ORIGINAL PAPER

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

Anatomical description of the deep venous channel from the anterior vestibular wall of the right atrium

F. M. FILIPOIU[1)], MIHAELA BĂLGRĂDEAN[2)], I. BREZEAN[3)], V. JINGA[3)]

[1)]*Department of Morphological Sciences*
[2)]*Department of Pediatrics*
[3)]*Department of General Surgery*
"Carol Davila" University of Medicine and Pharmacy, Bucharest

Abstract

The deep venous channels in the walls of the right atrium are not routinely described in medical treatises although their existence has been remarked from some time. Our study demonstrates that the right atrium is opened for some of the anterior veins of the heart through a venous channel located deep in the myocardium of the vestibule of the right atrium. We suggest that no Thebesian veins drain into this channel. We achieved anatomical dissection in 14 adult human cadaveric hearts, which had been fixed in formalin solution, and we found the channel in 75% of cases. These channels were measured, photographed and presented in detail. We highlighted the importance of the proximity with the tricuspid annulus in order to avoid incidents during tricuspid annuloplasty. The authors intend that through a qualitative study to draw attention to such a structure often ignored. This vascular structure and its role in cardiac physiology and pathology have not been investigated yet. Although not constant, specialists in cardiology and cardiac surgery should be informed about this basic detail on the endocardium morphology.

Keywords: deep venous channel, right subauricular vestibule, anterior veins of the heart, cardiac veins, Thebesian veins, endocardium.

Introduction

The anterior veins of the heart drain mainly the anterior wall and the right margin of the right atrium and also the right part of the subpulmonary infundibulum and of the sternocostal wall of the right ventricle. The distribution and ending mode for these veins are highly variable [1–3]. In spite of this, numerous classifications have been offered, including standardization and venous typology [4–7].

Anterior cardiac veins may drain directly into the right atrium (by foramina), into a small cardiac vein or a venous channel in the right atrial wall [4, 8].

Some authors have shown that venous tunnels of the right atrium (1–12 cm in length, 1–4 mm in diameter) drain into the right atrium or superior vena cava [4, 9]. Consisting of sinusoids, channels, and lacunae of variable sizes, the lesser cardiac venous system (venae cordis minimae or Thebesian vessels) is a subendocardial and intramyocardial communicating network that conducts blood from the epicardial coronary vessels into the cardiac chambers. Four distinct parts are described: venoluminal, arterioluminal, venosinusoidal, and arteriosinusoidal [4, 10, 11]. The orifices of the Thebesian vessels, named also foramina, are found in the right atrium and are usually less than 0.5 mm in diameter [4, 12, 13]. The term of compound cardiac venous system has been used recently to describe myocardial structures in which venous drainage is performed equally by anterior veins and Thebesian veins [4, 10, 14, 15]. Historically the venous channel was given different names, by the various authorities describing it: a large subendocardic vein [16], collecting channel [17], intramural sinus in the right atrium [9], intramural venous tunnel [10], right atrial coronary sinus [4, 13].

Materials and Methods

We performed anatomical dissection in 14 adult human cadaveric hearts, which have been fixed in formalin solution (Table 1).

Table 1 – ***Distribution of bodies according to sex***

Age of corpses [years]	62	64	68	69	70	72
No. of bodies and the sex of each	1 M	2 M 1 F	3 M 2 F	2 M	1 F	3 F

M – Male, F – Female.

We have chosen of the corpses in the anatomy lab on the criterion of the absence of any particular cardiac disease. This is only a descriptive study, not a statically significant one as the number of dissected hearts is not large enough. We performed the dissection identifying and following the anterior veins of the heart in the right coronary sulcus, until these veins penetrate the cardiac wall. We highlighted the deep venous channel in the subauricular vestibule of the right atrium. The internal wall of this channel was resected in order to visualize the anterior veins ostia. We have carefully examined the channel walls (with the magnifying glass) to identify all the foramina. The channels dimensions were measured using an electronic digital caliper. The pictures were taken using a digital camera.

Results

We have identified the deep venous channel in 11 of the 14 (75%) dissected hearts. In the situations described by us, two to five veins from the anterior group course perpendicularly or obliquely through the wall of the subauricular vestibule of the right atrium (Figure 1A) and open through very well defined foramina into a deep venous channel, located in the vestibule of the subauricular region (Figures 1B, 2 and 3). The diameters of these foramina are between 1–3 mm (Figure 3, B and C). Besides the foramina of the anterior veins, we have not identified in the channels another type of orifices. This deep venous channel has not well-structured walls, so it may be considered a conduit in the atrial wall. It was generally ranging between 2–3.2 cm in length and between 0.4–2.2 cm in diameters (Table 2).

Table 2 – ***The diameter and length of each identified venous channel***

Serial No.	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
Length [cm]	2	2.4	2.8	2.8	2.9	2.9	2.9	3	3	3.1	3.2
Diameter [cm]	0.4	0.4	0.5	0.5	0.6	0.5	0.5	1	1.5	2	2.2

In one case, the maximum diameter was 2.2 cm and a length of 3.2 cm. In this heart, venous channel reaches the vicinity of tricuspid annulus (Figure 2, C and D). The conduit begins at the level of the anterior wall of the right atrium and ends toward the septum. Its diameter increases from right to left, as the channel receives more affluents. It terminates through an aperture located in the left portion of the subauricular vestibule. On the left, the aperture is delimited and sometimes even hidden by an endocardial ridge or a muscular trabecula, which might be called "sentinel" (Figure 1, B and C; Figure 2B). This is a characteristic of the Thebesian veins also, but foramina of Thebesian ducts do not have a diameter larger than 0.5 mm. On the right the aperture is delimited by a semilunar endocardial fold (Figure 2, A and C). Sometimes this fold has false chordae that anchor it to the venous channel wall (Figures 1 and 3D). The venous channel has two walls. The outer wall is thicker and it is perforated by the anterior veins of the heart. The inner wall is thinner, depressible and probably mobile during the atrial contractions. Sometimes this wall is fenestrated (Figure 3A).

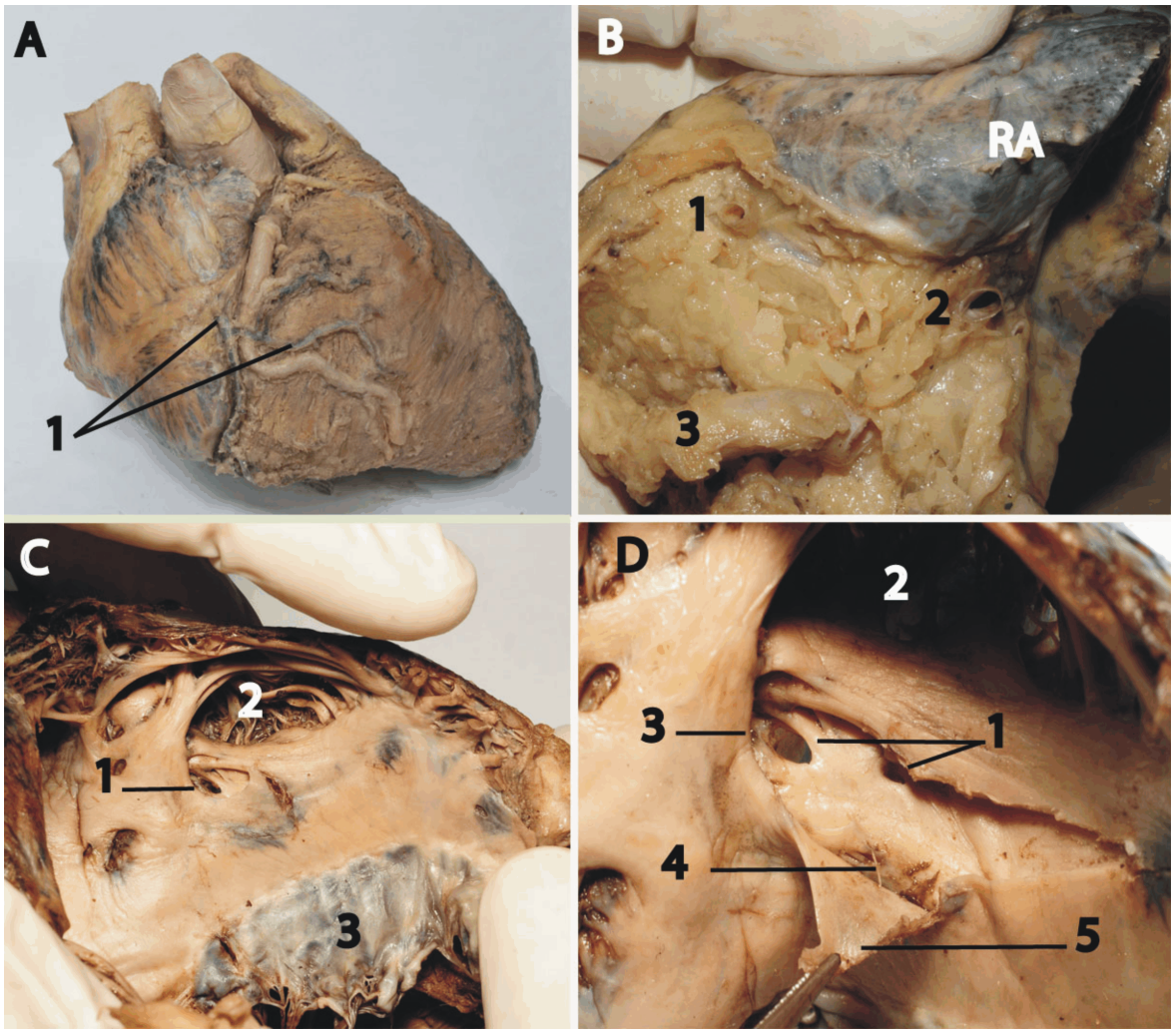

Figure 1 – ***(A) The right atrium and the right ventricle seen from right: 1 – Anterior group of veins, which open into right atrium. (B) After removing right coronary artery we observe the anterior veins that open into right atrium: 1, 2 – Anterior veins were cut in order to explore the way it ends. (C) The anterior vestibular wall of the right atrium seen from posterior: 1 – Trabecula, which might be called "sentinel"; 2 – Right auricle; 3 – Anterior cusp of tricuspid valve. (D)Detail of the previous figure. The internal wall of the channel is cut. The semilunar fold is reversed: 1 – Orifices of an anterior group of veins which open into the deep venous channel. Through the great one we see the wall of an anterior vein; 2 – Right auricle; 3 – "Sentinel" trabecula; 4 – False chordae.***

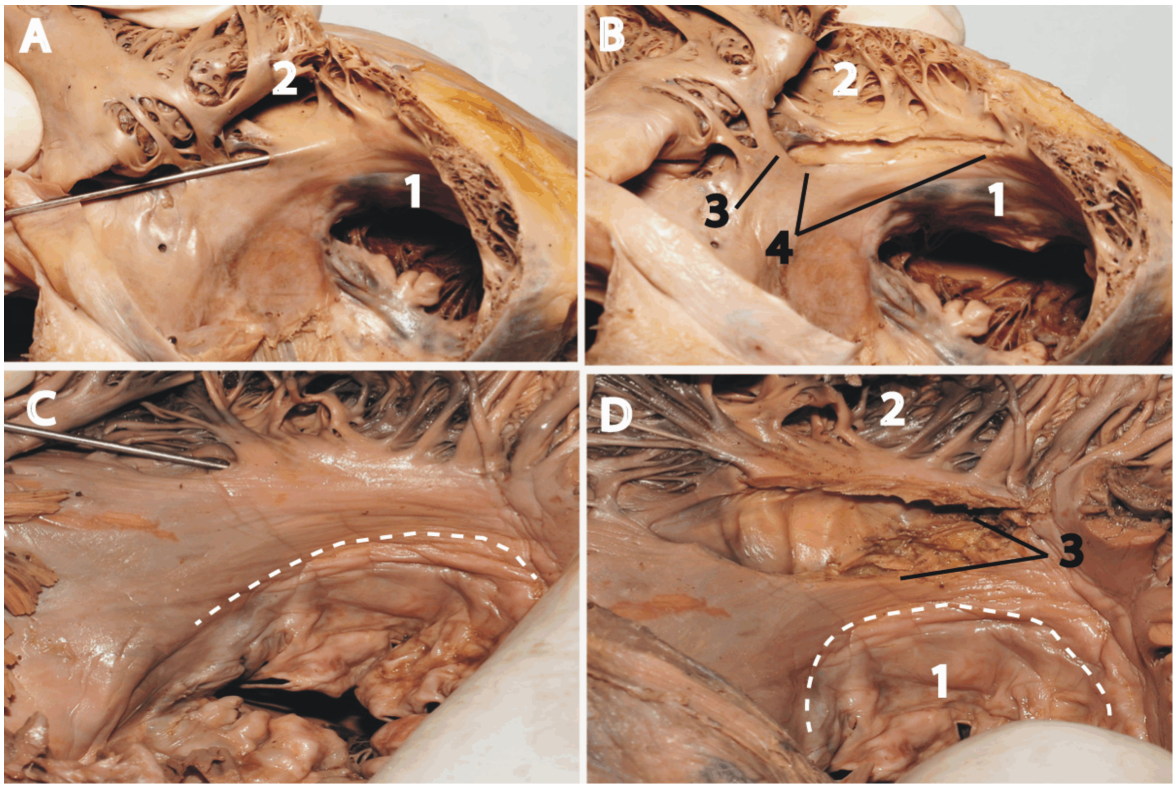

Figure 2 – *(A) The anterior vestibular wall of the right atrium seen from posterior: 1 – Anterior cusp of tricuspid valve; 2 – Right auricle; the probe evidences the semilunar fold. (B) The same heart as shown in previous: 1 – Anterior cusp of tricuspid valve; 2 – Right auricle; 3 – "Sentinel" trabecula; 4 – Deep venous channel with the internal wall cut. (C) The anterior vestibular wall of the right atrium seen from posterior. The probe evidences the semilunar fold. The dotted line indicates the tricuspid annulus. (D) The same heart as shown in previous. We see the channel with the largest diameter: 1 – Anterior cusp of tricuspid valve; 2 – Right auricle; 3 – After the external wall of the channel cut we observe the adipose tissue in the coronary sulcus. The dotted line indicates the tricuspid annulus.*

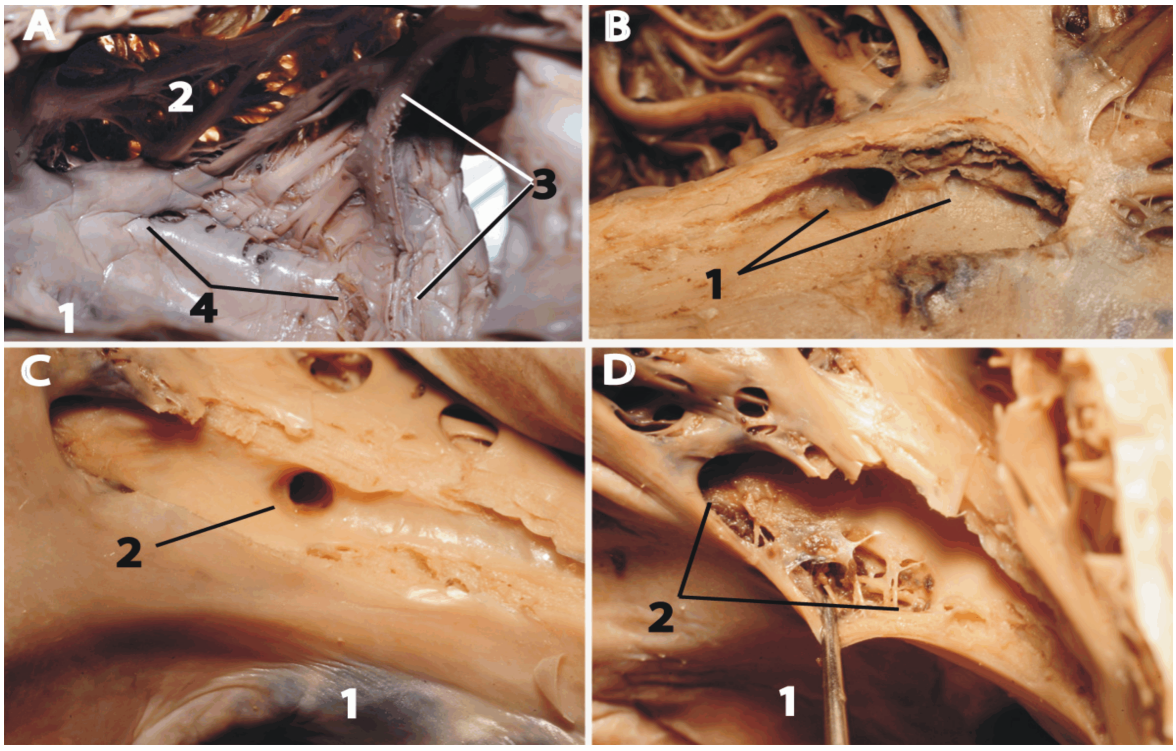

Figure 3 – *(A) The anterior vestibular wall of the right atrium seen from posterior: 1 – Anterior cusp of tricuspid valve; 2 – Right auricle; 3 – Terminal crest of the right atrium; 4 – Aspect of the deep venous channel with a fenestrated internal wall. (B) Highlighting the venous orifices at the right end of the venous channel: 1 – Orifices of anterior veins. (C) Detail of the Figure 2B depicting the appearance of the endocardium inside the venous channel: 1 – Anterior cusp of tricuspid valve; 2 – Foramen of an anterior vein. (D) The internal wall of the channel is cut to highlight the false chordae: 1 – Anterior cusp of tricuspid valve; 2 – False chordae in connection with the anterior wall of the channel.*

Discussion

The deep venous channel from the anterior vestibular wall of the right atrium is not constant, but present in a large number of cases. This channel is an endocardial channel emptying into the right atrial cavity.

Termination of the anterior cardiac veins in the right atrium is variable. They may drain directly into the right atrium, into a small cardiac vein, or in some cases into a venous tunnel [4, 11].

In our study all the venous orifices identified and explored inside venous channels, belong to the anterior veins of the heart. This observation is different from observations of other authors who consider that in these channels open also the Thebesian ducts [18, 19]. The orifices of the Thebesian ducts are found in the cardiac chambers (mostly the right atrium and right ventricle) and are usually less than 0.5 mm in diameter [4, 20, 21]. The diameters of the foramina found by us in venous channels are much larger (between 1–3 mm). Only in congenital heart diseases, the orifices of the Thebesian ducts can be much larger [22]. Some authors consider that where it exists, the venous channel is parallel to and 1–2 cm cephalad to the tricuspid orifice along the posterior or posterolateral wall of the right atrium [4, 18]. In all cases, we have found the venous channel corresponds to the sternocostal wall of the right atrium. The distance between venous channel and tricuspid annulus becomes important in tricuspid annuloplasty. We have found that distance ranging between 0.4–0.6 cm. We showed that in some hearts the venous channel can reach the vicinity of the tricuspid annulus (with figure). During surgery for tricuspid valve annuloplasty one of the sutures is placed in the region of the anteroseptal commissure and threaded along the tricuspid annulus where the anterior leaflet is attached [23–25]. The surgeon might intercept the deep venous channel with consequences unknown and uninvestigated yet. The thrombosis or infectious processes of the right atrium can extend affecting the deep venous channel. This might impair the circulation of blood in the anterior veins of the heart with consequences on the functionality of the right atrio-ventricular junction. Although it seems a speculative claim such a situation is possible and should be taken into consideration. In high-quality CT angiograms, these venous channels may be partially visible [4, 26–28]. However, there is not still a generally accepted way of exploring the channel.

Conclusions

The deep venous channel represents a variable and less known structure. It is a randomly formed channel within the very substance of the right atrial wall. When it exists and it is well developed the deep venous channel represent a common way for the anterior veins to empty in the vestibular wall of the right atrium. The existence of the channel in the vicinity of the tricuspid annulus must be known by the surgeons who make tricuspid annuloplasty, to prevent the channel interception. The deep venous channel might be affected by thrombosis or by infectious processes of the right atrium, with unknown impact on the physiology of the right atrioventricular junction and on the general performance of the heart. Such potential implication of the deep venous channel in the cardiac pathology, justifies the need to inform clinicians about its existence. The effort to establish a way of exploring this channel seems to be necessary.

References

[1] Baroldi G, Scomazzoni G, *Coronary circulation in the normal and pathologic heart*, Office of the Surgeon General, Washington, DC, 1967, 31–70.

[2] Loukas M, Bilinsky S, Bilinsky E, el-Sedfy A, Anderson RH, *Cardiac veins: a review of the literature*, Clin Anat, 2009, 22(1):129–145.

[3] Cendrowska-Pinkosz M, *The variability of the small cardiac vein in the adult human heart*, Folia Morphol (Warsz), 2004, 63(2):159–162.

[4] Saremi F, Muresian H, Sánchez-Quintana D, *Coronary veins: comprehensive CT-anatomic classification and review of variants and clinical implications*, Radiographics, 2012, 32(1): E1–E32.

[5] Meisel E, Pfeiffer D, Engelmann L, Tebbenjohanns J, Schubert B, Hahn S, Fleck E, Butter C, *Investigation of coronary venous anatomy by retrograde venography in patients with malignant ventricular tachycardia*, Circulation, 2001, 104(4):442–447.

[6] Gensini GG, Di Giorgi S, Coskun O, Palacio A, Kelly AE, *Anatomy of the coronary circulation in living man: coronary venography*, Circulation, 1965, 31:778–784.

[7] Bates RJ, Toscano M, Balderman SC, Anagnostopoulos CE, *The cardiac veins and retrograde coronary venous perfusion*, Ann Thorac Surg, 1977, 23:83–90.

[8] von Lüdinghausen M, Ohmachi N, Besch S, Mettenleiter A, *Atrial veins of the human heart*, Clin Anat, 1995, 8(3):169–189.

[9] von Lüdinghausen M, *Clinical anatomy of cardiac veins, Vv. cardiacae*, Surg Radiol Anat, 1987, 9(2):159–168.

[10] von Lüdinghausen M, *The venous drainage of the human myocardium*, Adv Anat Embryol Cell Biol, 2003, 168:I–VIII, 1–104.

[11] Ho SY, Sánchez-Quintana D, Becker AE, *A review of the coronary venous system: a road less traveled*, Heart Rhythm, 2004, 1(1):107–112.

[12] Ratajczyk-Pakalska E, *Variation of the smallest cardiac veins*, Folia Morphol (Warsz), 1978, 37(4):415–418.

[13] Ansari A, *Anatomy and clinical significance of ventricular Thebesian veins*, Clin Anat, 2001, 14(2):102–110.

[14] Younger JF, Plein S, Crean A, Ball SG, Greenwood JP, *Visualization of coronary venous anatomy by cardiovascular magnetic resonance*, J Cardiovasc Magn Reson, 2009, 11:26.

[15] Jongbloed MR, Lamb HJ, Bax JJ, Schuijf JD, de Roos A, van der Wall EE, Schalij MJ, *Noninvasive visualization of the cardiac venous system using multislice computed tomography*, J Am Coll Cardiol, 2005, 45(5):749–753.

[16] Parsonnet V, *The anatomy of the veins of the human heart with special reference to normal anastomotic channels*, J Med Soc N J, 1953, 50(10):446–452.

[17] Huu N, Doutriaux M, Leroy JP, Thuan RH, *Small veins of the heart auricle*, Bull Assoc Anat (Nancy), 1975, 59(167):955–967.

[18] Ortale JR, Marquez CQ, *Anatomy of the intramural venous sinuses of the right atrium and their tributaries*, Surg Radiol Anat, 1998, 20(1):23–29.

[19] Pina JA, *Morphological study on the human anterior cardiac veins, venae cordis anteriores*, Acta Anat (Basel), 1975, 92(1):145–159.

[20] Mierzwa J, Kozielec T, *Variation of the anterior cardiac veins and their orifices in the right atrium in man*, Folia Morphol (Warsz), 1975, 34(2):125–133.

[21] Blendea D, Shah RV, Auricchio A, Nandigam V, Orencole M, Heist EK, Reddy VY, McPherson CA, Ruskin JN, Singh JP, *Variability of coronary venous anatomy in patients undergoing cardiac resynchronization therapy: a high-speed rotational venography study*, Heart Rhythm, 2007, 4(9):1155–1162.

[22] Bottega NA, Kapa S, Edwards WD, Connolly HM, Munger TM, Warnes CA, Asirvatham SJ, *The cardiac veins in congenitally corrected transposition of the great arteries: delivery options for cardiac devices*, Heart Rhythm, 2009, 6(10):1450–1456.

[23] Sarraj A, Duarte J, *Adjustable segmental tricuspid annuloplasty: a new modified technique*, Ann Thorac Surg, 2007, 83(2):698–699.
[24] Revuelta JM, Garcia-Rinaldi R, *Segmental tricuspid annuloplasty: a new technique*, J Thorac Cardiovasc Surg, 1989, 97(5):799–801.
[25] Deloche A, Guérinon J, Fabiani JN, Morillo F, Caramanian M, Carpentier A, Maurice P, Dubost C, *Anatomical study of rheumatic tricuspid valvulopathies. Applications to the critical study of various methods of annuloplasty*, Arch Mal Coeur Vaiss, 1974, 67(5):497–505.
[26] Knackstedt C, Mühlenbruch G, Mischke K, Schimpf T, Spüntrup E, Günther RW, Sanli B, Kelm M, Schauerte P, Mahnken AH, *Imaging of the coronary venous system in patients with congestive heart failure: comparison of 16 slice MSCT and retrograde coronary sinus venography: comparative imaging of coronary venous system*, Int J Cardiovasc Imaging, 2008, 24(8):783–791.
[27] Van de Veire NR, Schuijf JD, De Sutter J, Devos D, Bleeker GB, de Roos A, van der Wall EE, Schalij MJ, Bax JJ, *Non-invasive visualization of the cardiac venous system in coronary artery disease patients using 64-slice computed tomography*, J Am Coll Cardiol, 2006, 48(9):1832–1838.
[28] Mühlenbruch G, Koos R, Wildberger JE, Günther R, Mahnken AH, *Imaging of the cardiac venous system: comparison of MDCT and conventional angiography*, AJR Am J Roentgenol, 2005, 185(5):1252–1257.

Corresponding author
Mihaela Bălgrădean, Department of Pediatrics, "Carol Davila" University of Medicine and Pharmacy, 8 Eroii Sanitari Avenue, Sector 5, 050474 Bucharest, Romania; Phone +40722–280 110, e-mail: mbalgradean@gmail.com

Received: March 16, 2013

Accepted: August 14, 2013