CASE REPORT

High renal regional oxygen saturation in femoral arteriovenous fistula after neonatal cardiac surgery

Jean-Sébastien Tremblay-Roy,¹ Karen Harrington,¹ Suzanne Vobecky,² Guillaume Emeriaud¹

¹Department of Pediatric Intensive Care, CHU Ste-Justine, Montreal, Canada
²Department of Pediatric Cardiac Surgery, CHU Ste-Justine, Montreal, Canada

Correspondence to

Dr Jean-Sébastien Tremblay-Roy, jeanseb9@hotmail.com

Accepted 20 January 2015

SUMMARY

The use of an indwelling arterial catheter is standard practice in the postoperative monitoring of paediatric cardiac surgery patients. Arteriovenous fistula related to this procedure can be difficult to diagnose. Regional haemoglobin oxygen saturation (rSO₂) using near-infrared spectroscopy and central venous oxygen saturation (ScvO₂) are monitored to follow the balance between oxygen consumption and delivery. Low values of these parameters are a sign of low cardiac output. High rSO₂ and high ScvO₂ are less frequently described. We report the discovery of an iatrogenic arteriovenous fistula in a neonate after cardiac surgery who had unexpectedly high values of renal rSO₂ and femoral ScvO₂. High renal rSO₂ after femoral instrumentation should alert the physician to the possibility of arteriovenous fistula.

BACKGROUND

Central venous oxygen saturation (ScvO₂) provides crucial information about the balance between oxygen consumption and delivery, an important feature in shock management. It is, therefore, part of the standard monitoring in critical care and especially after congenital cardiac surgery. Regional haemoglobin oxygen saturation (rSO₂) using near-infrared spectroscopy (NIRS) is a non-invasive technique which uses sensors placed on forehead and renal somatic area to estimate adequacy of oxygen delivery.¹ Low ScvO₂ and low rSO₂ are the main concern for clinicians, because they have been associated with low cardiac output syndrome (LCOS) in this population.^{2–5} High value of these parameters is less frequently observed in these patients and its differential diagnosis is less well known.

Arteriovenous fistula (AVF), an abnormal communication between arterial and venous systems, is an infrequent complication of vascular access. The incidence of femoral AVF postcardiac catheterism in adults is 0.3% to 2.8%.^{6–7} Paediatric data are less exhaustive. A few case reports have been published since 1965⁸ and a retrospective study in a neonatal intensive care unit found an incidence of AVF, following vascular access of 1.8% and 0.08% in neonates, of less than 1500 g and more than 1500 g, respectively.⁹

We report, to the best of our knowledge, the first case of high renal regional haemoglobin oxygen saturation (rSO₂R) using NIRS associated with femoral AVF following a femoral arterial catheter insertion.

CASE PRESENTATION

A 38-week gestation neonate was born with a complex congenital heart defect. His birth was unremarkable for any complication, APGAR score was 9–9 and birth weight was 2855 g. He was admitted in neonate intensive care unit and an echocardiography confirmed the antenatal diagnosis (aortic arch hypoplasia with moderate hypoplastic left ventricle). Abdominal and cerebral ultrasounds were normal. Prostaglandins were started preoperatively. Surgery was performed on day 4 of life. In the operating room, a 3 Fr 5 cm catheter was installed in the right femoral artery on first attempt by an anaesthesiologist using echo guidance; no complication was noted during the procedure. A radial arterial line and a left femoral central venous catheter were also placed. Complete corrective surgery was performed without complication.

Postoperatively, the patient was admitted to paediatric intensive care unit (PICU) with NO, milrinone, dopamine and adrenaline support. Vital signs were reassuring. Lactate was 5.5 mmol/L 1 h postsurgery, peaked at 7 mmol/L 2 h postoperative and normalised 18 h after surgery. An abnormally high rSO₂R (>90%) was detected by NIRS monitoring soon after PICU admission (figure 1) and contrasted with the normal expected value of cerebral rSO₂ (rSO₂C). The ScvO₂ obtained via the femoral venous catheter was also high (figure 1). The aetiology of this unusual finding was not clear to the physician at that time and no specific actions were taken, except the usual weaning of supportive therapies.

Thirty-six hours following surgery, the patient's right leg was found to be colder, and the right tibial posterior and pedis pulse was difficult to find.

INVESTIGATIONS

A right femoral echo -Doppler was performed after discovery of right leg hypoperfusion on physical examination. It revealed an AVF between the femoral common vein and artery proximal to the arterial catheter.

TREATMENT

The catheter was removed and compression was applied. A repeat echo -Doppler performed the following day showed resolution of the AVF.

OUTCOME AND FOLLOW-UP

Three days later, right leg perfusion had improved and a final echo -Doppler confirmed the absence of AVF. The patient was discharged from PICU on day

CrossMark

To cite: Tremblay-Roy J-S, Harrington K, Vobecky S, et al. *BMJ Case Rep* Published online: [please include Day Month Year] doi:10.1136/bcr-2014-205532

Figure 1 ScvO₂ and rSO₂ of the patient in the first 26 h of PICU hospitalisation. rSO₂, regional haemoglobin oxygen saturation; ScvO₂, femoral venous oxygen saturation; PICU, paediatric intensive care unit.

7 postsurgery. No abnormality of the right leg was noted during the cardiology follow-up.

DISCUSSION

ScvO₂ is used to monitor the balance between oxygen delivery and consumption as an indirect reflect of cardiac output. NIRS monitoring is a non-invasive, continuous measure of oxygen extraction. NIRS uses 2 wavelengths to measure deoxygenated haemoglobin (Hb) and oxygenated Hb to provide the saturation (rSO₂) of blood 1–2 cm below the skin. Since there is more haemoglobin in the venous circulation compared to arterial circulation in the tissue, NIRS gives a venous-weighted relative oxygen index of tissue beneath the probe.¹ Low ScvO₂ and rSO₂ are quite useful to diagnose and monitor LCOS, but high values are less often seen in day-to-day practice. High ScvO₂ has a large differential diagnosis including (1) high oxygen transport favoured by high FiO₂ and/or inotrope utilisation, (2) low oxygen consumption as observed during hypothermia, neuromuscular blockade, deep anaesthesia, (3) low oxygen extraction secondary to shock or cyanide poisoning and (4) intracardiac and extracardiac left to right shunting¹⁰ as illustrated in our case.

Abnormally high value of rSO₂ has not been reported, but its interpretation should logically follow the same pathophysiology as high ScvO₂. One difference stems from the local nature of the information provided by NIRS. As observed in our case, the fact that rSO₂R was superior to 90% while lower values (60–70%) were obtained for cerebral rSO₂ was in favour of a local extracardiac left-to-right shunt.

Physical findings of femoral AVF are often non-specific. Symptoms can include limb oedema, skin discolouration, weak peripheral pulses, Nicoladoni sign, groin haematoma, pulsatile mass, groin pain, femoral murmur, and later gangrene and ulceration.^{11 12} On rare occasions, high output cardiac failure can occur if the AVF is large.¹³ Occasionally, symptoms can be absent. As suggested by our case, high rSO₂ could alert to the possibility of AVF prior to the appearance of symptoms. Diagnosis of AVF is usually made with ultrasonography and Doppler studies.^{11 13 14} Contrast CT scan, MRI and conventional angiography are more invasive, expose children to radiation, require sedation, are more expensive and are, therefore, reserved for difficult cases.^{11 13 15} In adult patients with postcardiac catheterism AVF, spontaneous resolution occurs in 38–81%^{7 16} in a

mean time of 20 days.¹⁶ Treatment of persistent AVF in paediatric patient is mostly surgical.^{9 15} Echo guidance compression and percutaneous implantation of endovascular stent are alternative treatments that have been most described in adults.^{13 17}

In conclusion, femoral AVF must be considered when high rSO₂R and high femoral ScvO₂ are observed in the context of femoral vascular access. The recognition of this early abnormality could allow earlier diagnostic and treatment of an AVF.

Learning points

- Femoral arteriovenous fistula should be considered in the presence of a high rSO₂R and femoral ScvO₂.
- Femoral arteriovenous fistula can occur even when the catheter placement was easy with no apparent complication.
- Ultrasonography and Doppler studies are the primary diagnostic tests to confirm diagnosis of arteriovenous fistula.

Contributors J-ST-R, GE and KH contributed to literature search. J-ST-R and GE contributed to data collection. J-ST-R, GE and SV made data analysis and interpretation. J-ST-R, GE, KH and SV contributed to manuscript writing.

Competing interests None.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

- 1 Drayna PC, Abramo TJ, Estrada C. Near-infrared spectroscopy in the critical setting. *Pediatr Emerg Care* 2011;27:432–9.
- 2 Crowley R, Sanchez E, Ho JK, et al. Prolonged central venous desaturation measured by continuous oximetry is associated with adverse outcomes in pediatric cardiac surgery. *Anesthesiology* 2011;115:1033–43.
- 3 Ranucci M, Isgrò G, Carlucci C, et al. Central venous oxygen saturation and blood lactate levels during cardiopulmonary bypass are associated with outcome after pediatric cardiac surgery. *Crit Care* 2010;14:R149.
- 4 Seear MD, Scarfe JC, LeBlanc JG. Predicting major adverse events after cardiac surgery in children. *Pediatr Crit Care Med* 2008;9:606–11.
- 5 Hansen JH, Schlenger J, Armbrust S, et al. Monitoring of regional tissue oxygenation with near-infrared spectroscopy during the early postoperative course after superior cavopulmonary anastomosis. *Eur J Cardiothorac Surg* 2012;43:e37–43.
- 6 Kent KC, McArdle CR, Kennedy B, et al. A prospective study of the clinical outcome of femoral pseudoaneurysms and arteriovenous fistulas induced by arterial puncture. *J Vasc Surg* 1993;17:125–33.
- 7 Kelm M, Perings SM, Jax T, et al. Incidence and clinical outcome of iatrogenic femoral arteriovenous fistulas: implications for risk stratification and treatment. *J Am Coll Cardiol* 2002;40:291–7.
- 8 Davis SD, Baum D, Dillard DH. Femoral arteriovenous fistula following venipuncture. *Pediatrics* 1965;35:118–20.
- 9 Gamba P, Tchaprassian Z, Verlato F, et al. Iatrogenic vascular lesions in extremely low birth weight and low birth weight neonates. *J Vasc Surg* 1997;26:643–6.
- 10 Lacroix J. *Urgences et soins intensifs pédiatriques*. Montréal: du CHU Sainte-Justine, 2007:1271.
- 11 Megremis SD, Christaki MA, Mourkoyiannis NK, et al. Iatrogenic brachial arteriovenous fistula in a child: color Doppler ultrasonographic evaluation. *J Ultrasound Med* 2006;25:809–12.
- 12 Kotagal M, Reiss A, Vo N, et al. Iatrogenic arteriovenous fistula in the arm in an infant: diagnostic and therapeutic considerations. *J Clin Ultrasound* 2012;40:381–4.
- 13 Seay T, Soares G, Dawson D. Postcatheterization arteriovenous fistula: CT, ultrasound, and arteriographic findings. *Emerg Radiol* 2002;9:296–9.
- 14 Adams CP, Taylor DS. The utility of ultrasound in a case of femoral artery pseudoaneurysm and femoral arteriovenous fistula. *J Emerg Med* 2002;22:291–2.
- 15 Lin PH, Dodson TF, Bush RL, et al. Surgical intervention for complications caused by femoral artery catheterization in pediatric patients. *J Vasc Surg* 2001;34:1071–8.
- 16 Toursarkissian B, Allen BT, Petrinc D, et al. Spontaneous closure of selected iatrogenic pseudoaneurysms and arteriovenous fistulae. *J Vasc Surg* 1997;25:803–8; discussion 808–809.
- 17 Thalhammer C, Kirchherr AS, Uhlrich F, et al. Postcatheterization pseudoaneurysms and arteriovenous fistulas: repair with percutaneous implantation of endovascular covered stents. *Radiology* 2000;214:127–31.

Copyright 2015 BMJ Publishing Group. All rights reserved. For permission to reuse any of this content visit <http://group.bmj.com/group/rights-licensing/permissions>.
BMJ Case Report Fellows may re-use this article for personal use and teaching without any further permission.

Become a Fellow of BMJ Case Reports today and you can:

- ▶ Submit as many cases as you like
- ▶ Enjoy fast sympathetic peer review and rapid publication of accepted articles
- ▶ Access all the published articles
- ▶ Re-use any of the published material for personal use and teaching without further permission

For information on Institutional Fellowships contact consortiasales@bmjgroup.com

Visit casereports.bmj.com for more articles like this and to become a Fellow