CASE REPORTS

RJME
Romanian Journal of Morphology & Embryology
http://www.rjme.ro/

Atretic aortic coarctation – transradial approach. Case series and review of the literature

ELIZA-ELENA CINTEZĂ[1,2)], CRISTINA FILIP[1)], ANDRADA BOGDAN[1)], ALIN MARCEL NICOLESCU[1)], HYAM MAHMOUD[1,3)]

[1)]*Department of Pediatric Cardiology, "Maria Skłodowska Curie" Emergency Children's Hospital, Bucharest, Romania*
[2)]*Department of Pediatrics, "Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania*
[3)]*University of Damascus, Damascus, Syria*

Abstract

Stenting of aortic coarctation became the method of choice. In severe aortic coarctation, when retrograde crossing of the coarctation is impossible, a secondary approach with antegrade arterial crossing proved to be the solution in many cases. Here we report two cases of severe aortic coarctation in males aged 12 and 14, respectively, in which we used a secondary transradial approach (right and left) followed by guidewire snaring. For the first case, a right radial–right femoral arterio-arterial circuit was created, which offered a stable position during stent implantation. In both cases, we predilated the lesion and then implanted a 45 mm Cheatham-platinum (CP) covered stent. The final result was very good in both patients; only the first one required post-dilatation of both ends of the stent. Asymptomatic post-procedural absence of left radial pulse was noticed in the second case. In conclusion, even in the case of children, secondary transradial approach is suitable for antegrade crossing of the coarctation in extremely severe cases and possibly in stabilization of the circuit for stent implantation.

Keywords: stenting, snaring, aortic coarctation, atresia, children.

Introduction

Stenting in aortic coarctation tends to become the best therapeutic approach since its description in 1991 [1]. The procedure has been proved to be effective in 96–98% of the cases [2]. Several techniques for crossing the coarctation or fixing the guidewire were developed. Usually, this is performed with retrograde access *via* the femoral artery or rarely with antegrade venous vascular access through a ventricular septal defect. Fixing the guidewire is crucial for deploying the stent. Dual access (radial/brachial and femoral) may be necessary for many reasons including angiographic imaging to better highlight the origin of the left subclavian artery and stent position; stabilization to create an artero-arterial circuit and improve guidewire stability; or procedural reasons for crossing antegradely the coarctation in extreme aortic coarctation cases [3–6]. Transradial approach as a secondary access in extreme aortic coarctation or atresia has been reported in adult population [5, 6], but not in pediatric population. There are only few reports on the feasibility of the radial artery access in children [7, 8], usually for coronary angiography evaluation.

Here we report two cases of near aortic atresia in two male patients aged 12 and 14, respectively, in which we could not cross the coarctation retrogradely and therefore, we had to access the radial artery for crossing it and snare the super stiff guidewire. We also had the benefit of a stable arterio-arterial circuit in the first case.

Case presentations

Case No. 1

A 12-year-old boy was referred to our Hospital with severe resistant arterial hypertension and lack of arterial pulsation at lower extremities, outlining suspicion of aortic coarctation. The clinical examination showed a good general state of health; also, he had a normal clinical examination except arterial hypertension stage II, blood pressure (BP) 165/112 mmHg and absent femoral arterial pulsation on both sides. The blood tests were normal. Electrocardiogram (ECG) showed left ventricular hypertrophy. At echocardiography, severe reduction of the aortic isthmus diameter with a weak flow at that level was noticed. Normal functioning of the bicuspid aortic valve, concentric left ventricle hypertrophy and important dilation of the ascending aorta (39 mm) were diagnosed. An angioCT (computed tomography) was performed and showed severe aortic coarctation, with a diameter of 2 mm (Figure 1A) and impressive collateral circulation. The 3D angioCT reconstruction is illustrated in Figure 1, A (Case No. 1) and B (Case No. 2).

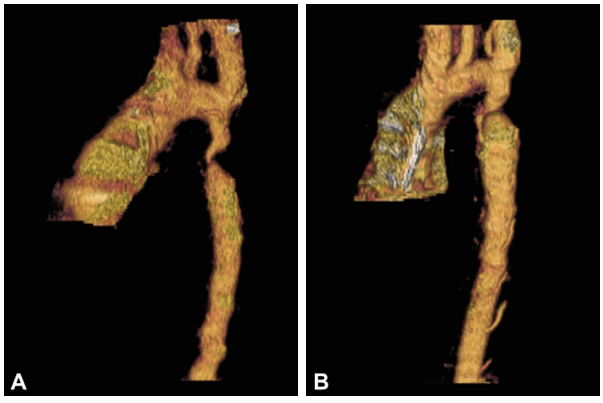

Figure 1 – ***3D angioCT reconstruction in atretic aortic coarctation in Case No. 1 (A) and Case No. 2 (B).***

We decided to stent the extreme aortic coarctation. We proceeded with a 7F right femoral artery and 5F right radial artery approach. We started from the femoral artery with a 4F MPA2 catheter using a hydrophilic 0.035" guidewire (Terumo) and tried to perform a left heart catheterization and aortographies. We exchanged the guidewire to a thinner hydrophilic type up to 0.014" (Pilot 50). We tried different catheters too, but all our attempts failed. Several times, we thought that we passed the coarctation level but in fact, the tip of the guidewire took the way of different collaterals.

We changed the strategy and went from the right radial artery towards the descending aorta to pass the coarctation. Firstly, we performed several guiding injections (AP – antero-posterior) in the aortic isthmus with the 4F pigtail catheter (Merit Medical) (Figure 2) and we succeeded to pass the coarctation from the ascending to the descending aorta using a 0.035" hydrophilic guidewire and a 4F MPA2 catheter (Merit Medical). We advanced the guidewire and the catheter into the abdominal descending aorta. We exchanged the hydrophilic guidewire with a 0.035" super stiff guidewire (Kimal) in the abdominal aorta. Then, we used an Amplatz GooseNeck Snare Kit (eV3) 120×2.5 mm to snare the super stiff guidewire. After several attempts, the super stiff guidewire was caught and exteriorized through the femoral sheath.

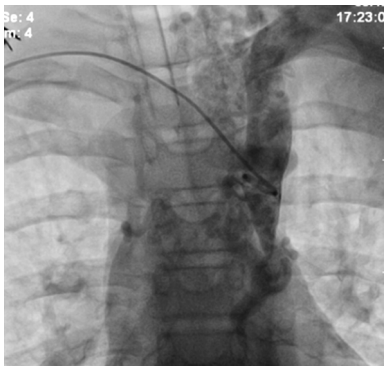

Figure 2 – ***Aortic isthmus injection with the pigtail catheter coming from a 5F radial artery access.***

Going to the MPA2 with a 7F multi-track catheter "mouth-to-mouth", we succeeded in crossing the coarctation retrogradely and performing aortographies (AP and LL – latero-lateral) using a multi-track catheter (Figure 3). The aorta had a diameter of 14.5 mm at the level of the isthmus and 15 mm at the level of the diaphragm. Then, we used a 14×40 mm Osypka balloon (VACS II) to test the aortic wall compliance and predilate the coarctation. We predilated up to 5 mm (Figure 4).

Afterwards, we went directly *via* femoral access using a 12F Mullins designed Performer sheath, 75 cm (Cook). On a 12×45 mm BIB balloon (NuMED), we manually mounted a covered 8 zig 45 mm long Cheatham-platinum (CP) stent, which was positioned and then revealed from the sheath at the coarctation level. Using the stability of the super stiff guidewire (from radial to femoral) with both ends exteriorized, we implanted the stent by inflation of the inner balloon at 5 atm and the outer balloon at 7 atm (Figure 5, A and B).

A post-dilatation of both ends of the stent was performed using a 14×3 mm Tyshak II balloon, with very good final results (the gradient between the ascending and descending aorta was 5 mmHg) (Figure 5, C and D).

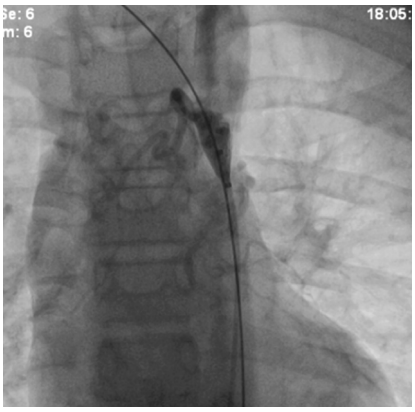

Figure 3 – ***Injections at the coarctation level using a multi-track catheter.***

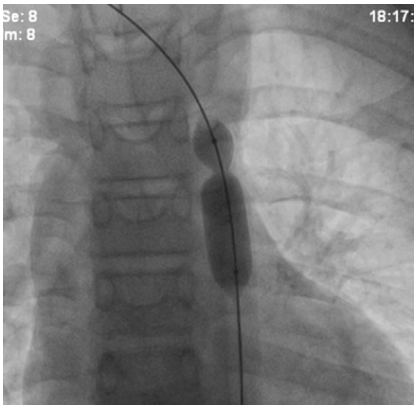

Figure 4 – ***Pre-dilation of the coarctation using a 14×40 mm Osypka balloon (VACS II).***

Case No. 2

Almost during the same period, a 14-year-old boy originating from the same county as the first case was referred to our Hospital with severe resistant arterial hypertension and lack of arterial pulsation at lower extremities, outlying suspicion of aortic coarctation. Similarly, all investigations pointed to a severe form of aortic coarctation with a diameter of 2.5 mm and impressive collateral circulation on angioCT (Figure 1B).

We decided to go for stenting the aortic coarctation. Similarly to the previous case, we proceeded with two arterial accesses: 7F right femoral artery and 5F left radial artery approach. Using a 4F MPA2 catheter on a hydrophilic 0.035" guidewire (Terumo), it was impossible to cross the coarctation retrogradely (Figure 6A).

We moved to the left radial artery and performed an injection in the precoarctation segment by the antegrade approach (Figure 6B), then we passed the coarctation antegradely firstly with a hydrophilic 0.035" guidewire (Terumo) (Figure 6C) and afterwards with a 4F MPA2. A small resistance was encountered when crossing it effectively.

After advancing the 4F MPA2 in the abdominal aorta, we exchanged the hydrophilic guidewire with a 0.025" straight tip standard guidewire (Kimal). Then, we tried to use an Amplatz GooseNeck snare kit (eV3), 120×2.5 mm to snare the super stiff guidewire, but the straight tip of the 0.025" standard guidewire went directly into the Amplatz GooseNeck snare catheter. This was exteriorized through the femoral sheath only by pushing it from the radial end.

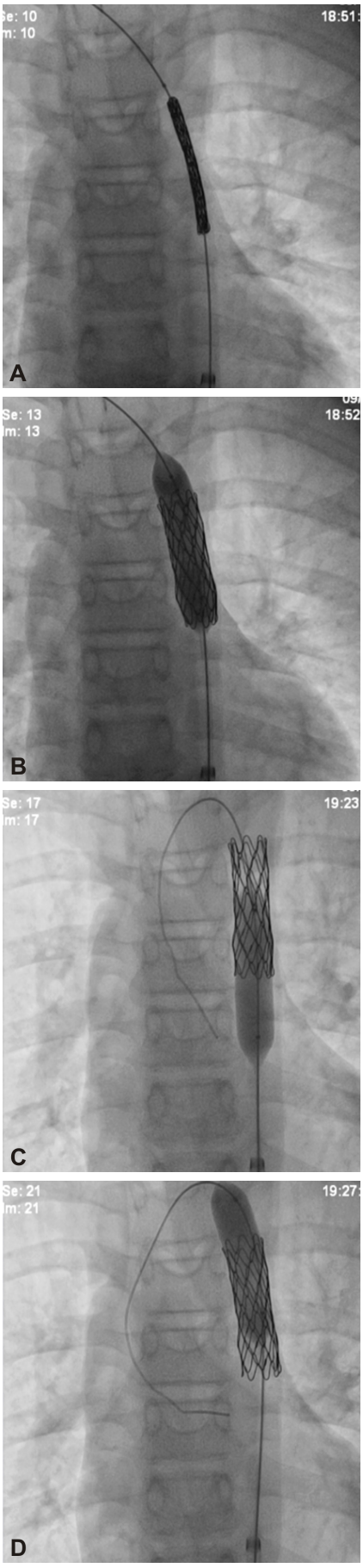

Figure 5 – ***(A) Stent positioning; (B) Stent deployment; (C and D) Post-dilation of the CP covered stent 12×45 mm (inferior and superior ends).***

We predilated the coarctation with a 9×30 mm Osypka balloon (Figure 7A) on the 0.025" standard guidewire with both ends exteriorized. Then, we performed an angiography to better delineate the coarctation (Figure 7B). The aortic diameters at the isthmic and diaphragmatic levels were 14.5 mm and 15 mm, respectively. Afterwards, we went through the femoral access on a 0.035" super stiff guidewire stabilized into the left ventricle with a 12F Mullins designed Performer sheath, 75 cm (Cook) with a 45 mm covered CP stent (NuMED), manually mounted on a 12×45 mm BIB balloon (NuMED); it was positioned and then revealed from the sheath at the coarctation level (Figure 7C). The stent was implanted with the recommended pressures of 5 atm (inner balloon) and 7 atm (outer balloon) (Figure 7D). A very good final result with no need for post-dilatation was obtained (Figure 7E). As a complication, we report the absence of radial pulse after the procedure, but without any signs of ischemia.

Discussion

Stenting results in coarctation of the aorta are reported to be very good, but there is no prediction for getting a positive result [2]. Procedural complications can occur for technical reasons (10.4% – stent migration, balloon rupture, stroke or peripheral embolic events) or by damaging the vessel wall (1–4% – dissection, rupture of the aorta) [2]. Implantation of covered stents is recommended to reduce long-term risks and is addressed to patients with severe forms of the disease, like coarctation mimicking isthmus atresia, adults, patients with Turner syndrome, or vasculopathies [2].

In severe forms, which mimic isthmic atresia, the retrograde crossing may be impossible. In similar cases reported in the literature, antegrade crossing was chosen using either brachial arterial access or radial vascular access [5, 6]. Brachial access was reported in the pediatric population with good results in coarctation of the aorta [5]. Ramamurthy *et al.* reported a case of coarctation of aorta mimicking aortic arch interruption and its successful dilation by an innovative approach, describing the arterio-arterial antegrade approach in a child, but using the brachial artery and then snaring the guidewire [5]. In the same situation, in adults, radial access is used either for imaging, crossing the coarctation or stability in the deployment of the stent in coarctation [3, 4, 6].

Pediatric arterial radial access is not frequently reported. Radial access in the pediatric population is rarely used for angiographic purposes because of its possible complications (permanent or temporary artery occlusion, local hematoma, and local infection). In the second of our reported cases, we encountered such a complication – absence of radial pulse after the procedure, but without any signs of ischemia. Despite that, radial arterial access is routinely used in neonatal and intensive care units, even for radial artery catheter placement. In their study on 1473 newborns and small children with radial or brachial access, Schindler *et al.* reported only five cases of temporary artery occlusion. They also demonstrated that the placement of the radial artery catheter was directly related to increasing body weight [9].

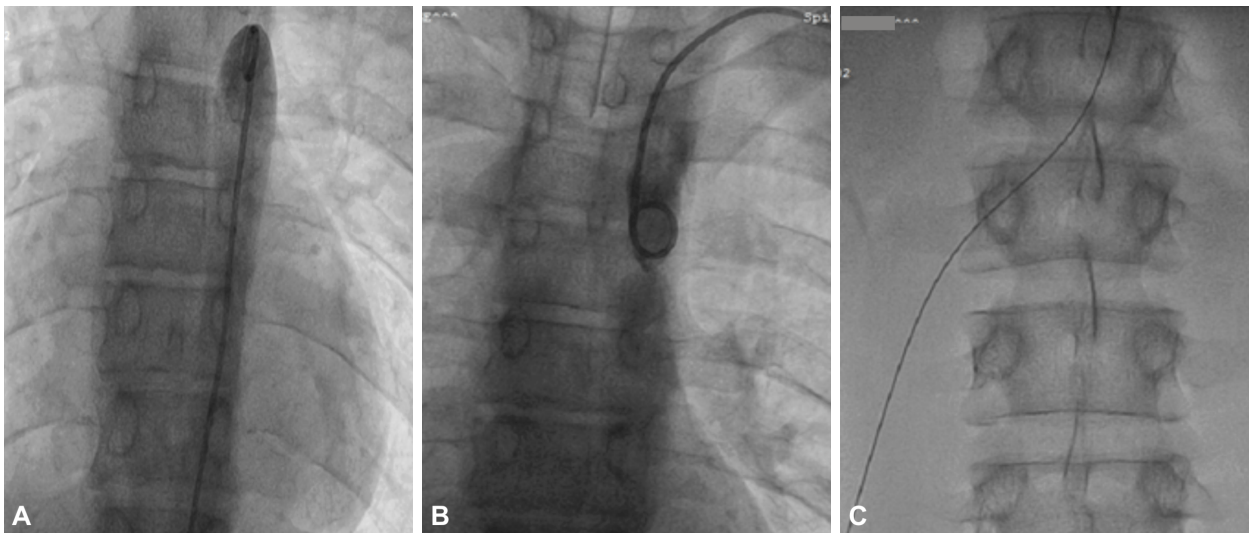

Figure 6 – ***(A) Descending aorta in retrograde injection. Dilation of the first descending postcoarctation artery but apparently without any communication with the precoarctation segment; (B) Precoarctation segment of the descending aorta with a tinny communication between, less than 1 mm; (C) Guidewire passing from the left radial artery to the right femoral artery (arterio-arterial circuit).***

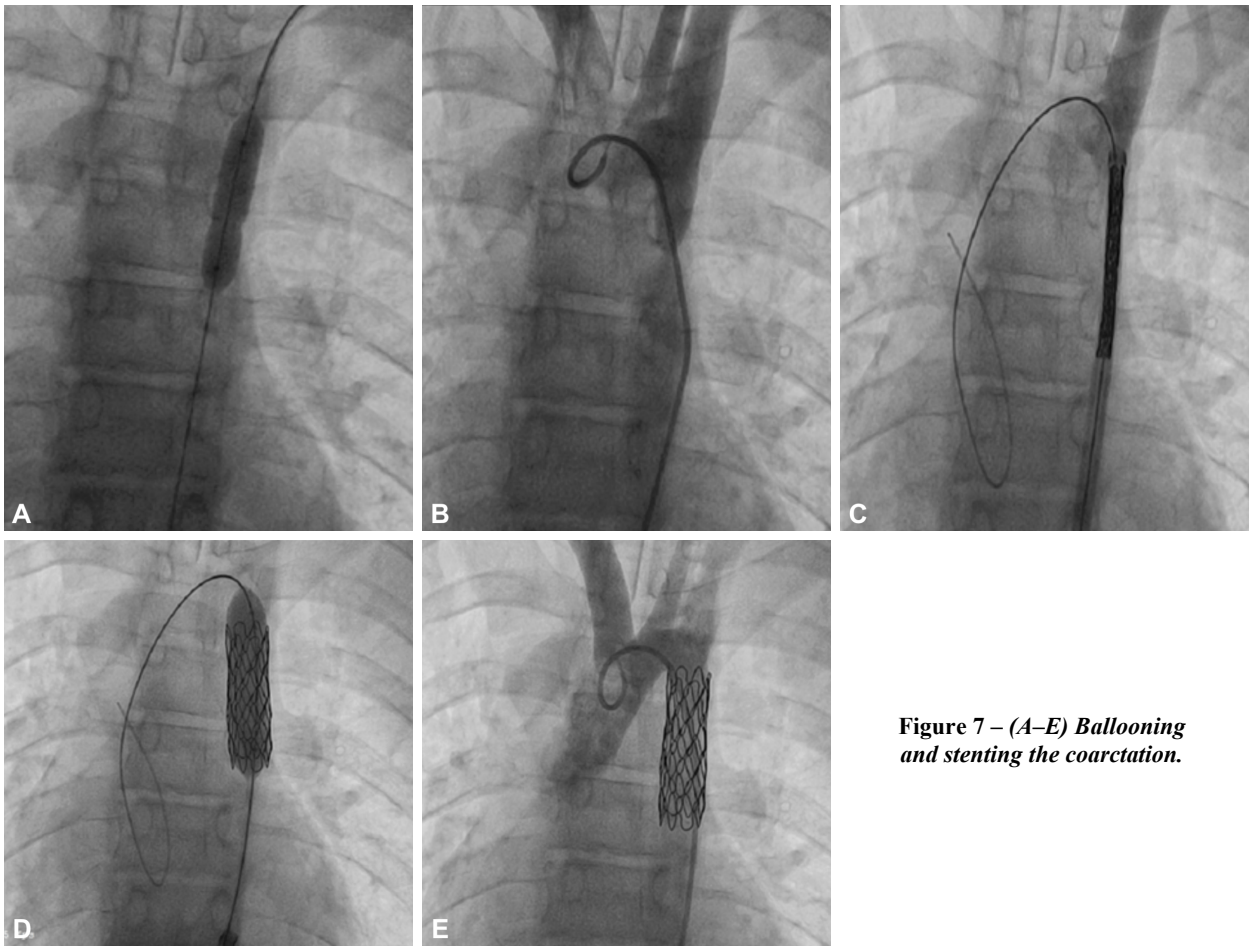

Figure 7 – ***(A–E) Ballooning and stenting the coarctation.***

Regarding the radial artery access for angiographic purpose, Irving *et al.* reported that 13 transradial approaches with 5F radial introducers were performed in 12 children with mean age of 12.1–18.8 years and body weight 39–81 kg, with a success rate of 85% and no complications [7]. Vascular complications (spasm, obstruction, perforation, hematoma) depend on the relationship between the vascular introducer and the vessel diameter. The vessel diameter correlates with gender, body weight, height, body mass index, wrist circumference, shoe size, pulse pressure and occupation [10].

Evaluation of the radial artery diameter can be achieved through 2D vascular ultrasound/Doppler [10] and could determine potential pediatric candidates for secondary radial approach for cases of coarctation of the aorta in which antegrade passage of severe coarctation is expected.

Conclusions

Transradial approach is feasible as a secondary access in severe aortic coarctation even in children. This may help the angiographic diagnosis and stent positioning in cases in which the retrograde passage is possible. In antegrade crossing of the aortic coarctation, the transradial approach ensures a stable circuit for stent implantation. In cases when very challenging situations are anticipated, procedure planning (angioCT evaluation, vascular ultrasound exploration of radial and brachial arteries) is crucial.

Conflict of interests

The authors declare that they have no conflict of interests.

Acknowledgments

This work was performed in "Maria Skłodowska Curie" Emergency Children's Hospital, Bucharest, Romania.

References

[1] Qureshi SA. Stenting in aortic coarctation and transverse arch/isthmus hypoplasia in percutaneous interventions for congenital heart disease. In: Sievert H, Qureshi SA, Wilson N, Hijazi ZM (eds). Percutaneous interventions for congenital heart disease. Informa Healthcare Books, London, 2007, 475–486.
[2] Forbes T, Turner DR. Complications encountered in intravascular stent treatment for native and recurrent coarctation of the aorta in complications during percutaneous interventions for congenital and structural heart disease. In: Hijazi ZM, Feldman T, Cheatham JP, Sievert H (eds). Complications of percutaneous interventions for congenital and structural heart disease. Informa Healthcare Books, New York, 2009, 125–130.
[3] Dehghani P, Collins N, Benson L, Horlick E. Role of routine radial artery access during aortic coarctation interventions. Catheter Cardiovasc Interv, 2007, 70(4):622–623.
[4] Butera G, Heles M, Carminati M. Percutaneous treatment of aortic isthmus atresia: use of radiofrequency perforation and covered stents. Catheter Cardiovasc Interv, 2011, 78(6):933–939.
[5] Ramamurthy S, Juneja R, Yadave RD, Manchanda SC, Rajani M. Coarctation of aorta mimicking aortic arch interruption and its successful dilatation by an innovative approach. J Invasive Cardiol, 1998, 10(7):405–408.
[6] Hamid T, Jamallulail SI, Clarke B, Mahadevan VS. Dual arterial access for stenting of aortic coarctation in patients with near-total descending aortic interruption. Cardiol Ther, 2015, 4(2):203–207.
[7] Irving C, Zaman A, Kirk R. Transradial coronary angiography in children and adolescents. Pediatr Cardiol, 2009, 30(8): 1089–1093.
[8] Davenport JJ, Lam L, Whalen-Glass R, Nykanen DG, Burke RP, Hannan R, Zahn EM. The successful use of alternative routes of vascular access for performing pediatric interventional cardiac catheterization. Catheter Cardiovasc Interv, 2008, 72(3):392–398.
[9] Schindler E, Kowald B, Suess H, Niehaus-Borquez B, Tausch B, Brecher A. Catheterization of the radial or brachial artery in neonates and infants. Paediatr Anaesth, 2005, 15(8):677–682.
[10] Aykan AÇ, Hatem E, Kalaycıoğlu E, Altıntaş Aykan D, Gökdeniz T, Arslan AO, Çelik Ş. Prediction of radial artery diameter in candidates for transradial coronary angiography: is occupation a factor? Turk Kardiyol Dern Ars, 2015, 43(5): 450–456.

Corresponding author

Eliza-Elena Cinteză, Lecturer, MD, PhD, Department of Pediatric Cardiology, "Maria Skłodowska Curie" Emergency Children's Hospital, 20 Constantin Brâncoveanu Avenue, 041451 Bucharest, Romania; Phone +40723–314 232, e-mail: elizacinteza@yahoo.com

Received: October 12, 2016

Accepted: November 9, 2017