Positioning and complications of umbilical catheters

Verheij, G.H.

CHAPTER 7

Cardiac arrhythmias associated with umbilical venous catheterisation. Two case reports.

Gerdina H. Verheij
Vivianne E.H.J. Smits-Wintjens
Lieke Rozendaal
Nico A. Blom
Frans J. Walther
Enrico Lopriore

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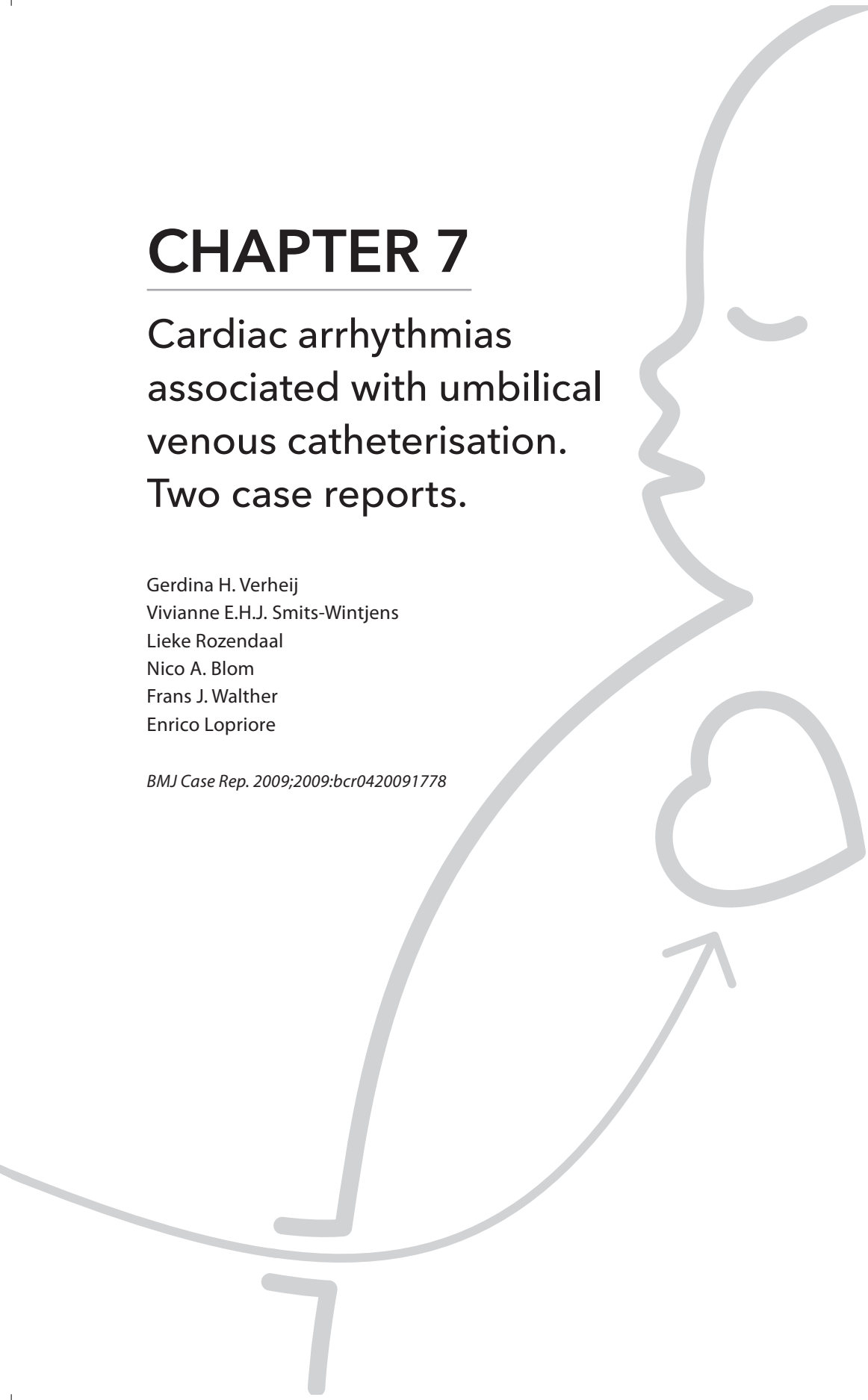

ABSTRACT

Umbilical venous catheters (UVCs) are commonly used in the management of severely ill neonates. Several life-threatening complications have been described, including catheter-related infections, myocardial perforation, pericardial effusion and cardiac arrhythmias. This report describes two neonates with cardiac arrhythmias due to umbilical venous catheterisation. One neonate had a supraventricular tachycardia requiring treatment with intravenous adenosine administration. Another neonate had an atrial flutter and was managed successfully with synchronized cardioversion. The primary cause of cardiac arrhythmias after umbilical venous catheterisation is inappropriate position of the UVC within the heart and the first step to treat them should be to pull back or even remove the catheter.

Cardiac arrhythmia is a rare but potentially severe complication of umbilical venous catheterisation in neonates.

INTRODUCTION

Umbilical venous catheters (UVCs) are commonly used in the management of severely ill neonates for intravenous administration of parenteral nutrition, hypertonic solutions, blood products and medication. However, the advantages of UVCs must be carefully balanced against the potential risks. Several life-threatening complications have been associated with the use of UVCs, including catheter-related infections, thrombosis, myocardial perforation, pleural and pericardial effusion.[1-6]

Cardiac arrhythmias by indwelling atrial lines, such as UVCs, have also been described in neonates.[7-10] In the perinatal period paroxysmal supraventricular tachycardia (SVT) and atrial flutter are the most common types of tachyarrhythmias, usually in the absence of structural heart disease. The onset of atrial flutter and paroxysmal supraventricular tachycardia has also been reported secondary to umbilical (or jugular) venous catheterization.[6, 11-14] The aetiology of these tachyarrhythmias in each case was inappropriate placement of the venous catheter within the heart.

Although most neonatal textbooks report on the risk of arrhythmias after umbilical venous catheterisation, not much is known about the underlying pathophysiological mechanism and the incidence of this complication.[6, 10] Moreover, the clinical course of cardiac arrhythmias due to placement of UVCs has not well been studied. Establishing the risks associated with any medical procedure is crucial.

We describe two neonates with cardiac arrhythmias associated with umbilical venous catheterisation and discuss the management of these sometimes acute life-threatening situations.

CASE NO. 1

A 3750 g male infant was born at 41 weeks of gestation in a secondary care center. Because of perinatal asphyxia the child was intubated, mechanically ventilated and transported to our hospital. Apgar scores were 2, 5 and 8 at 1, 5 and 10 minutes, respectively. Umbilical cord arterial pH was 6.9 with a base excess of -11.8 mmol/l. On admission to our neonatal nursery, the infant had a normal heart rate (119 beats/min) and a normal blood pressure (54/46 mm Hg). Physical examination showed no major congenital malformations, normal heart sounds, no heart murmur, equal pulses on all extremities and no hepatosplenomegaly. Laboratory investigations, including serum electrolytes, showed no abnormalities.

On day 1, the infant developed seizures and was treated successfully with phenobarbital (20 mg/kg). An electro-encephalogram on day 2 did not show epileptic activity. Cranial ultrasound examinations on day 1, 2 and 5 were normal. There was no cerebral edema.

Umbilical venous and arterial catheters were placed on day 1. Insertion length was determined by using the method from Shukla.[15] Directly after catheterisation, the infant developed a tachycardia of 300 beats/min and the diagnosis of SVT was confirmed by electrocardiogram (ECG). The ECG showed a regular narrow QRS complex tachycardia with retrograde p waves buried within the T waves indicating the presence of an atrioventricular reentry tachycardia (Figure 1).

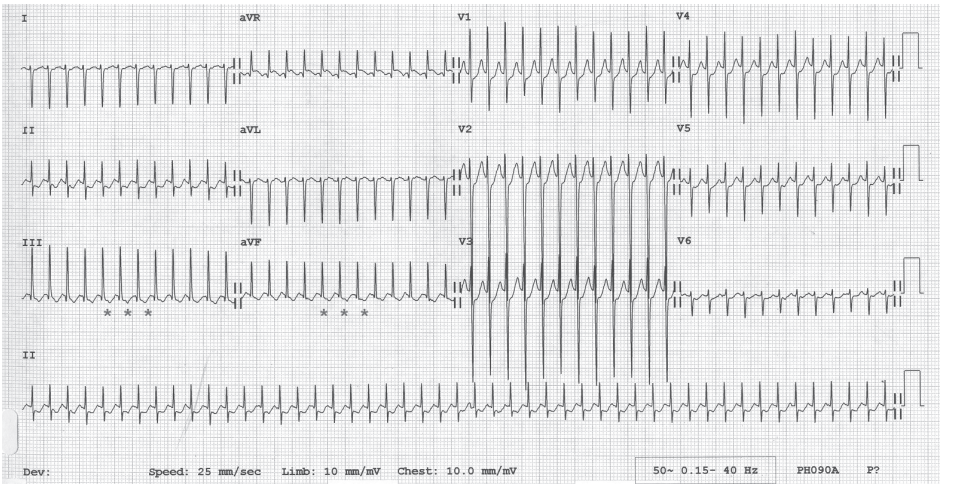

Figure 1. Supraventricular tachycardia of case no. 1. The ECG shows narrow QRS complex tachycardia of 300 beats/min with retrograde p waves (stars) within the T waves suggestive for atrioventricular re-entrant tachycardia.

The catheters were pulled back 1 cm, but the tachycardia persisted. Placement of an ice pack on the infant's face failed to decrease the infant's heart rate. Intravenous adenosine (0.1 mg/kg) was given without success. A second dose of adenosine (0.2 mg/kg intravenous) converted the heart rhythm to a normal sinus rhythm. A chest X-ray showed malposition of the venous catheter tip at the sixth thoracic vertebra. The catheter was subsequently pulled back 2 cm. After repositioning of the catheter, SVT reoccurred. Administration of a third dose of adenosine (0.2 mg/kg intravenous) converted the heart rate to a normal sinus rhythm. Further clinical course was uncomplicated, without other episodes of tachycardia. The catheters were removed 2 days later.

CASE NO. 2

A 1564 g male infant was born at 28 weeks of gestation at our centre and admitted to our neonatal nursery. Apgar scores were 8, 9 and 9 at 1, 5 and 10 minutes, respectively. On admission the infant had a sinus rhythm with a normal heart rate (146 beats/min)

and blood pressure (47/28 mm Hg). On physical examination slight groaning and subcostal retractions were found, with normal heart sounds and without heart murmur. Pulses were felt equally on all extremities and no hepatosplenomegaly was detected. Laboratory investigations, including serum electrolytes, showed no abnormalities.

Umbilical venous catheterisation was performed. Insertion length was determined by using the method from Dunn.[16] Directly after introduction of the catheter the infant developed a tachycardia (heart rate up to 240 beats/min). Placement of an ice pack on the infant's face resulted in a short bradycardia, but after a few seconds tachycardia reoccurred. Due to suspicion of malposition of the UVC, the catheter was pulled back 1 cm, but tachycardia persisted. A chest X-ray showed malposition of the catheter tip localized at the seventh thoracic vertebra. The catheter was pulled back 2 cm, but normalization of the heart rhythm did not occur. Intravenous adenosine was given four times (0.1, 0.1, 0.2 and 0.4 mg/kg, respectively) without success of converting to sinus rhythm. The ECG performed during adenosine administration revealed an atrial flutter (Figure 2).

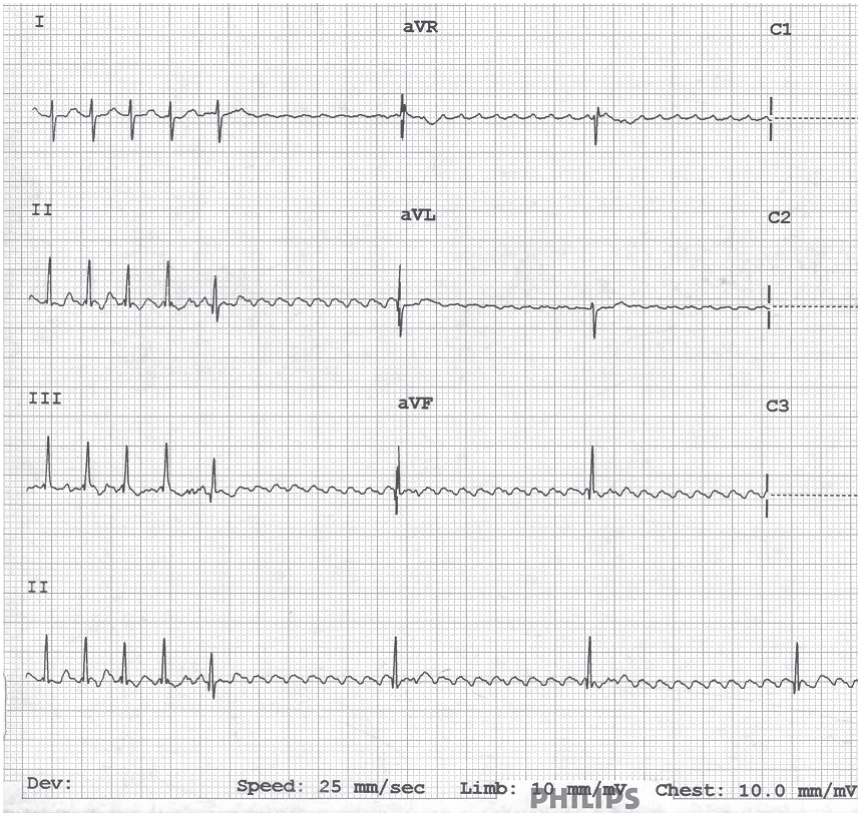

Figure 2. Atrial flutter of case no.2. Intravenous adenosine for a supraventricular tachycardia (see left) resulted in transient atrioventricular blockade unmasking an atrial flutter of 450 beats/min.

Echocardiography was performed and showed no anatomical abnormalities. The tip of the catheter was in the inferior venal cava (just below the junction with the right atrium). Subsequently synchronized cardioversion was performed with 2 J and converted the heart rhythm to a normal sinus rhythm. During tachycardia the infant remained hemodynamically stable. Further clinical course was unremarkable and episodes of tachycardia did not reoccur. The UVC was removed 1 week later.

DISCUSSION

Umbilical venous catheterisation is an often essential routine procedure in the neonatal period. UVCs provide an easy and secure access route for continuous intravenous administration of fluids and medication. However, several complications associated with the use of UVCs have been described, including cardiac arrhythmias. This study shows that the incidence of cardiac arrhythmias after umbilical venous catheterisation is low (0.4%). Nevertheless, cardiac arrhythmias may be life-threatening and require prompt medical treatment.

Several cases of cardiac arrhythmias (mostly atrial flutter) after UVC placement have been reported in the literature (Table 1).

Table 1. Literature review of cases with arrhythmia related to placement of an umbilical venous catheter (UVC).

Author (year)	Cases (n)	Position of UVC	Arrhythmia	Treatment
Egan et al (1971)	3	Right atrium (n=2), left atrium (n=1)	Atrial arrhythmia (n=1) Bigeminy rhythm (n=1) Prolonged sinus bradycardia (n=1)	Catheter withdrawal (n=3)
Dunnigan et al (1985)	3	Right atrium (n=3)	Atrial flutter (n=3)	Transoesophageal pacing (n=3)
Leroy et al (2002)	1	Left atrium	Atrial flutter	Transoesophageal pacing
Sinha et al (2005)	1	Fifth thoracic vertebra	Atrial flutter	Synchronised cardioversion
This study (2008)	2	Sixth thoracic vertebra (n=1) Seventh thoracic vertebra (n=1)	Supraventricular tachycardia (n=1) Atrial flutter (n=1)	Adenosine (n=1) Synchronised cardioversion (n=1)

In four cases, heart rhythm was converted to normal sinus rhythm by transoesophageal pacing,[12, 14] in another case successful treatment was achieved with synchronized cardioversion.[11] In three cases with a cardiac arrhythmia related to a catheter with the tip in the heart, the arrhythmia reverted to normal sinus rhythm after removing the catheter.[6]

The primary cause of cardiac arrhythmias after umbilical venous catheterisation is inappropriate position of the UVC within the heart.[6, 14] Intracardiac catheters may cause mechanically induced premature atrial beats that can be the initiating trigger for atrial flutter or even SVT in the presence of an accessory atrioventricular myocardial pathway as shown in the first case.

Radiographic investigations are therefore mandatory to ensure that the catheter is correctly positioned. The optimal position for catheters is at the junction of the inferior venal cava and the right atrium.[16] This will correspond to the catheter tip being visible between the ninth and tenth thoracic vertebra on a chest X-ray, although positioning at the level of the eighth thoracic vertebra may also be adequate in some patients.[17] Malposition has been defined as either a catheter tip above the eighth thoracic vertebra or a position below the tenth thoracic vertebra. Some authors suggested that position of the catheter tip should ideally be asserted with echocardiography instead of chest X-ray.[17, 18]

Two methods are commonly used to determine the correct insertion length of UVCs. The Dunn method is based on the measurement of the shoulder-umbilicus length.[16] This method is hampered by several important limitations, including interobserver variation.[19] The second method, from Shukla et al uses equations based on the birth weight of the neonate.[15] Importantly, both methods have been developed based on a small group of infants (range 10-50 infants) and have not been validated prospectively in larger groups of neonates. Whether the estimation of the insertion length based on these methods is accurate is not known. In both our reported cases, the catheter position was too deep.

The optimal management of neonates with cardiac arrhythmias secondary to umbilical venous catheterisation has not well been studied. As arrhythmias are usually due to malposition of the catheter, the first step should be to pull back or even remove the catheter. However, in both our cases pulling back was not successful and in the first case even induced another episode of tachycardia. As most of the newborns with SVT have atrioventricular re-entry tachycardia,[20] the next step should aim to stop the re-entry loop by inducing a vagal response, initially by placing an ice pack on the child's face.[10, 20] If tachycardia persists, administration of adenosine, an endogenous purine nucleoside, is relatively safe and effective. Adenosine impairs atrioventricular nodal conduction and thereby terminates re-entrant SVTs.[21] Adenosine has a very short half-life of less than 15 s because of rapid metabolization by adenosine deaminase.[22] It must be administered within seconds as an intravenous bolus and will terminate 85-93 % of SVTs caused by a re-entry mechanism.[21] Termination of the tachycardia will occur within 20 s of injection.[21, 22] Because of the short half-life of adenosine possible side-effects are transient and thus acceptable. Side-effects include transient disturbance of respiration, flushing, nausea, headache, short bradycardia and very short complete atrioventricular block.[22]

The starting dose of adenosine in infants is controversial. Some advocate a starting dose of 0.05 mg/kg,[21-23] but this is effective in less than 10 % of infants. Infants tend to need a higher dose to terminate the tachycardia than older children and this may be explained by the difference in weight to body surface area ratio.[24] One danger of a starting dose that is too low is that parents and physicians lose confidence in what is a very effective drug. More recent literature advocates a starting dose of 0.1 mg/kg or even higher.[20, 24] In our first patient three doses of adenosine (cumulative dose of 0.5 mg/kg) were necessary to treat the patient successfully. Cardiac arrhythmia in our second patient was not caused by a re-entry tachycardia but by an atrial flutter which explains the lack of effect of adenosine. Administration of adenosine does not terminate tachycardias of atrial origin, such as atrial flutter. However, by producing a transient atrioventricular block, adenosine administration may help detect atrial flutter.[10, 21, 22] Treatment of an atrial flutter requires synchronized cardioversion or transoesophageal atrial pacing.

In conclusion, this case reports show that cardiac arrhythmia can be the result of intracardiac position of a UVC. Given the potential severity of this complication, physicians involved in the care of neonates should be aware of this risk and be familiar with its diagnosis and management.

LEARNING POINTS

- Cardiac arrhythmia is a rare but potentially severe complication of umbilical venous catheterisation in neonates.
- The primary cause of cardiac arrhythmias after catheterisation is inappropriate position of the umbilical venous catheter within the heart.
- The first step to treat cardiac arrhythmias should be to pull back or even remove the catheter.
- As most of the newborns with SVT have atrioventricular re-entry tachycardia, the next step should aim to stop the re-entry loop by inducing a vagal response, initially by placing an ice pack on the child's face. If tachycardia persists, administration of adenosine, an endogenous purine nucleoside, is relatively safe and effective.

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