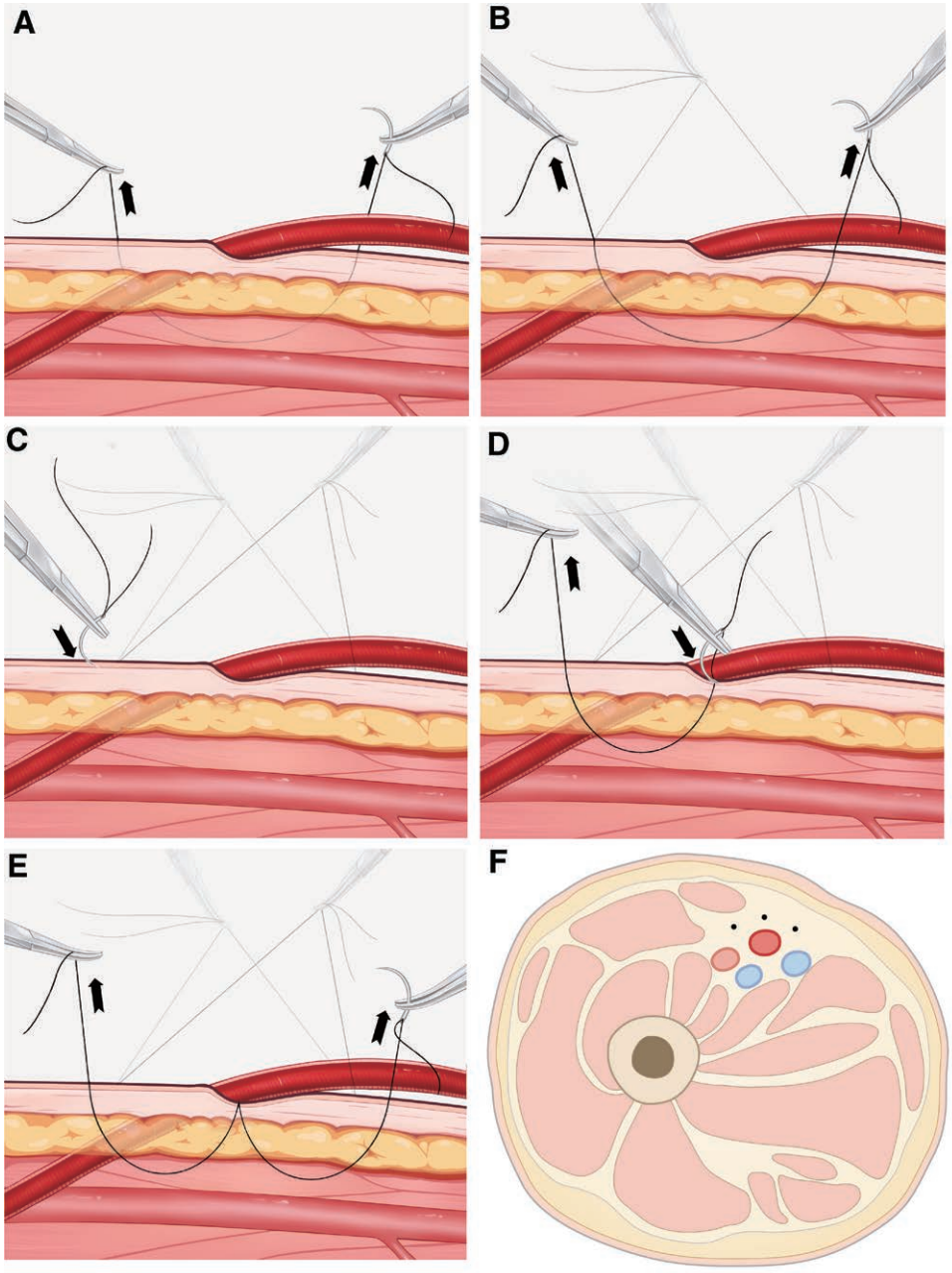

Figure 1. Step-by-step illustrations of 3 stitch suturing process. To initiate the suturing process, a needle is inserted 0.5 cm from the catheter's right side and positioned 1.5 cm away from the proximal end of its skin-entry point (**A**). The second stitch is performed by inserting and withdrawing the needle on the opposite side of the catheter, mirroring the location of the first stitch (**B**). The third stitch requires careful attention as the needle is inserted parallel to the blood vessel approximately 2 cm away from the near-side skin-entry point of the catheter (**C**) and then withdrawn and reinserted in a parallel alignment with both the skin entry and the blood vessel (**D**), gradually withdrawing the needle approximately 2 cm from the far side of the entry point to ensure a depth of approximately 0.8–1.0 cm while minimizing the risk of vessel damage (**E**). The accompanying diagram provides a transverse view that depicts the path followed by the three stitches and illustrates their spatial relationship with the decannulated vessels, using the femoral artery as an example (**F**).

thread with forceps for subsequent application, as shown in Figure 1B and Supplementary Video (Steps 2–4), Supplemental Digital Content.

Third Stitch

As shown in Supplementary Video (Steps 2–4), Supplemental Digital Content, to start the third stitch, securely hold the suture needle with a needle holder. Insert it parallel to the blood vessel, about 2 cm from the near-side skin entry of the ECMO catheter, maintaining a depth of 0.8–1 cm. Withdraw and reinsert the needle from the same point, ensuring parallel alignment. Gradually withdraw the needle about 2 cm from the far side of the entry point, keeping the depth constant. Secure both thread ends with hemostatic forceps.

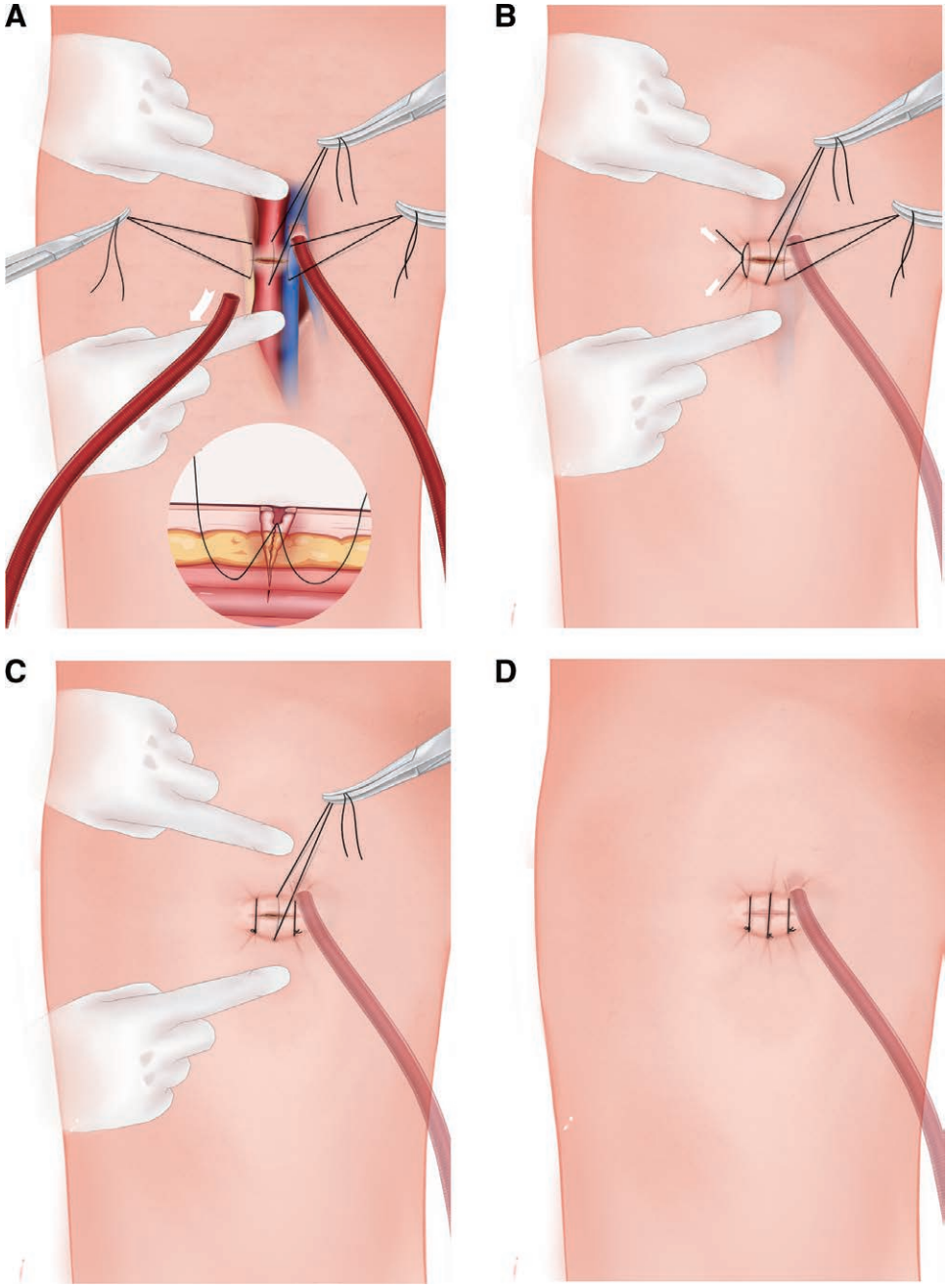

Figure 2. Removal of cannula and knotting. Following cannula removal, an assistant assesses the puncture site for bleeding by applying pressure (**A**). The three sutures are tightened, tied, and cut one by one, leaving a neatly arranged vessel site (**B**–**D**). To provide a clear depiction of the middle stitching path in relation to the skin wound and blood vessels, a circular inset from the sagittal view is included in (**A**).

Cannula Removal and Suture Knotting

Following standard practice, the conventional sequence for removal involves extracting the femoral vein tube first, followed by the distal perfusion tube, and culminating with removal of the femoral arterial tube. On reducing ECMO speed to below 1,500 revolutions per minute, one assistant clamps the circuit to halt flow while another swiftly removes the cannula from the distal end. Simultaneously, pressure is applied 3–5 cm from the puncture site to assess bleeding, with a pressure dressing applied afterward for hemostasis. Postoperative assessments are crucial, including checking for swelling, blood leakage, measuring limb diameter, assessing dorsalis pedis artery pulsation, and evaluating skin temperature. The procedure is illustrated in Figure 2, and demonstrated in Supplementary Figure 1, Supplemental Digital Content, http://links.lww.com/ASAIO/B250 and Supplementary Video (Steps 5–9), Supplemental Digital Content.

Suture Removal

After 48–72 hours following the decannulation, the three sutures from the puncture site can be removed. Sterile gauze is

then applied and secured using 3M tape for compression. The 3M tape can typically be removed after 24 hours.

Vascular Ultrasonic Examination

A trained vascular ultrasonographer performed examinations on the punctured femoral artery or vein at least 2 weeks post-decannulation from the wound site. This ensured consistency and minimized variability among examiners. The purpose was to identify late vascular complications (LVCs) potentially associated with ECMO decannulation using the 3 stitch suture technique.

Outcomes and Definitions

The primary efficacy outcome was a procedural success, defined as instant hemostasis of the decannulation site without additional surgical or endovascular procedures to prevent vessel leaking. The secondary efficacy outcomes were procedural time and rate of surgical conversion. Safety outcomes were procedure-related complications (such as bleeding, early or LVCs, wound complications, and lymphocele), and procedure-related death. Early vascular complications (EVCs) included acute lower limb ischemia, arterial thrombus, venous thrombus, and arterial dissection. Late vascular complications included lower limb ischemic necrosis, arteriovenous fistula, minor arterial stenosis (<50%), major arterial stenosis (>50%), and pseudoaneurysm. Wound complications include infection, delayed healing. Femoral vascular ultrasound assessments were conducted at most 6 weeks after decannulation.

We categorized bleeding using Bleeding Academic Research Consortium (BARC) guidelines: types 1 or 2 were minor, while types 3, 4, or 5 indicated major bleeding.[29] Limb ischemia was defined as pale, cold limbs due to reduced blood flow. Early vascular complication and LVC were defined based on timing during or after hospitalization. All patients underwent follow-up ultrasound between 2 and 6 months to assess femoral vascular status. Late vascular complications were those occurring postdischarge. Wound infection was sepsis signs with positive culture from the groin, needing surgical revision. Delayed wound healing referred to persistent ulceration at the access site lasting over 7 days.

Data Collection and Statistical Analysis

Retrospective data from electronic medical records were collected, including ECMO duration, intensive care unit (ICU) and hospital stays, and survival outcomes at ICU, hospital, and 90 days post-treatment. Patients without follow-up vascular examinations were excluded. Continuous variables were summarized as mean ± standard deviation or median (interquartile range), while categorical variables were presented as numbers and percentages with 95% confidence intervals. Statistical analysis used the pandas package in Python version 3.8.

Results

Clinical and Demographic Data of Patients

Over the study period, 56 patients received VA-ECMO. After excluding 30 patients who met the exclusion criteria, and were unsuitable for any form of 3 stitch suture technique, a total of 26 patients were included. The median age was 53 (36–60) years, with 18 (69.2%) males. The median body mass index (BMI) was 24.0 kg/m^2. The median Acute physiology and chronic health evaluation (APACHE) II score was 35. Around one-third had a smoking history. Common comorbidities included diabetes (n = 6), coronary heart disease (n = 4), and hypertension (n = 4). See Table 1 for baseline patient characteristics.

Extracorporeal Membrane Oxygenation Characteristics

Table 1 illustrates that the median ECMO duration was 9 days. Main indications were acute myocardial infarction (n = 9), myocarditis (n = 7), and cardiac arrest (n = 5). Bilateral femoral vessel access (53.8%) was preferred over ipsilateral access (46.2%). The right femoral artery (n = 17) was most commonly used. Arterial cannula size most frequently used was 17 Fr (n = 24), while venous cannulas sizes were 21 Fr (n = 13) and 20 Fr (n = 8). Over 90% of patients (n = 19) had distal perfusion catheters, mostly 8 Fr (79.2%, n = 19) and some 7 Fr (12.5%, n = 3). Heparin was used for circuit anticoagulation in 88.5% (n = 23), while nafamostat was used in 11.5% (n = 3). Median ACT during ECMO was 176 seconds.

Survival Characteristics

The median ICU stay was 20 days, while the median hospital stay was 31 days. Approximately 60% of patients (n = 15) survived during their ICU stay, and 50% (n = 13) survived at discharge. Among the patients who underwent decannulation, 41.7% (n = 10) survived at the 90 day follow-up.

Outcomes

Primary efficacy outcome and secondary efficacy outcomes. According to Table 2, a 100% success rate was observed in all 26 patients who underwent decannulation procedures utilizing the 3 stitch suture technique, with immediate and effective hemostasis achieved at the decannulation site. No additional surgical or endovascular interventions were required to prevent vessel leakage. The median procedural time was 28 minutes, with an interquartile range of 16–30 minutes. The rate of surgical conversion was 0.

Safety outcomes. No procedure-related deaths occurred, and there were no cases of femoral neuropathy or lymphocele resulting from lymphatic tube injury. Regarding bleeding incidents, two cases (7.7%) of minor bleeding were observed, with no instances of major bleeding or hematoma reported. Rates of early and LVCs were 19.2% and 7.7%, respectively. Early vascular complications were mild, including four cases (15.4%) of acute lower limb ischemia and three cases (11.5%) of venous thrombus. No serious LVCs were observed. Only two cases (7.7%) of mild arterial stenosis were detected during ultrasound examination 2 weeks postdecannulation.

Discussion

This case series assessed the percutaneous 3 stitch suture technique as an alternative to surgical intervention or VCDs for VA-ECMO decannulation when surgical backup and devices are unavailable. To our knowledge, this is the first reported series evaluating this technique as the primary strategy for

Table 1. Study and Patients Data

Characteristics	Summary Statistics*
Study characteristics	
Number of patients	26
Patient characteristics	
Age (years)	53 [36, 60]
Male	18 (69.2)
Height (cm)	168 [160, 171]
Weight (kg)	68 [59, 71]
BMI (kg/m^2)	24.0 [22.6, 24.7]
Smoking	8 (30.8)
Comorbidities	
Diabetes	6 (23.1%)
Coronary heart disease	4 (15.4%)
Hypertension	4 (15.4%)
Chronic kidney disease	2 (7.7%)
APACHE II score	35 [26, 50]
VA-ECMO characteristics	
Indication for ECMO	
Acute myocardial infarction	9 (34.6)
Acute fulminant myocarditis	7 (26.9)
Cardiac arrest (ECPR)	5 (19.2)
Other	5 (19.2)
ECMO femoral access site	
Bilateral	14 (53.8)
Left femoral artery	9 (34.6)
Right femoral artery	5 (19.2)
Ipsilateral	12 (46.2)
Left femoral artery	0 (0)
Right femoral artery	12 (46.2)
Arterial cannula size (Fr)	
17	24 (92.3)
18	1 (3.8)
19	1 (3.8)
Distal perfusion catheter	24 (92.3)
Distal perfusion catheter size (Fr)	
8	19 (79.2)
7	3 (12.5)
6	2 (8.3)
Venous cannula size (Fr)	
21	13 (50.0)
20	8 (30.8)
23	4 (15.4)
22	1 (3.8)
Circuit anticoagulation	
ACT (seconds)	176 [148, 196]
Antithrombotics	
Heparin	23 (88.5)
Nafamostat	3 (11.5)
ECMO duration (days)	9 [7, 11]
Survival characteristics	
ICU stay (days)	20 [13, 31]
Hospital stay (days)	31 [19, 50]
ICU survival	15 (57.7%)
Hospital survival	13 (50.0%)
90 day survival	10 (38.5%)

*Summary statistics are shown as median [IQR] or number (%).

ACT, activated clotting time; APACHE, Acute physiology and chronic health evaluation; BMI, body mass index; ECPR, extracorporeal cardiopulmonary resuscitation; ICU, intensive care unit; IQR, interquartile range; VA-ECMO, venoarterial extracorporeal membrane oxygenation.

Table 2. Outcomes

Outcome	Summary Statistics*
Procedural success†	26 (100%, 100–100%)
Procedural time (minutes)	28 [16, 30]
Surgical conversion‡	0 (0%, 0–0%)
Bleeding	2 (7.7%, 0–17.9%)
Major bleeding	0 (0%, 0–0%)
Minor bleeding	2 (7.7%, 0–17.9%)
Hematoma	0 (0%, 0–0%)
Early vascular complications	5 (19.2%, 4.1–34.4%)
Acute lower limb ischemia	4 (15.4%, 1.5–29.3%)
Arterial thrombus	0 (0%, 0–0%)
Venous thrombus	3 (11.5%, 0–23.8%)
Arterial dissection	0 (0%, 0–0%)
Late vascular complications	2 (7.7%, 0–17.9%)
Lower limb ischemic necrosis	0 (0%, 0–0%)
Arteriovenous fistula	0 (0%, 0–0%)
Minor arterial stenosis (<50%)	2 (7.7%, 0–17.9%)
Major arterial stenosis (>50%)	0 (0%, 0–0%)
Pseudoaneurysm	0 (0%, 0–0%)
Lymphocele	0 (0%, 0–0%)
Wound complications	2 (7.7%, 0–17.9%)
Infection	1 (4.2%, 0–11.2%)
Delayed healing	4 (15.4%, 1.5–29.3%)
Procedure-related death	0 (0%, 0–0%)

*Summary statistics are shown as median [IQR] or number (%) with 95% CI.

†Procedural success was defined as instant hemostasis of the decannulation site without additional surgical or endovascular procedures to prevent vessel leaking.

‡Surgical conversion was defined as any surgical cutdown at decannulation or later.

IQR, interquartile range; CI, confidence interval.

VA-ECMO decannulation. The study achieved a 100% success rate in immediate site hemostasis, with a median time of 28 minutes. Rates of access site vascular and wound complications were comparable and acceptable, with no serious adverse events observed. Thus, this method, relying solely on percutaneous sutures, simplifies decannulation site closure, obviating the need for more invasive surgical procedures or device-dependent decannulation in many patients. It represents a valuable approach for VA-ECMO decannulation.

Since the widespread use of VA-ECMO, various decannulation strategies exist, including surgical cutdown vascular repair[14–18] and VCDs.[19–25] However, there are no standardized guidelines across institutions. Surgical cutdowns offer direct vessel visualization and precise closure control but may result in larger incisions, increased scarring, bleeding risks, prolonged operation times, and dependency on skilled surgeons.[14–16,18] Vascular closure devices provide a minimally invasive approach with shorter procedural times, rapid hemostasis, and faster ambulation but carry risks of device-related complications such as hematoma, pseudoaneurysm, or infection.[19–21,23] However, their applicability is limited in certain anatomies or contraindications, potentially increasing costs and limiting use in resource-limited settings.

The concept of the 3 stitch-only suture technique for site closure stemmed from the application of pressure with a purse-string suture to achieve hemostasis. The success of this technique hinges on using three sutures passing through the vascular puncture site from different directions to ligate and constrict the soft tissue, as illustrated in Figure 1. This creates a high-pressure wrapping around the puncture site, effectively achieving hemostasis. Over time, the vascular puncture site is naturally repaired through the body's hemostatic mechanisms, clotting, vasoconstriction, platelet aggregation, as well as cell proliferation and regeneration processes.[28] This technique offers a simplified, cost-effective, and reliable approach to decannulation by using only three sutures and has potential advantages over the two methods discussed. This simplicity may lead to decreased procedural complexity and potentially reduce the learning curve for healthcare providers.

While the effectiveness of this method in venous decannulation site closure is widely accepted, introducing it for arterial decannulation site closure has faced skepticism among vascular surgery experts. Skepticism arises from factors influencing the success of soft tissue compression, including the distance between the access site and artery, amount of surrounding soft tissue, challenges with deep arteries, calcification presence, and long-term cannulation effects. Long-term cannulation leads to tissue changes that hinder hemostasis through pressure alone, casting doubts on the efficacy of this method for arterial hemostasis.

Seeing is believing. Our patients are all consecutively enrolled without selection. The suturing method of arterial and venous decannulation closure used at our center has been routinely applied for the past 3 years, with over 50 cases treated using this approach, all of which have achieved good hemostasis and closure results. When we start from the facts and attempt to analyze from an anatomical perspective, it is not surprising to find that our method is effective in achieving hemostasis during arterial decannulation, and is minimally affected by factors such as age, gender, BMI, and fistula formation, etc. First, the groin area is rich in soft tissue, providing sufficient relaxation and compression space, which is conducive to the implementation of the suture technique and the formation of high-pressure compression wrapping. In addition, the muscle and ligament structures around the groin area can provide stable support, helping to ensure the firmness and durability of the suture. Therefore, even in the presence of various influencing factors, this method can still achieve effective hemostasis during arterial decannulation.

Due to the routine application of this method in our ECMO center, there are virtually no patients who require surgical incision or device-assisted decannulation if the cannulation is done by percutaneous puncture. As a result, we did not establish a control group involving surgical or device-assisted approaches. Nonetheless, we conducted a literature search and reviewed adverse event reports associated with surgical and device-assisted decannulation, comparing them to our technique. The adverse events in our study were found to be comparable, and even relatively lower, compared with those reported in surgical or device-dependent studies. Regarding surgical cutdown approach, Majunke *et al*.[16] conducted a comparative study between surgical femoral cutdown and completely percutaneous approach for decannulation after VA-ECMO, and reported more occurrence of severe wound complications and sustained paresthesia, greater need for transfusion of packed red blood cells, longer hospital stay in surgical group. Sun *et al*.[14] reported that the incidence of groin infection and delayed healing was significantly higher in the surgical removal group.

Regarding VCDs use, Ng *et al*.[22] performed a systematic review and meta-analysis of the techniques and outcomes associated with percutaneous decannulation of VA-ECMO using the Manta vascular closure device, and reported an overall incidence of bleeding, vascular, and wound complications was 1.7%, 13.8%, and 3.4%, respectively. However, Dalén *et al*.[24] reported six (17.7%) patients had to undergo immediate or late conversion to surgical cutdown of the groin using the MANTA plug-based VCD for percutaneous arterial closure of the femoral artery after VA-ECMO. Bemtgen *et al*.[20] reported three patients (27.3%) had a visible thrombus at the closure device resulting in a >60% stenosis. Another emerging VCD for VA-ECMO decannulation is ProGlide,[14,17,25] which has been associated with a 20% incidence of vascular-related complications, such as acute lower limb ischemia, major bleeding, severe hematoma, pseudoaneurysm, and arteriovenous fistula, as well as a 3.3% incidence of groin infection and delayed healing, according to Sun *et al*.[14] The most frequent adverse events in our percutaneous 3 stitch suture technique are acute lower limb ischemia (four cases, 15.4%) and delayed healing (four cases, 15.4%), which may be attributed to distal thrombosis. However, we observed that lower limb ischemia was almost completely reversible under critical care or through the endogenous thrombolysis mechanism, resulting in no ischemic necrosis or need for amputations. Importantly, the majority of complications were minor, and no serious complication occurred. All these suggested that the current method represented a minimally invasive technique. While a low complication rate has been reported, caution should be exercised regarding severe complications. This is particularly important when using the technique for removing larger-sized cannulas, as it does not repair the blood vessels involved.

When attempting to provide insights into patient factors or body characteristics of those who experience complications with this technique, we discovered that long-term diabetes, especially a diabetes history of 10 years or more, is a risk factor for all complications. Among the four patients who experienced acute vascular complications or delayed wound healing, all were diabetic. This is related to the fact that diabetic patients are prone to developing large vessel hardening and stenosis, which increases the risk of thrombosis. Regarding age, gender, BMI, and tube diameter, we did not observe significant differences.

We demonstrated that the percutaneous suture-only approach, independently delivered by intensivists, is highly practicable, safe, and cost-effective for ECMO decannulation. This technique offers several advantages, making it a preferable method for VA-ECMO decannulation. It avoids the training and cost associated with surgical or device-dependent methods while achieving excellent success rates. Additionally, it can be performed at the bedside by intensivists, reducing risks related to transportation, which is particularly important in critically ill settings.[30,31] Furthermore, it simplifies the decannulation process compared with surgery or device-dependent methods, facilitating the establishment of ECMO centers with rapid response capabilities and enabling medical staff in different institutions to operate independently.[27] Therefore, this minimally invasive decannulation method can be easily reproduced in other ECMO care environments.

This case series had several limitations to consider. Due to the exclusive use of the 3 stitch suture technique, a matched control group was not included. Being single-center, the findings may not be universally applicable. Additionally, a substantial portion of patients lacked follow-up ultrasounds, potentially introducing selection bias. To fully validate and build upon the promising results of this technique in bedside decannulation, further research with larger samples, comparative designs, longer follow-up, and multicenter settings is warranted.

Conclusions

The perivascular suture technique, omitting direct artery suture for access site closure in VA-ECMO decannulation has

the potential to offer a safe and effective alternative when surgical or device-dependent approaches are not available. This technique may significantly facilitate decannulation procedures performed by intensivists.

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