Journal of Pediatric Surgery 52 (2017) 1806–1809

Contents lists available at ScienceDirect

Journal of Pediatric Surgery

journal homepage: www.elsevier.com/locate/jpedsurg

Trauma/Critical Care

Patency of common carotid artery and internal jugular vein after a simple vessel sparing cannulation for extracorporeal membrane oxygenation support

Mustafa Kurkluoglu [a], Sara Badia [b], Syed Murfad Peer [a], Richard Jonas [a], Venkat Shankar [c], Pranava Sinha [a,*]

[a] Department of Cardiovascular Surgery, Children's National Health System, 111 Michigan Av. NW, Washington, DC, 20010
[b] Hospital Universitario de La Princesa, Calle de Diego Leon, 62, 28006 Madrid, Spain
[c] Division of Critical Care, Children's National Health System, 111 Michigan Av. NW, Washington, DC, 20010

ARTICLE INFO

Article history:
Received 30 November 2016
Received in revised form 11 July 2017
Accepted 2 August 2017

Key words:
ECMO cannulation
Carotid artery
Jugular vein

ABSTRACT

Background: Common carotid artery and internal jugular vein are commonly cannulated for establishment of peripheral venoarterial extracorporeal membrane oxygenation (VA ECMO) support. We present our results of a vessel sparing cannulation technique for neck vessels, which helps maintain vessel patency after decannulation.
Methods: All patients who underwent ECMO, between January 2004 and January 2013 at a single center, were retrospectively reviewed. Follow up data for the patency of common carotid artery (CCA) and internal jugular vein (IJV) after decannulation were recorded.
Results: Twenty-four consecutive patients who were successfully decannulated after VA ECMO support who underwent vessel sparing cannulation were retrospectively reviewed. Follow up data were unavailable in 4 and 1 patient did not survive. Amongst the remaining 19 patients the median duration of ECMO support in the remaining was 7 (IQR; 4–10) days. Follow up studies documenting vessel patency were available for IJV in 18 patients and CCA in 14 patients. At a median follow up of 137 days (IQR; 35–7240) 15 (78%) patients had patent IJVs and 14 (100%) patients had patent CCAs.
Conclusion: The simple vessel sparing technique is effective in allowing restoration of the patency of the neck vessels after ECMO decannulation.
Level of evidence: Case series with no comparison group (Level IV).

ECMO is an extremely valuable treatment option for supporting critically ill children with severe cardiovascular or respiratory failure that is unresponsive to conventional therapies [1]. Cannulation of neck vessels (common carotid artery & internal jugular vein) is a standard method for establishing venoarterial ECMO support in the pediatric population.

Despite some promising early attempts of reanastomosis and repair of Common Carotid Artery (CCA) at the time of ECMO decannulation, this practice has not gained widespread adoption owing to its technical complexity as well as debatable benefits on neurodevelopmental outcomes [2–11]. Whereas ligation of the internal jugular vein (IJV) has not been consistently shown to increase the intracranial pressure [12], it still remains an important point of access to the vascular system. Often IJV is needed for placement of central venous catheters and for dialysis. Additionally, IJV patency is critical in children with cardiac disease who often require subsequent diagnostic and interventional cardiac catheterizations [13]. Despite reports of less complex vessel sparing techniques that preserve the patency of IJV and CCA after decannulation [11], ligation of the vessels remains a common practice after separation of ECMO support.

We have practiced a vessel sparing technique for ECMO cannulation that is technically simple, reproducible and time efficient. In this study, we sought to determine the incidence of patency of CCA and IJV in patients undergoing venoarterial ECMO cannulation and decannulation using our novel simple vessel sparing technique for arterial and venous cannulation.

1. Materials and methods

We undertook a retrospective review of the medical records of twenty-four consecutive patients who were successfully decannulated after VA ECMO support at Children's National Medical Center, between January 2008 and January 2013. All patients underwent cannulation of

Abbreviations: CCA, Common Carotid Artery; CT, Computerized Tomography; ECMO, Extracorporeal Membrane Oxygenation; E-CPR, ECMO cannulation during cardiopulmonary resuscitation; IJV, Internal Jugular Vein; IQR, Interquartile Range; MRI, Magnetic Resonance Imaging; O, Occluded; P, Patent; SV, Single Ventricle; US, Ultrasonography.

* Corresponding author at: Department of Cardiovascular Surgery, Children's National Health System, 111 Michigan Av. NW, Washington, DC, 22043. Tel.: +1 202 476 2020; fax: +1 202 476 5572.
E-mail address: psinha@childrensnational.org (P. Sinha).

http://dx.doi.org/10.1016/j.jpedsurg.2017.08.001
0022-3468/© 2017 Published by Elsevier Inc.

neck vessels using the simple vessel sparing technique described below. Owing to the retrospective nature of the study, documentation of informed consent was waived by the Institutional Review Board.

We excluded patients who were unable to be weaned from ECMO, or those in whom the vessel-sparing cannulation was not performed. Patients with inadequate imaging data were also excluded.

The medical records and imaging data from all subjects were reviewed to document patency of CCA and IJV.

Follow up imaging studies for assessment of neck vessel patency included venous and/or arterial Doppler ultrasounds, cardiac magnetic resonance imaging (MRI), computerized tomography (CT) scans, angiograms, cardiac catheterization images (venograms/arteriograms) as well as any fluoroscopic or ultrasound guided vascular access procedures for subsequent cardiac catheterizations or catheter placement through these vessels after decannulation. Vessels were considered to be patent if there was less than 70% luminal narrowing by two-dimensional imaging in any imaging plane. For the carotid artery significant stenosis was defined by Doppler peak systolic flow velocity > 230 cm/s [14]. Additionally, vessels that could be cannulated again for another course of ECMO (for both artery and vein), or allowed placement of central venous catheters, dialysis catheters, or access for cardiac catheterization (for vein) were considered to be functionally patent. All other vessels were considered to be compromised or nonpatent.

1.1. Surgical technique

1.1.1. Cannulation

With standard positioning and preoperative preparation the CCA and IJV were exposed through a short transverse incision via a small transverse supraclavicular incision placed over the ipsilateral sternomastoid muscle. In patients with normal venous anatomy or with bilateral superior vena cavae, right-sided neck vessels were cannulated. In patients with dominant left superior vena cava, left-sided neck vessels were cannulated. The sternomastoid was retracted laterally to expose the carotid sheath, and the CCA and IJV. Diamond shaped purse string sutures were placed on the anterior aspect of the vessels (length of the purse-string along the long axis of the vessel, minimizing the width of the purse-string) using 5/0 polypropylene (Prolene®; Ethicon, Somerville, NJ) sutures. Purse strings were controlled using Rommel's tourniquets (Fig. 1). After heparinization, a longitudinal incision was made on the vessels within the purse string using an 11 blade scalpel. If needed the opening was gently dilated with a hemostat. If necessary, sides biting vascular clamps were used for control to improve exposure. The arterial and venous cannulas were placed through the arteriotomy or venotomy respectively, and advanced up to the desired length. The purse-string sutures were snared using the tourniquets which were then tied to the cannulas using heavy silk sutures (Fig. 2 A & B). The tourniquets were folded over and fixed with medium sized hemoclips (Fig. 2 C & D). The skin was closed around the cannulas using interrupted horizontal mattress sutures of nylon.

The cannulation strategy was standard irrespective of whether the cannulation was urgent, emergent or an eCPR situation (defined as ECMO cannulation during active cardiopulmonary resuscitation).

1.1.2. Decannulation

After recovery of the cardiovascular and respiratory failure, when a patient met ECMO weaning and decannulation criteria, the neck incision was reopened. The hemoclips on the tourniquets were removed; the tourniquets were unfolded and controlled with hemostats during removal of the cannulas. Some deliberate bleeding and back-bleeding was allowed to flush out any thrombus or debris within the vessels. The tourniquets were removed and the purse-string sutures were tied down. There was no need for an extensive vascular repair of the vessel after decannulation. At the most the purse-string site may need reinforcement with a single horizontal mattress suture of 5-0/6-0 Prolene for hemostasis.

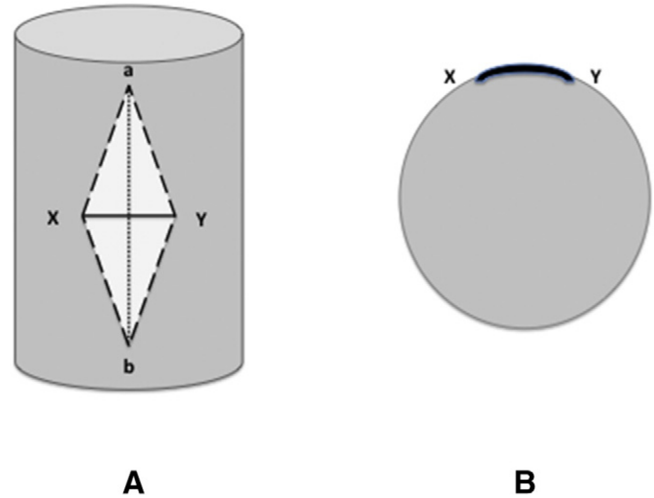

Fig. 1. Vessel sparing technique for cannulation of the common carotid artery and internal jugular vein for ECMO support. A: A diamond shaped purse string suture (Coarse Dotted Line) using four bites is placed along the long axis of the vessel. The width of the purse string (X–Y, Solid Line) is minimized. Increasing the length of the purse string (a–b, Fine Dotted Line) allows ease of cannulation. Cross section of the vessel showing the reduction in the circumference of the vessel upon decannulation and tying off the purse string is equal to the width of the purse string (Corresponding to distance X–Y depicted by solid line). The loss of luminal circumference is therefore minimized by reducing the width of the purse string (distance X–Y).

2. Results

During the study period the extracorporeal life support program at Children's National Medical center supported 453 patients with ECMO. Of these, 317 (70%) were successfully weaned and decannulated from ECMO. Among the successfully decannulated patients, 57 were placed on ECMO using neck cannulation. Twenty four (24) of those patients had the simple vessel sparing cannulation of the IJV and CCA. The remaining 33 patients had the conventional ECMO cannulation and decannulation procedure with ligation of the neck vessels after decannulation. The technique was initially chosen based on the surgeon's preference; however since 2009 there was universal adoption of the vessel sparing technique at our center. Four patients who underwent vessel-sparing cannulation had no follow up imaging data and were excluded. One patient was successfully decannulated but died during the hospital course. Nineteen (19) surviving patients had at least one follow up modality for assessment of neck vessel patency and comprised the study cohort (Fig. 3).

The patient characteristics are summarized in Table 1. The study group consisted of neonates (n = 5), infants (n = 9) and young children (n = 5) with the overall median (IQR) weight and age of 6.7 (4.0–11.3) kg and 5.4 (0.8–12.5) months respectively. Nine patients were cannulated during eCPR conditions (50%). This complex group of patients included 11 patients with single ventricle cardiac anatomy (61%). All patients in the study group were supported by venoarterial (VA) ECMO. One patient was initially supported using venovenous (VV) ECMO, but 1 day later had to be converted to VA ECMO. The cannulation sites were through the right vessels in 17 (94%) patients and through the left in 1 (6%) patient with dominant left superior vena cava. Two patients (11%) had previous central venous catheters in their IJV prior to ECMO cannulation (present at the time of cannulation). The duration of ECMO support was median (IQR) time of 7 (4–10) days. Blood loss during cannulation was not quantified and no patient had any neck bleeding or hematoma after the procedure.

Two patients in the cohort required a second run of ECMO (during the same admission on postdecannulation days 8 & 10) and were