

# Value of computed tomography angiography in the evaluation of coarctation of the aorta in children — a single centre experience

Zastosowanie angiografii tomografii komputerowej  
u dzieci z koarktacją aorty — doświadczenia własne

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## Abstract

**Introduction.** Coarctation of the aorta (CoA) is a congenital narrowing of the aorta at the aortic isthmus. Computed tomography angiography (CTA) plays a major role in the imaging of aortic pathologies in children. As a non-invasive method, CTA combined with echocardiography is increasingly used for precise evaluation of cardiovascular pathologies. The aim of the study was to evaluate the use of CTA in children with ambiguous echocardiographic diagnosis of CoA or in patients before planned surgical repair of an aortic arch defect, and to evaluate the agreement between measurements of the aortic dimensions by CTA and echocardiography.

**Material and methods.** We retrospectively evaluated CTA studies performed in 37 children with suspected CoA and compared aortic diameter measurements by CTA and echocardiography. In all patients, the effective dose was estimated using CTA protocol data.

**Results.** Based on CTA findings, CoA was diagnosed in 26 children, including 5 children with simple CoA, while 21 children had complex CoA with other coexisting anomalies. A number of additional pathologies were identified when evaluating other chest structures. Statistical analysis showed the agreement of aortic diameter measurements by the two imaging methods. The mean effective dose was 7.5 mSv.

**Conclusions.** CTA allows precise imaging of aortic pathology in children and is an important diagnostic tool. Echocardiography remains the primary tool for imaging of CoA but has some limitations, particularly in older patients. Indications for CTA should be carefully considered due to the associated radiation exposure.

Key words: computed tomography angiography (CTA), coarctation of the aorta (CoA), children, cardiac surgery

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## Introduction

Coarctation of the aorta (CoA) is a congenital narrowing of the aorta, usually at the aortic isthmus distal to the origin of the left subclavian artery, that comprises about 5–7% of all congenital cardiovascular anomalies [1, 2].

Preductal CoA (also known as the neonatal/infantile form but this term is currently rarely used) may be characterized by hypoplasia of a large portion of the aortic arch, distal to the origin of the brachiocephalic trunk and extending to the insertion of the ductus arteriosus. Postductal CoA (the adult form) is characterized by a localized ring-like aortic narrowing below or at the level of the ligamentum arteriosum [3, 4]. Another type is ductal CoA at the insertion of the ductus arteriosus.

Coarctation of the aorta may be simple or complex. Simple CoA is an isolated cardiovascular anomaly. Complex CoA is associated with other concomitant cardiovascular anomalies, e.g. bicuspid aortic valve, ventricular septal defect (VSD), atrial septal defect (ASD), and mitral valve defects. Arterial hypertension is seen in most patients with CoA. Some patients, particularly neonates and infants, develop severe heart failure. Mean life expectancy in untreated CoA is 32 years, and factors contributing to premature mortality include heart failure, endocarditis, aortic aneurysms and intracranial haemorrhage. Symptoms of untreated CoA usually develop in the second to third decade of life and are associated with hypertension in the arterial beds proximal to the aortic narrowing. For these reasons, early detection and appropriate treatment of CoA are major prognostic factors in patients with this defect [1].

In neonates and infants, CoA often presents with overt heart failure which is life-threatening and requires urgent surgical intervention due to rapidly developing multiorgan failure. Major clinical manifestations include dyspnoea, tachypnoea, tachycardia, arterial hypertension, and oliguria or anuria. A characteristic clinical sign of CoA is absent pulse on the lower limbs. Sometimes, a large right-to-left shunt through the ductus arteriosus results in normal pulse in the femoral artery. In older children,

CoA mostly manifests with hypertension, headaches, dizziness, and sometimes with nasal bleeding and calf pain during running.

The diagnosis of CoA is based on physical examination findings, including evaluation of pulse and blood pressure on both arms in comparison to lower limbs. Laboratory test findings may include abnormal results of arterial and capillary blood gases in the lower part of the body, indicating much lower oxygenation compared to the upper part. Pulse oximetry may be a useful method. However, contemporary paediatric cardiology evaluation is not limited to clinical findings, and imaging studies are necessary for a definitive diagnosis of CoA.

The imaging method of choice in children is echocardiography which is easily available, reproducible, non-invasive and allows real-time, high resolution image acquisition [5]. It may be used to evaluate the degree and nature of coarctation, determine its type, and measure dimensions of the aortic arch and the diameter of its branches in their initial segments. In addition, coexisting anomalies may be identified, and flow may be evaluated using Doppler measurements. However, echocardiography has a number of limitations including subjective nature of the assessment depending on operator experience, narrow acoustic windows, poor ability to image extracardiac vascular structures, e.g. rings and collateral vessels, and difficulties with imaging of the distal aorta [1, 2, 5–8].

Invasive angiography has been considered a gold standard in the diagnosis of CoA [8]. This is, however, an invasive method that involves radiation exposure and contrast agent administration [7] and thus has a potential for serious complications. Procedural mortality is up to 1%. Invasive angiography is mostly used for haemodynamic evaluation of CoA and percutaneous interventional procedures [8, 9].

Computed tomography angiography (CTA) is a non-invasive method that provides high-resolution images that may be digitally processed to obtain three-dimensional colour and greyscale reconstructions [8, 10]. Advantages of CTA include detailed visualization of the aortic lumen

and wall, with simultaneous imaging of the adjacent chest structures [2]. This allows evaluation of both intracardiac and extracardiac anatomic structures, coronary vessels, and overall chest anatomy [1]. ECG gating during CTA reduces motion and pulsation artifacts during examination of extracardiac vascular pathologies [7, 8, 11]. As this method involves radiation exposure, its long-term consequences should be considered when establishing indications for CTA.

Indications for interventional treatment of CoA include systolic blood pressure gradient between the upper and lower part of the body > 20 mm Hg, or < 20 mm Hg when accompanied by arterial hypertension, left ventricular hypertrophy or heart failure which cannot be explained otherwise, and coarctation confirmed by imaging studies. Current option in the treatment of CoA include surgical intervention, with resection of the stenosed aortic segment followed by an end-to-end anastomosis as the preferred approach, and intravascular interventional treatment using balloon angioplasty and possibly stent implantation. The latter is the treatment of choice in case of recoarctation, native CoA in an adolescent patient, and in some cases of a well-localized CoA.

The aim of the study was to evaluate the use of CTA in children with suspected or ambiguous echocardiographic diagnosis of CoA before planned cardiac surgical procedure, and to evaluate the agreement between measurements of the aortic narrowing by CTA and echocardiography.

## Material and methods

We retrospectively evaluated CTA examinations in 37 children referred to our computed tomography (CT) laboratory due to a diagnosis or initial suspicion of CoA based on the echocardiographic findings of abnormal aortic arch morphology and abnormal blood flow in the abdominal aorta. The examinations were performed in the Department of Paediatric Radiology, Poznań University of Medical Sciences, at the Karol Jonscher Clinical Hospital in Poznań from June 2009 till October 2012.

The study group included 19 boys aged 2 days to 16 years (median age 7 years 6 months) and 18 girls aged 2 weeks to 16 years (median age 7 years and 11 months). Neonates comprised 19%, and infants (from 1 month to 1 years of age) comprised 11% of the study group.

Patients were referred for CTA when echocardiography showed abnormal aortic arch morphology and abnormal blood flow in the abdominal aorta but the anatomy of the defect could not be clearly established by echocardiography. Diagnostic problems during echocardiographic examination arose mostly in older patients in whom an inadequate acoustic window limited the ability to evaluate the aortic arch precisely. In addition, CTA with three-dimensional volume rendering technique (VRT) image reconstructions was performed after consultation with a cardiac surgeon to plan surgical approach in diagnostically unclear cases (e.g., with suspected aortic arch hypoplasia).

Echocardiography was performed using a Vivid 7 system (GE Healthcare, USA) according to established protocols in our laboratory. For the purpose of the present study, the diameter of the ascending aorta above the sinotubular junction (Ao-asc) and the aortic isthmus (Ao-isth) were retrieved from the echocardiographic study reports.

Computed tomography angiography was performed using a 128-slice Somatom Definition AS system (Siemens Healthcare, Germany). Iomeprolum 350 contrast agent (Bracco Altana Pharma GmbH) volume and the rate of administration were adjusted to the patient body weight in the ranges of 1.5–2.0 mL/kg body mass and 1.0–3.0 mL/sec, respectively. Short-term sedation according to an established anaesthesiology protocol was used in 18 patients below 7 years of age.

Computed tomography angiography was used to evaluate aortic arch branches and other adjacent anatomical structures of the chest. In patients scheduled for cardiac surgery, three-dimensional VRT image reconstructions were performed. Measurements of the aortic diameter, performed by two radiologists, were made at the level of the ascending aorta above the sinotubular junction and at the aortic isthmus. In patients scheduled for cardiac surgery, percentage aortic lumen narrowing was calculated based on the performed measurements.

The agreement between measurement by echocardiography and CTA was evaluated using the Bland-Altman method and the R statistical software [12, 13].

In all patients, effective dose was estimated based on the study protocol data. Dose length product (DLP) or the cumulative dose considering imaging volume and the scan length was multiplied by an appropriate conversion factor (Table 1).

**Table 1.** Conversion factor from dose length product (DLP) to effective dose in [mSv/(mGy•cm)]

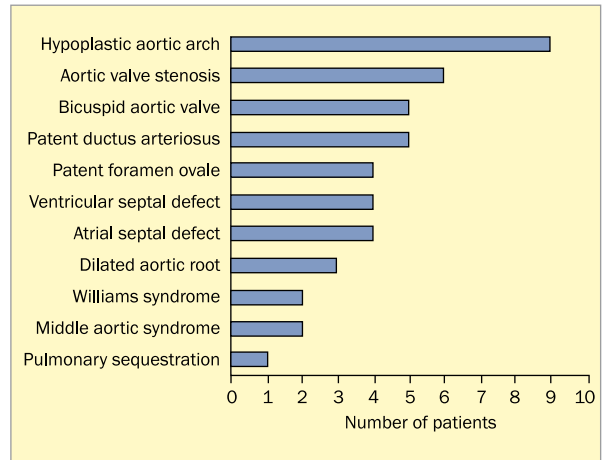
Body area	Age in years				
	0	1	5	10	Adult
Chest	0.039	0.026	0.018	0.013	0.014

**Results**

Echocardiography was performed in all 37 patients before referral for CTA. CoA was diagnosed in 23 patients and suspected in 14 patients.

The final diagnosis of CoA was made based on CTA in 26 children. Further analyses were limited to the results of imaging studies in these children. In 11 children, CTA excluded the presence of CoA or some other type of aortic narrowing.

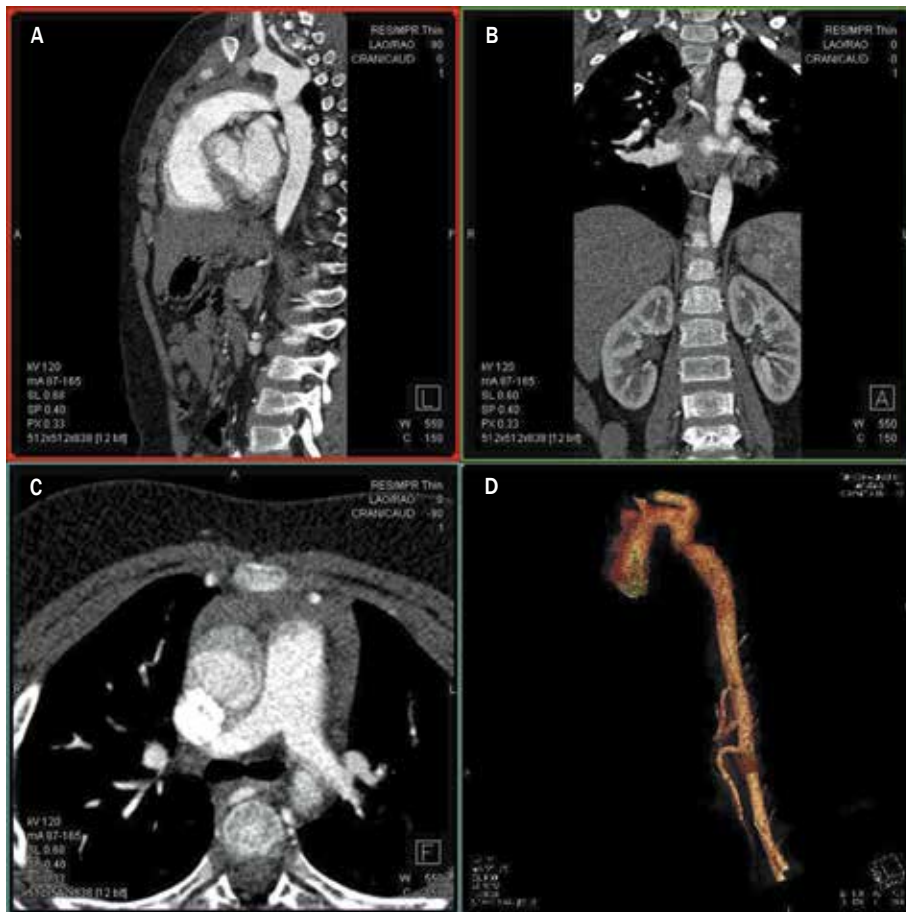
Simple CoA was found in 5 patients, including recoarctation (reCoA) in 2 patients, and complex CoA was diagnosed in 21 patients. Identified coexisting anomalies (Fig. 1) included hypoplastic aortic arch (HAA) in 9 children, ASD in 4 children, bicuspid aortic valve in 5 children, aortic valve stenosis in 6 children, VSD in 4 children, patent ductus arteriosus in 5 children, patent foramen ovale in 4 children, and dilated aortic root in 3 children (Z-score from +3.2 to +5.03). Among 10 children referred for CTA with suspected restenosis at the site of surgical repair of CoA, reCoA was confirmed in 4 patients and excluded in 6 patients. Figure 2



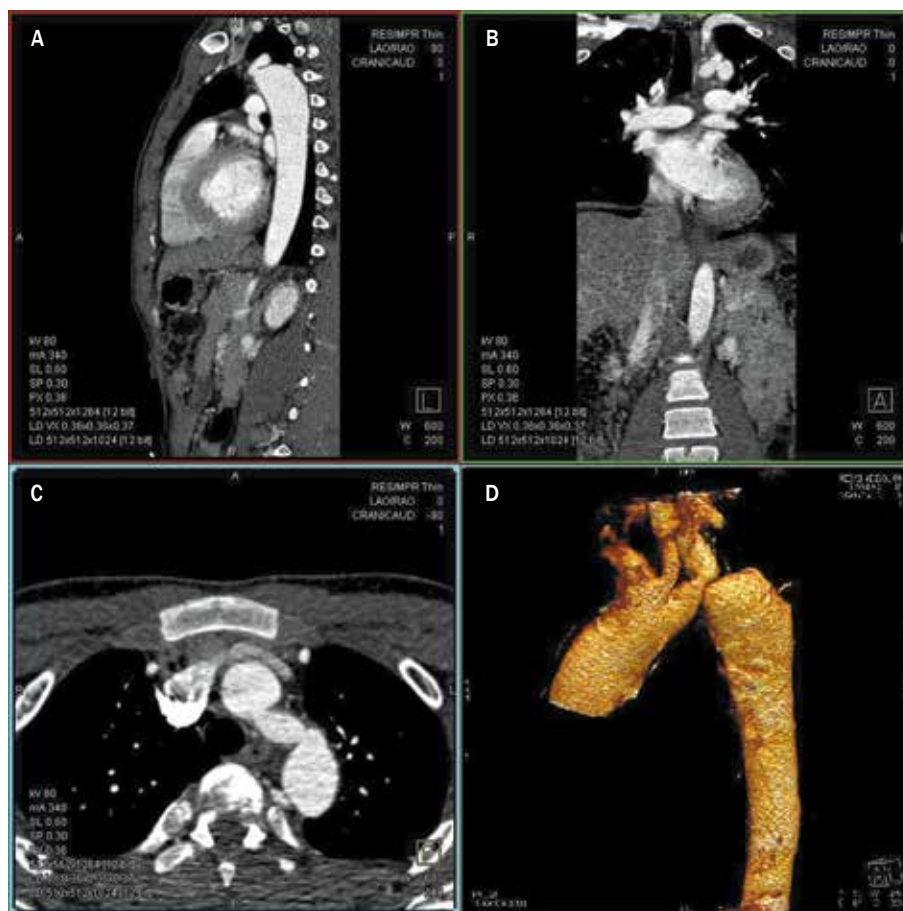
**Figure 1.** Identified coexisting anomalies

shows a case of an annular stenosis at the aortic isthmus with normal aortic arch branches.

In addition, CTA identified an abnormal aortic branch pattern in 14 patients, including arteria lusoria in 4 cases,



**Figure 2A–D.** Aorta with normal branch pattern and an annular stenosis at the isthmus. Proximal part of the left subclavian artery runs parallel to the aortic arch. VRT and MPR image reconstructions



**Figure 3A–D.** The aortic arch with an abnormal branch pattern (the brachiocephalic trunk and the left common carotid artery having a common origin, and the second aortic arch branch is the left subclavian artery) and an annular isthmus stenosis (just distal to the origin of the left subclavian artery). Note dilated ascending aorta and the poststenotic segment of the descending aorta. VRT and MPR image reconstructions

and the bovine-type arch in 8 patients (i.e the presence of only two major arterial branches of the aortic arch, with the left common carotid artery either having a common origin with the innominate artery or, more rarely, originating directly from the innominate artery rather than as a common trunk. Although a misnomer, the bovine-type arch is the most common anomaly of aortic arch branches, found in about 20% of cases [14]. Figure 3 shows a case of an annular isthmus stenosis with an abnormal pattern of aortic arch branches.

Pulmonary sequestration in addition to CoA was found in one patient, and Williams syndrome was diagnosed in 2 children. An additional coarctation of the abdominal aorta was found in 2 patients.

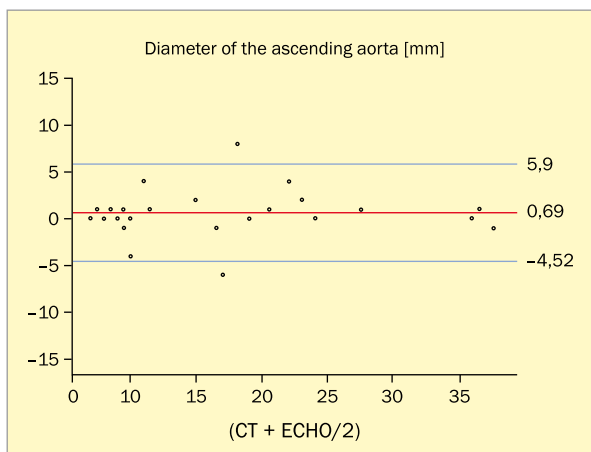
Based on echocardiographic and CTA findings, we analyzed the ratio of the aortic diameter at the isthmus relative to the ascending aorta, and calculated the percentage aortic lumen stenosis. Table 2 summarizes echocardiographic and CTA findings in individual patients. The agreement

between Ao-asc and Ao-isth measurements is shown in Figures 4 and 5. The mean Ao-asc difference between CTA and echocardiographic measurements was 0.69 mm (95% confidence interval: -4.52 to +5.9 mm), showing slight systematic underestimation of this parameter by echocardiography. The mean Ao-isth difference was 0.85 mm (95% confidence interval: -2.3 to +4.04 mm), again with slight underestimation by echocardiography. Both measurement approaches yielded relatively large confidence intervals due to a small patient sample. The agreement between Ao-asc measurements by echocardiography and CTA was relatively constant throughout the range of the measured values, while echocardiography was less concordant with CTA for Ao-isth values above 7 mm, seen in older patients with poorer acoustic windows.

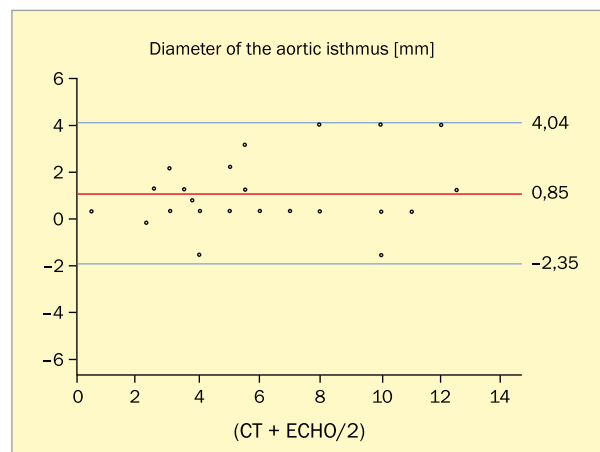
The mean DLP was 175.2 mGy/cm, with a minimum value of 37 mGy/cm and a maximum value of 805 mGy/cm. The mean effective dose was 7.5 mSv, with a minimum value of 1.5 mSv and a maximum value of 23 mSv (Fig. 6).

**Table 2.** Summary of aortic measurements by echocardiography and computed tomography angiography (CTA)

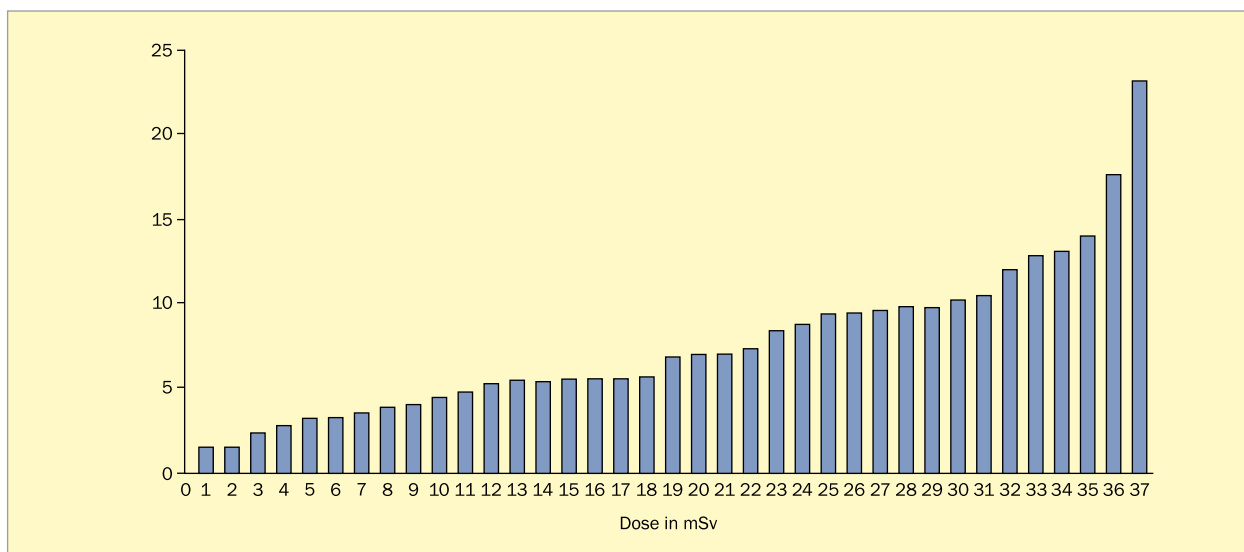
Patient No.	Aortic dimensions by echocardiography [mm]			Aortic dimensions by CTA [mm]		
	Ascending aorta	Isthmus	% stenosis	Ascending aorta	Isthmus	% stenosis
1	8	0,4	95	9	0,4	96
2	9	4	56	13	6	54
3	7	2,5	64	7	2	71
4	24	8	67	24	12	50
5	17	3	82	16	4	75
6	27	12	56	28	13	54
7	38	10	74	37	14	62
8	9	5	44	9	3	67
9	36	5	86	36	5	86
10	12	4	67	8	4	50
11	14	7	50	16	7	56
12	7	3	57	8	3	62
13	10	3,5	65	10	4	60
14	20	8	60	14	8	43
15	36	4	89	37	7	81
16	20	6	70	24	10	58
17	20	11	45	21	9	57
18	10	5	50	9	5	44
19	9	2	78	10	3	70
20	22	2	91	24	4	83
21	8	2	75	8	3	63
22	19	10	47	19	10	47
23	24	11	54	24	11	54
24	9	2	78	13	4	69
25	11	5	55	12	6	50
26	14	6	57	22	6	73



**Figure 4.** A Bland-Altman graph for the diameter of the ascending aorta



**Figure 5.** A Bland-Altman graph for the diameter of the aortic isthmus.



**Figure 6.** Graphical representation of the effective dose in mSv. X-axis, patient number; Y-axis, mSv value

## Discussion

Our study results indicate that CTA is an important additional diagnostic tool in the evaluation of aortic anomalies in children. CTA allows definite verification of the echocardiographic diagnosis in cases that are unclear due to limitations of transthoracic echocardiography or complex anomalies of great vessels. In addition, CTA images complex spatial relationships of extracardiac structures and identifies their pathologies. These advantages are of major importance when planning surgical or interventional procedures and further management [1, 7]. Surgical repair of a typical CoA is performed via left thoracotomy without the use of cardiopulmonary bypass. In contrast, aortic arch hypoplasia that involves the segment between the brachiocephalic trunk and the left common carotid artery requires cardiopulmonary bypass with deep hypothermia and cardiac arrest. Evaluation of the transverse part of the aortic arch is thus a major factor when choosing the surgical approach, selecting appropriate techniques and equipment, and predicting possible postoperative complications.

Current CT devices are equipped with sophisticated computational systems that do not only display axial view images but also allow three-dimensional reconstructions of individual organs by digital image processing. Most commonly used image reconstruction techniques for the evaluation of the aorta and great vessels include multiplanar reformations (MPR), producing two-dimensional images in any plane and at any angle which allow cross-sectional evaluation of the vessels, myocardium, and cardiac valves; and volume rendering technique (VRT) that allows spatial reconstructions of the vessel course or overall anatomy of

a given area, producing popular, realistic three-dimensional images. In CTA, VRT image reconstruction has become a new standard for displaying the aorta, pulmonary arteries, and abdominal vessels. The use of segmentation, or appropriate image edition to remove selected structures, to eliminate overlapping tissues allows displaying the vessel lumen and its pathologies [15]. Three-dimensional VRT image reconstruction allows more user-friendly (as compared to axial view images) presentation of the location and dimensions of a narrowing, the length of the narrowed vessel segment, and the overall anatomy of the aorta and great vessels. In addition, three-dimensional image reconstructions are a good approach to visualise collateral vessels, location of which may be important when planning a surgical procedure [1]. Preoperative three-dimensional reconstruction of a complex anomaly of great vessels provides the cardiac surgeon with an excellent approach that allows detailed planning of the surgical treatment.

Our study showed the agreement between the two imaging methods when measuring Ao-asc and Ao-isth, with slight measurement underestimation by echocardiography. We also showed that echocardiographic Ao-isth measurements may be less concordant with CTA measurements in older patients. CTA is thus justified in the latter patient group as it may provide reliable data to guide appropriate therapeutic decisions.

Despite these advantages of CTA, negative effects of ionizing radiation should also be taken into account. This remains a major problem in paediatric radiology [1], as radiation exposure is associated with an increased risk of leukaemias and brain tumours later in life [16, 17]. Thus, we provided information regarding the effective radiation dose associated with CTA studies. The effective dose is a sum

of all equivalent doses, i.e. doses absorbed by a specific tissue or organ when different biological effects of various radiation types are accounted for. The effective dose indicates the degree of overall body exposure to radiation when only its specific regions are irradiated. Effective doses in our patients were consistent with data reported in the literature [8, 11]. According to recent studies, radiation associated with ECG-gated CTA has been reduced over the years with systematic modifications of study protocols [18]. Radiologists are obliged by law to monitor radiation doses, particularly in paediatric patients, but we believe that clinicians should also be aware of this problem. Reliable data indicate that 20–50% of CT studies may be replaced by other imaging studies including magnetic resonance imaging (MRI) and echocardiography. Benefits associated with CT imaging should outweigh the risk of adverse effects of radiation exposure. Exposure optimization involves using as low as reasonably achievable (ALARA) radiation doses, tailoring the study protocol to individual clinical circumstances, and limiting the area under study [17]. The choice of CTA as a diagnostic tool may not be related only to its wider availability, shorter examination time, and lower costs compared to MRI. Indications for CTA should be carefully considered due to the associated radiation exposure. In our opinion, CTA should be performed in special cases which cannot be reliably evaluated using echocardiography and requiring additional diagnostic pro-

cedures, and in atypical cases requiring complex surgical or interventional procedures.

## Conclusions

CTA accurately images aortic arch pathology and adjacent chest structures in children and allows, using three-dimensional image reconstruction techniques, accurate planning of both surgical and interventional treatment approaches in patients.

Our findings indicate an agreement between both imaging methods when used for aortic measurements, with slight underestimation by echocardiography. The latter imaging technique remains the standard and usually sufficient diagnostic tool for the diagnosis of CoA. However, aortic isthmus diameter measurements by echocardiography may be less concordant with CTA measurements in older patients due to poorer acoustic windows. Due to the risk of radiation exposure, CTA should be reserved mostly for older children and those with a suspicion of CoA with ambiguous echocardiographic findings. In this group, CTA is particularly justified as it may provide reliable data to guide appropriate therapeutic decisions.

## Conflict of interest

The authors report no conflict of interests.

## Streszczenie

**Wstęp.** Koarktacja aorty (CoA) jest wadą wrodzoną polegającą na zwężeniu aorty w miejscu cieśni. Angiografia tomografii komputerowej (angio-CT) odgrywa znaczącą rolę w obrazowaniu patologii aorty u dzieci. Jako metoda nieinwazyjna angio-CT w połączeniu z echokardiografią serca jest coraz powszechniej stosowana do precyzyjnej oceny patologii serca i dużych naczyń.

Celem pracy jest ocena zastosowania angio-CT u dzieci z niejednoznacznym rozpoznaniem echokardiograficznym CoA lub u pacjentów przed korekcją wad łuku aorty oraz porównanie zgodności pomiarów średnic aorty uzyskanych w badaniu CT i echokardiograficznym.

**Materiał i metody.** Materiał obejmuje ocenę retrospektywną badań angio-CT wykonanych u 37 dzieci z podejrzeniem CoA, porównanie wyników pomiaru aorty uzyskanych w angio-CT i badaniu echokardiograficznym. U wszystkich pacjentów na podstawie danych z protokołu badania CT oszacowano pochłoniętą dawkę skuteczną.

**Wyniki.** U 26 dzieci rozpoznano CoA w badaniu angio-CT, u 5 dzieci rozpoznano prostą CoA, u 21 dzieci zaś rozpoznano złożoną CoA z występowaniem wad dodatkowych. W ocenie narządów klatki piersiowej rozpoznano wiele dodatkowych patologii. Analiza statystyczna wykazała zgodność obu metod obrazowania użytych do pomiarów aorty. Średnia dawka skuteczna wyniosła 7,5 mSv.

**Wnioski.** Angio-CT jest metodą dokładnie obrazującą patologię aorty u dzieci i ważnym narzędziem diagnostycznym. Badanie echokardiograficzne to nadal podstawowe narzędzie do diagnostyki obrazowej CoA, jednakże – zwłaszcza w przypadku starszych pacjentów – ma ono swoje ograniczenia. Narażenie na promieniowanie jonizujące w badaniu angio-CT skłania do szczególnego rozważenia wskazań do badania.

Słowa kluczowe: angiografia tomografii komputerowej (angio-CT), koarktacja aorty (CoA), dzieci, operacja kardiologiczna  
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## Komentarz



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Tematem pracy jest ocena przydatności angio-CT w diagnostyce koarktacji aorty u dzieci. W pracy w bardzo czytelny sposób przedstawiono możliwość wykorzystania jednej z dodatkowych metod diagnostycznych w grupie pacjentów o niejasnej lub – co bardziej cenne – złożonej morfologii wad serca i wielkich naczyń. Pragnę podkreślić, że zarówno temat pracy, jak i sposób przedstawienia wyników oraz podsumowująco opracowane wnioski są niezwykle wartościowe ze względu na oczekiwania współczesnej kardiologii wad wrodzonych. Nowoczesne metody obrazowania uzupełniają, a czasami wręcz

zastępują dotychczasowe, tradycyjne techniki. Właściwa kwalifikacja pacjentów i wybór optymalnej strategii terapeutycznej wymaga wysokiej jakości diagnostyki, co w końcu wpływa na poprawę wyników leczenia.

Autorzy przedstawili analizę wyników badań obrazowych metodą angio-CT w grupie 37 pacjentów w okresie 3 lat pracy ośrodka diagnostycznego, które uzupełniły obrazowanie przedoperacyjne koarktacji aorty i wad towarzyszących zwężeniu cieśni. Na podkreślenie zasługuje relatywnie liczna grupa pacjentów diagnozowanych z zastosowaniem angio-CT (12–13 dzieci rocznie), co – jak należy rozumieć – nie oznacza przecież całkowitej liczby pacjentów kwalifikowanych do leczenia z powodu koarktacji aorty w ośrodku. Na podstawie danych Klubu Kardiologów Polskich z roku 2013 w skali kraju wykonuje się 105 operacji plastyki koarktacji aorty rocznie, głównie u noworodków (50) i niemowląt (47) [1]. Biorąc pod uwagę strukturę wiekową analizowanej w opracowaniu grupy, z medianą bliższą okresowi wczesnoszkolnemu (odpowiednio: chłopcy – 7 lat i 6 miesięcy, dziewczynki – 7 lat i 11 miesięcy), oraz 30-procentowy udział noworodków i niemowląt, należy się zgodzić ze wstępnym założeniem Autorów sugerujących zastosowanie metody angio-CT jedynie w wybranych przypadkach, podlegających leczeniu w trybie bardziej planowym. W okresie noworodkowym i wczesnoniemowlęcym operacje łuku aorty wykonuje się ze wskazań pilnych, często w celu ratowania

życia, a podstawową metodą obrazową jest echokardiografia dopplerowska [2]. Zarówno ocena zwężeń natywnych, jak i wtórnych po zabiegach wykonanych w okresie noworodkowo-niemowlęcym oraz dodatkowych anomalii naczyniowych u kilkuletnich dzieci, niewątpliwie, wyłącznie na podstawie echokardiografii (okno sonograficzne) bywa trudna. Dlatego właśnie angio-CT może być rozsądną alternatywą dla tradycyjnie stosowanej klasycznej angiografii. W sposób czytelny dowodzą tego twierdzenia Autorzy, dodatkowo zwracając uwagę na ograniczenie ekspozycji pacjentów na promieniowanie jonizujące z niezbędną personalizacją protokołu badania (ALARA) [2]. Wątpliwości diagnostyczne, stanowiące podstawę do rozszerzenia obrazowania serca i wielkich naczyń o angio-CT, ułatwiają identyfikację dodatkowych, często ważnych dla planowania strategii operacyjnej anomalii, także pozasercowych. Z wielkim uznaniem przyjmują informacje o rozpoznaniu pierścieni naczyniowych, skrajnych postaci koarktacji z hipoplazją łuku aorty w formie tak zwanego łuku bawolego, *middle aortic syndrome* czy też sekwestru wenątrzęplucznego. Wszystkie te dodatkowe wrodzone anomalie, a *de facto* składowe towarzyszące wadzie podstawowej, mogą wpływać zarówno na sposób postępowania, wczesne wyniki leczenia, jak i na dalsze losy dziecka [3]. Zwrócenie uwagi na często złożoną morfologię wad towarzyszących koarktacji aorty świadczy o profesjonalnej współczesnej wiedzy Autorów z zakresu wrodzonych anomalii układu sercowo-naczyniowego. Jest to, bez wątpienia, cenne dla wartości diagnostycznej wykonywanych badań, choć bezdyskusyjnie wymaga bardzo dobrego przygotowania kardiologicznego zespołu diagnostyki radiologicznej.

Na podstawie wstępnej, wykonanej na potrzeby niniejszego komentarza, analizy własnej strategii i wyników leczenia 77 pacjentów z koarktacją aorty na Oddziale Kardiologii Dziecięcej Szpitala im. Kopernika w Gdańsku w okresie ostatnich 5 lat (2008–2013) pragnę zauważyć, że w moim doświadczeniu jedynie 5,19% leczonych (4 dzieci) było w wieku powyżej 12. miesiąca życia. Mimo różnych, także złożonych, wariantów anatomicznych odnotowano 100-procentową przeżywalność. W moim ośrodku podstawową metodą diagnostyczną zapewniającą optymalną kwalifikację do leczenia operacyjnego w grupie noworodków i niemowląt była wyłącznie echokardiografia przezklatkowa. Angiografię i angio-CT stosowano w przypadku 4 pacjentów, leczonych interwencyjnie lub hybrydowo [4], oraz zaledwie kilku dzieci wymagających naprawy łuku aorty w konsekwencji wtórnych zwężeń lub restenozy, kwalifikowanych do powtórnej operacji w obserwacji średnioodległej. U żadnego noworodka ani niemowlęcia nie zastosowano też dyskusyjnej metody leczenia krytycznej koarktacji z towarzyszącą hipoplazją łuku aorty w krążeniu pozaustrojowym (ECC, extracorporeal circulation) i głębokiej hipotermii z zatrzymaniem krążenia (DHCA, deep hypothermia circulatory arrest) [5].

Wobec powyższego na podkreślenie zasługuje potencjał Autorów pracy oferujących realną, dobrze przygotowaną, przemyślaną i bezpieczną metodę diagnostyczną, która może wspomagać planowanie strategii operacyjnej. Nowe nieinwazyjne techniki obrazowania, czego wspomniałem dowodem jest niniejsza praca, zyskują coraz większą popularność, także w Polsce [1, 6–8]. Z tą świadomością w codziennej praktyce kardiologii wad serca u dzieci staram się unikać stosowania materiałów, szwów i protez potencjalnie ograniczających wykorzystanie zaawansowanych technik obrazowania w przyszłości, głównie ze względu na zawarte w nich metalowe elementy.

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### Piśmiennictwo

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