Instituto Nacional Cardiovascular
Archivos Peruanos de Cardiología y Cirugía Cardiovascular
Arch Peru Cardiol Cir Cardiovasc. 2024;5(3). doi: 10.47487/apcyccv.v5i3.402.
Sociedad Científica de Medicina Cardiovascular del Perú

Short original article

Percutaneous correction of structural congenital heart diseases during the early postpartum period: experience of a center

Alejandro Narváez Orozco[1,a], **Alberto Navarro Navajas**[2,b], **Carolina Cardona Buitrago**[2,c], **Emilio Herrera Céspedes**[3,d], **Juan Camilo Ortiz Uribe**[2,4,5,d], **Juan Andrés Delgado Restrepo**[5,d], **Juan Manuel Senior Sánchez**[2,4,5,d], **Jairo Alfonso Gándara Ricardo**[2,4,5,d], **Edison Muñoz Ortiz**[2,4,5,d]

Received: June 12, 2024
Accepted: August 8, 2024
Online: August 31, 2024

Authors' affiliation
[1] Departamento de Medicina Interna, Universidad de Antioquia, Medellín, Colombia
[2] Sección de Cardiología, departamento de Medicina Interna, Universidad de Antioquia, Medellín, Colombia
[3] Servicio de Cardiología, Clínica Medellín, Medellín, Colombia
[4] Grupo para el estudio de las enfermedades cardiovasculares, Universidad de Antioquia, Medellín, Colombia
[5] Servicio Cardiovascular y pulmonar, Hospital Universitario San Vicente Fundación, Medellín, Colombia
[a] Internal medicine resident.
[b] Interventional cardiology fellow.
[c] Clinical cardiology fellow.
[d] Clinical cardiologist.

Correspondence
Narváez Orozco A.
Cra. 51D #62-29 Medellín Antioquia.
0572432860

Email
alejo.narvaez9717@gmail.com

Conflicts of interest
None declared

Funding
No funding was received for the realization of this manuscript.

Cite as
Narváez Orozco A, Navarro Navajas A, Cardona Buitrago C, Herrera Céspedes E, Ortiz Uribe JC, Delgado Restrepo JA, et al. Percutaneous correction of structural congenital heart diseases during the early postpartum period: experience of a center. Arch Peru Cardiol Cir Cardiovasc. 2024;5(3). Doi: 10.47487/apcyccv.v5i3.402.

ABSTRACT

Objective. Congenital heart diseases (CHD) can be found in pregnant women. Although cardiac interventions in the hemodynamics laboratory are considered safe and effective, it is preferred to wait 3-6 months after delivery to correct simple, uncomplicated CHDs; however, this may result in loss to follow-up. The objective is to present our experience in correcting CHDs during the early postpartum period (EPP). **Materials and Methods.** All cases of pregnant women with CHD type atrial septal defect (ASD), patent ductus arteriosus (PDA), and aortic coarctation (CoA) between 2017-2023, who underwent percutaneous correction of the defect during the EPP, were collected. **Results.** 15 pregnant women diagnosed with ASD (5), PDA (6), and CoA (4) were included. Five patients (33.3%) were classified as modified World Health Organization (mWHO) risk IV; the procedure was successful in 80% of cases, and only 1 patient presented complications. **Conclusions.** In our experience, the closure of non-complex congenital defects during the EPP did not present major complications and could be a treatment strategy to avoid loss to follow-up after delivery in pregnant women with CHD.

Keywords: Hearts Defects, Congenital; Pregnancy; Puerperium (Source: MeSH-NLM).

RESUMEN

Objetivo. Las cardiopat.as cong.nitas (CC) pueden ser encontradas en mujeres embarazadas. Si bien las intervenciones cardiacas en el laboratorio de hemodinamia son consideradas seguras y efectivas, se prefiere esperar 3-6 meses luego del parto para corregir las CC simples, no complicadas; sin embargo, esto puede resultar en p.rdidas en el seguimiento. El objetivo es mostrar nuestra experiencia en la correcci.n de CC durante el puerperio temprano (PT). **Materiales y métodos**. Se recolectaron todos los casos de gestantes con CC tipo comunicaci.n interauricular (CIA), ductus arterioso persistente (DAP) y coartaci.n a.rtica (CoA) entre 2017-2023, llevadas a correcci.n percut.nea del defecto durante el PT. **Resultados.** Se incluyeron 15 gestantes con diagn.stico de CIA (5), DAP (6) y CoA (4). Cinco pacientes (33,3%) se clasificaron como riesgo OMSm IV; el procedimiento fue exitoso en el 80% de los casos y solo 1 paciente present. complicaciones. **Conclusiones.** En nuestra experiencia el cierre de defectos cong. nitos no complejos durante el PT no present. complicaciones mayores y podria ser una estrategia de tratamiento para evitar p.rdidas en el seguimiento posterior al parto de gestantes con CC.

Palabras clave: Cardiopat.as Cong.nitas; Embarazo; Puerperio (Fuente: DeCS Bireme).

Introduction

Cardiovascular disease occurs in 0.2-4% of pregnant women and is responsible for 10-15% of maternal mortality worldwide [1]. In our setting, congenital heart diseases (CHD) are the most common diagnosis (51.9%), followed by valvular disease (25.9%) and arrhythmias (15.4%) [2], similar to the European registry of heart disease and pregnancy, where 57.4% of pregnant women had CHD [3].

Septal defects, Tetralogy of Fallot, and Coarctation of the Aorta (CoA) are the most common CHDs; outcomes depend on complexity, hemodynamic consequences, and care from a specialized team [4]. Percutaneous cardiac interventions in pregnant women have been considered safe, but factors such as timing, radiation dose, medications, and periprocedural preparation must be taken into account [5].

By the third to sixth month postpartum, pregnancy-induced hemodynamic changes tend to normalize. Given the interaction between breastfeeding and platelet antiaggregate drugs commonly used in patients undergoing percutaneous closure of defects, it is proposed to perform the percutaneous correction (PC) of uncomplicated or stable congenital heart defects after the sixth month postpartum [6].

In 2014, motivated by the high rate of follow-up loss and the risks of untreated CHD, a study reported the experience of eight patients undergoing PC during the early postpartum period (EPP), showing favorable outcomes [7]. The aim of this study is to present our experience in the correction of uncomplicated CHDs, specifically ostium secundum atrial septal defect (ASD), patent ductus arteriosus (PDA), and CoA, in pregnant women during the EPP.

Materials and methods

Design and population

This is an observational study, specifically a retrospective case series. Data were collected from the health records (HR) of pregnant patients diagnosed with CHD, including ASD, PDA, and CoA, between January 2017 and August 2023, who underwent PC during the EPP (within the first 7 days postpartum) at the Hospital San Vicente Fundación in Medellín, Colombia, a high-complexity center with a cardio-obstetrics clinic.

Interventions

The procedures were performed by interventional cardiologists experienced in structural heart disease. In patients with an intermediate or high probability of pulmonary hypertension (PH), invasive measurements were taken. ASD closures were carried out under transesophageal echocardiographic and fluoroscopic guidance according to conventional techniques, and PDA closures were performed similarly. CoA was corrected under fluoroscopic guidance. The ASD closure was performed using an Amplatzer® device, while the PDA closure was done with an Amplatzer® duct occluder. The CoA correction was achieved through balloon dilation and the implantation of an Andra® stent. The choice of antiplatelet therapy was at the discretion of the treating physician, and patients received at least 6 months of antiplatelet therapy.

Variables

Variables such as baseline characteristics before the procedure, intervention-related factors, and complications were collected. Baseline maternal-cardiac characteristics included: arrhythmias, cardiac function deterioration: ventricular dysfunction, elevated natriuretic peptides, or signs and symptoms of heart failure (HF), and intervention-related complications such as bleeding, vascular complications, cardiac tamponade, and mortality. Outcomes included hospitalization or death. The variables were collected through medical record review, using a Microsoft Excel® table, and follow-up was conducted for 6 months.

Statistical analysis

Qualitative variables were analyzed as absolute and relative frequencies, while quantitative variables were analyzed as median and interquartile range (IQR) due to the non-parametric distribution of the sample identified by the Shapiro-Wilk test. STATA v10 was used for statistical calculations.

Ethical aspects

It was conducted in accordance with the Declaration of Helsinki and the latest version of good research practice guidelines. The study was approved by the ethics and research committee.

Results

Between January 2017 and August 2023, 15 PC of CHD were performed during the EPP, with a median time from delivery to intervention of 6 days (IQR: 3-7): 6 PDA, 5 ASD, and 4 CoA. **Tables 1 and 2** present the clinical-sociodemographic characteristics and procedure-related information, respectively.

The median age was 26 years (IQR: 20-29) and the median gestational age at delivery was 38 weeks (IQR 37-39). Most patients (93.3%) had a functional class I according to the New York Heart Association (NYHA). Furthermore, according to the modified World Health Organization (mWHO) Classification of Maternal Cardiovascular Risk, five patients were classified as

Table 1. Clinical and sociodemographic characteristics

Characteristics	N (%)
Age years (median, IQR)	26 (20 -29)
Late assessment* n(%)	11 (73%)
Vulnerable population** n(%)	11 (73%)
Type of congenital heart disease n(%)	
ASD	5 (33 %)
PDA	6 (40%)
CoA	4 (26.7%)
NYHA n(%)	
I	14 (93.3%)
II	1 (6.6%)
Risk classification according to modified WHO scale n(%)	
II	7 (46.6%)
II-III	3 (20 %)
III	0 (0%)
IV	5 (33.3 %)
Comorbidities n(%)	
Secondary hypertension	4 (26.7%)
Diabetes mellitus	1 (6.7%)
Smoking	3 (20%)
Heart failure	0
Chronic kidney disease	0
Pulmonary hypertension	4 (26.6%)
Obstetric	
Multigravida	7 (46.6%)
Late assessment (>20 weeks)	12 (80%)
Previous abortions	1 (6%)
Subsidized regime	7 (46.9%)

ASD: atrial septal defect. PDA: patent ductus arteriosus. CoA: aortic coarctation. NYHA: New York Heart Association. IQR: interquartile range
* Late assessment if the first contact with the cardiologist was after 20 weeks of pregnancy
** Vulnerable population: those who are part of the subsidized health regime

mWHO risk IV; four due to pulmonary hypertension and one due to aortic recoarctation with high residual gradients. Of the remaining, three were classified as mWHO risk II-III and seven as mWHO risk II.

In CoA cases, three patients were classified as mWHO risk II-III, as although they met intervention criteria, they did not have severity criteria or severe recoarctation, allowing repair during EPP. The patient with CoA classified as mWHO risk IV had high

Table 2. Echocardiographic characteristics and procedure-related data

Characteristics	Value
Echocardiographic	
Left ventricular ejection fraction % (median, IQR)	60 (58 - 63)
Pulmonary artery systolic pressure mmHg (median, IQR)	32 (30 -35)
Tricuspid regurgitation velocity m/s (median, IQR)	2.62 (2.51 – 2.85)
Right ventricular diameter mm (median, IQR)	35 (34 -40)
Defect size (mm)	
PDA aorta (median, IQR)	8 (5.5 -11.5)
PDA pulmonary (median, IQR)	7 (4.5 -9.5)
ASD (median, IQR)	15 (13.5 – 20.5)
Intermediate or high PH probability*	4/15 (26.6%)
Qp/Qs > 1,5	
PDA	3/6 (100%)
ASD	5/5 (100%)
Procedure-related	
Right common femoral approach	14/15 (93.3%)
Procedure time (minutes)	
ASD (median, IQR)	31 (25 - 37.5)
PDA (median IQR)	28 (20 -33)
CoA (median, IQR)	46,5 (37.5-55.5)
Radiation time (seconds)	
ASD (median, IQR)	40 (17.5- 32.5)
PDA (median IQR)	120 (110-125)
CoA (median, IQR)	122.5 (110-137.5)
Complications	0/15 (0%)
Aortic coarctation gradient	
Initial (mmHg)	54,5 (30- 71,5)
Final (mmHg)	13,5 (3,5-47)
Device type:	
Amplatzer ®	5
Size mm (median, IQR)	28 (14-36)
PDA duct occluder II device for percutaneous closure	4
PDA duct occluder device for percutaneous closure	2
Size (#) **	
10	3
12	3
Andra ® balloon and stent	2
Balloon size - stent extension [mm])	16/40 - 43

ASD: atrial septal defect. PDA: patent ductus arteriosus. CoA: aortic coarctation. PH: pulmonary hypertension. CT: computed tomography.
* All patients with intermediate or high probability had PH confirmed by right heart catheterization.
** Diameters are expressed in mm for both ends of the device. #10 is 10/8 mm and #12 is 12/10 mm

residual gradients due to the impossibility of reintervention because of vascular access thrombosis. In general 73.5% of patients were evaluated late, 33.3% had some comorbidity, and 46.9% were part of the subsidized healthcare regime. In 9 women (60.3%), the mode of delivery was cesarean section, and of these, only 2 were for cardiac indications.

The procedure was successful in 80% of cases (12/15). ASD closure was successful in four cases (26.6%); the failed procedure occurred in a patient where the device could not be stabilized due to poor edges; this patient was scheduled for a new closure in 6 months. For PDA closure, the Amplatzer® duct occluder II device was used in four patients, and the Amplatzer® duct occluder device was used in two patients, being successful in all cases.

Regarding CoA correction, the procedure was successful in two patients, resulting in final gradients of 7 mmHg and 0 mmHg (initial 69 mmHg and 40 mmHg, respectively). Both patients underwent balloon dilation with a #18/40 balloon, and an Andra® type stent was implanted. In one patient, only balloon dilation was performed due to the impossibility of crossing the stent. Although the gradients decreased, it was considered unsuccessful. As previously mentioned, one patient could not be intervened due to thrombosis of the vascular access sites.

During follow-up, only one complication related to the procedure occurred (persistent atrial tachycardia, which improved with ablation). There was no maternal mortality or rehospitalization at 6 months.

Regarding antiplatelet management, 60.3% received acetylsalicylic acid (ASA) and clopidogrel for 3-6 months, with subsequent discontinuation of clopidogrel and indefinite continuation of ASA or discontinuation according to medical criteria; the remaining 20% received ASA monotherapy. Three patients (20%) who did not undergo intervention did not receive antiplatelet agents. **Table 3** presents the most relevant data of the 15 patients included in the case series.

Discussion

In this case series, the correction of uncomplicated simple CHD during the EPP suggests that the treatment could be effective and safe.

Due to the decrease in systemic vascular resistance (SVR) and the increase in cardiac output [8,9] during pregnancy, the hemodynamic conditions of CHD can worsen, hence the importance of invasive measurement prior to closure when the probability of PH is intermediate or high by echocardiography. In ASD, right ventricular overload can worsen and the right atrium can dilate, increasing the risk of developing HF and arrhythmias; PH can also appear due to the reduction of SVR, which favors the inversion of the short circuit, while hemostatic changes increase the risk of thromboembolism. In PDA, left ventricular overload may worsen, and in CoA, hemodynamic changes can favor uterine hypoperfusion and aortic dissection [10,11].

With the exception of patients with PH, HF, significant aortic dilation, and poorly controlled hypertension, pregnancy is well tolerated even without correction of the defects [3,12,13]. In a cohort that included 67 women with uncorrected ASD and 31 women with corrected ASD, the incidence of cardiac events was similar in both groups [12]. Compared to the general population, women with uncorrected ASD have a higher risk of preeclampsia, fetal mortality, and small for gestational age fetus [8]; this is possibly related to the reduction in placental perfusion mediated by the shunt. In our series, one patient with ASD presented with PH and deterioration of ventricular function, requiring urgent cesarean section. There were no obstetric complications.

In the ROPAC registry, in 29 (9.6%) of 303 patients with CoA, the defect had not been corrected. Only one cardiovascular event occurred in one of the patients with uncorrected CoA. Additionally, of the total cohort, 15 presented hypertensive disorders and 27 preterm labor syndrome [13]. In our series, two presented severe preeclampsia and one adverse neonatal event occurred. As mentioned, three of the four patients with CoA were reclassified as mWHO II-III, as they had no criteria for severity or severe recoarctation. It is important to underscore this classification, as until recently, patients with CoA in pregnancy were classified as mWHO IV [13,14].

There is limited data on the outcomes of patients with PDA. In the ROPAC registry, in 71 patients with PDA, few cardiovascular events occurred [3]. In our series, no events occurred and one patient underwent cesarean section due to PH.

Our data correlates with what has been reported in the literature; most pregnancies were well tolerated, and those that presented adverse events had some condition that increased the risk of complications. Therefore, correction of CHDs is rarely required during pregnancy [14,15]. In specialized centers, patients are detected, closely monitored, and electively scheduled; however, given the difficulties in accessing the health system and ensuring follow-up, our group proposes performing the correction during the EPP, unlike other groups that perform it after 6 months postpartum (late puerperium) [1,6]. 46.9% of the patients were part of the subsidized system (vulnerable population), and from previous experience, 50% never return to continue the repair process [7].

There is little data about the correction of uncomplicated simple CHDs during EPP, which highlights the importance of this work. Although interventions during the puerperium seem safe, there is a risk of decompensation due to hemodynamic changes during EPP, underscoring the importance of perioperative monitoring [15,16]. Other experiences show that percutaneous interventions during pregnancy are feasible and with satisfactory maternal-fetal results [16–18]. In our series, the repair of CHDs in EPP was successful in most cases, and only one complication occurred, which resolved with the provided management.

Table 3. Characteristics of the 15 intervened cases

Case	Age	CHD Type	Health Regime	Gestational age (weeks) at first evaluation	Medical History	mWHO	Defect size mm (ASD, PDA) or initial - final gradient mmHg (CoA)	Successful	Delivery Method	Cesarean Indication	Gestational age (weeks + days) at delivery	Antiplatelet therapy	Relevant hemodynamic or echocardiographic data and indication for CHD correction	Observations
1	22	PDA	S	40	None	II	11 mm Ao – 7 mm pulmonary	Yes	Ce	Obs	40	A	Dilated RV, Qp/Qs 2, low % PH	-
2	17	PDA	S	18 h post-cesarean	HTN and smoking	II	7 mm Ao – 8 mm pulmonary	Yes	Ce	Obs	39	A + Cl	Dilated LV, Qp/Qs 1.5, low % PH	Presented severe postpartum endometritis
3	26	PDA	S	20	Smoking	IV	12 mm Ao – 11 mm pulmonary	Yes	Ce	Car	35	A + Cl	Dilated LV, Qp/Qs 2, intermediate % PH, mPAP 41 PVR 3.5	Presented increase in BNP and PH
4	21	PDA	S	35 + 4	Syphilis	IV	8 mm Ao – 7 mm pulmonary	Yes	V	-	37 + 6	A + Cl	Dilated LV, Qp/Qs 1.7, intermediate % PH, mPAP 44 PVR 3.3	-
5	32	PDA	Co	17 + 3	None	II	4 mm Ao – 3 mm pulmonary	Yes	Ce	Obs	39 + 2	A	Dilated LV, Qp/Qs <1.5, low % PH	-
6	24	PDA	S	30 + 1	None	II	8 mm Ao – 6 mm pulmonary	Yes	V	-	39	A + Cl	Dilated LV, Qp/Qs <1.5, low % PH	-
7	29	ASD	Co	36 + 4	None	IV	25 mm	No	Ce	Car	37	-	Dilated RV, Qp/Qs 1.7, intermediate % PH, mPAP 21 PVR 2.3	Unsuccessful procedure due to poor borders. Presented LVEF deterioration and PH. During follow-up, presented incessant atrial tachycardia that resolved with ablation
8	33	ASD	Co	36 + 1	Diabetes	II	12 mm	Yes	Ce	Obs	38	A + Cl	Dilated RV, Qp/Qs 2, low % PH	-
9	20	ASD	Co	23 + 2	None	II	16 mm	Yes	V	-	38	A + Cl	Dilated RV, Qp/Qs 1.7, low % PH	-
10	25	ASD	Co	36 + 3	None	IV	15 mm	Yes	Ce	Obs	36 + 4	A + Cl	Dilated RV, Qp/Qs 1.6, intermediate % PH, mPAP 31, PVR 2.9	Fenestrated ASD closure
11	22	ASD	S	37 + 2	None	II	15 mm	Yes	V	-	37 + 4	A + Cl	Dilated RV, Qp/Qs 1.7, low % PH	-
12	20	CoA	S	21 +3	HTN	II	69/4	Yes	Ce	Obs	35	A	. Pre-coarctation diameter 24 mm, post-coarctation 40 mm	Presented severe preeclampsia, required urgent cesarean. Newborn with neonatal depression.
13	18	CoA	Co	12 + 3	HTN and smoking	IV	74/74	No	V	-	37	-	Pre-coarctation diameter 15 mm, post-coarctation 17 mm	Patient with recoarctation, without vascular access, so the procedure could not be performed
14	21	CoA	Co	31 + 5	HTN	II	40/0	Yes	V	-	36 + 5	A + Cl	Pre-coarctation diameter 11 mm, post-coarctation 24 mm	Presented severe preeclampsia
15	20	CoA	Co	26 + 5	-	II	40/15	No	Ce	Obs	38	-	Pre-coarctation diameter 22 mm, post-coarctation 19 mm	-

ASD: atrial septal defect, PDA: patent ductus arteriosus, CoA: aortic coarctation, mWHO: modified World Health Organization, CI: cesarean, V: vaginal, A: acetylsalicylic acid, CI: Clopidogrel, Obs: obstetric, Car: cardiac, HTN: hypertension, Ao: aortic border, PH: pulmonary hypertension, LVEF: left ventricular ejection fraction, Co: contributory, S: subsidized, BNP: brain natriuretic peptide, RV: right ventricle, LV: left ventricle Qp/Qs: pulmonary flow/systemic flow, mPAP: mean pulmonary arterial pressure

During follow-up, there were no complications associated with the use of antiplatelets. Although information on the use of antiplatelets during puerperium and breastfeeding is limited, due to hypercoagulability and potential thrombotic complications in the first and sixth week postpartum [19], we suggest the use of ASA and clopidogrel, frequent monitoring, and early discontinuation of clopidogrel [20].

Among the limitations, despite being a referral center, the number of patients is small, with half classified as mWHO II, so the results are not generalizable. It would be interesting to extend these observations to a larger sample and with longer follow-up. This study serves as a starting point for future research.

In conclusion, in our experience, the closure of non-complex congenital defects during EPP did not present major complications and could be a treatment strategy to avoid losses in the postpartum follow-up of pregnant women with CHD.

Authors' Contributions

Conceptualization: **ANN, ANO, JMSS, JAGR.** Investigation: **CCB, JCOU, JADR, ANN, ANO, JMSS.** Writing - Review & Editing: **ANN, ANO, JMSS, CEHC.** Revisión: **ANN, ANO, EMO, JMSS, JCOU, JADR, CEHC.** All authors had access to the data (including statistical analysis and tables) in the study and accepted responsibility for maintaining the integrity of the data and the accuracy of the data analysis.

References

1. Regitz-Zagrosek V, Roos-Hesselink JW, Bauersachs J, Blomstr.m-Lundqvist C, C.fkov. R, De Bonis M, *et al.* 2018 ESC Guidelines for the management of cardiovascular diseases during pregnancy. Eur Heart J. 2018;39(34):3165-241. doi: 10.1093/eurheartj/ehy340.
2. Muñoz-Ortiz E, G.ndara-Ricardo JA, Vel.squez-Penagos JA, Giraldo-Ardila N, Betancur-Pizarro AM, Ar.valo-Guerrero EF, *et al.* Caracterizaci.n de la enfermedad cardiaca en pacientes embarazadas y desenlaces hospitalarios materno-fetales. Rev Colomb Cardiol. 2020;27(5):373-9. doi: 10.1016/j.rccar.2019.12.016.
3. Park K, Bairey Merz CN, Bello NA, Davis M, Duvernoy C, Elgendy IY, *et al.* Management of Women With Acquired Cardiovascular Disease From Pre-Conception Through Pregnancy and Postpartum. J Am Coll Cardiol. 2021;77(14):1799-812. doi: 10.1016/j.jacc.2021.01.057.
4. Park K, Bortnick AE, Lindley KJ, Sintek M, Sethi S, Choi C, *et al.* Interventional Cardiac Procedures and Pregnancy. Compr Rev. 2022;1(5):100427. doi: 10.1016/j.jscai.2022.100427.
5. Baumgartner H, De Backer J, Babu-Narayan S V, Budts W, Chessa M, Diller GP, *et al.* 2020 ESC Guidelines for the management of adult congenital heart disease. Eur Heart J. 2021;42(6):563-645. doi: 10.1093/eurheartj/ehaa554.
6. Ramlakhan KP, Johnson MR, Lelonek M, Saad A, Gasimov Z, Sharashkina NV, *et al.* Congenital heart disease in the ESC EORP Registry of Pregnancy and Cardiac disease (ROPAC). IJC Congenital Heart Disease. 2021;3:100107. doi: 10.1016/j.ijcchd.2021.100107.
7. Senior JM, Fernández A, Rodriguez A. Seguridad de la corrección percutanea de cardiopat.as congénitas en mujeres en sus primeros días posparto. Acta Med Col. 2014;39(2):159-164. doi: 10.36104/amc.2014.251.
8. Drenthen W, Pieper PG, Roos-Hesselink JW, van Lottum WA, Voors AA, Mulder BJM, *et al.* Outcome of Pregnancy in Women With Congenital Heart Disease. J Am Coll Cardiol. 2007;49(24):2303-11. doi: 10.1016/j.jacc.2007.03.027.
9. Ouzounian JG, Elkayam U. Physiologic Changes During Normal Pregnancy and Delivery. Cardiol Clin. 2012;30(3):317-29. doi: 10.1016/j.ccl.2012.05.004.
10. Harris IS. Management of Pregnancy in Patients with Congenital Heart Disease. Prog Cardiovasc Dis. 2011;53(4):305-11. doi: 10.1016/j.pcad.2010.08.001.
11. Zhang Z, Wengrofsky A, Wolfe DS, Sutton N, Gupta M, Hsu DT, *et al.* Patent Ductus Arteriosus in Pregnancy: Cardio-Obstetrics Management in a Late Presentation. CASE (Phila). 2021;5(2):119-22. doi: 10.1016/j.case.2020.12.002.
12. Yap S, Drenthen W, Meijboom F, Moons P, Mulder B, Vliegen H, *et al.* Comparison of pregnancy outcomes in women with repaired versus unrepaired atrial septal defect. BJOG. 2009;116(12):1593-601. doi: 10.1111/j.1471-0528.2009.02301.x.
13. Ramlakhan KP, Tobler D, Greutmann M, Schwerzmann M, Baris L, Yetman AT, et al. Pregnancy outcomes in women with aortic coarctation. Heart. 2021;107(4):290-8. doi:10.1136/heartjnl-2020-317513.
14. Lindley KJ, Bairey Merz CN, Asgar AW, Bello NA, Chandra S, Davis MB, *et al.* Management of Women With Congenital or Inherited Cardiovascular Disease From Pre-Conception Through Pregnancy and Postpartum. J Am Coll Cardiol. 2021;77(14):1778-98. doi: 10.1016/j.jacc.2021.02.026.
15. Canobbio MM, Warnes CA, Aboulhosn J, Connolly HM, Khanna A, Koos BJ, et al. Management of Pregnancy in Patients With Complex Congenital Heart Disease: A Scientific Statement for Healthcare Professionals From the American Heart Association. Circulation. 2017;135(8):e50-e87. doi: 10.1161/CIR.0000000000000458.
16. Krishnamoorthy S, Butt M, Lip GYH. Asymptomatic hypoxia in a young pregnant lady — Unusual presentation of atrial septal defect. Int J Cardiol. 2010;143(2):e34-6. doi: 10.1016/j.ijcard.2008.12.039.
17. Manivannan S, Dadlani G, Parsons M, Crisan L, Belogolovkin V, Sastry N, *et al.* Surgical repair of atrial septal defect with severe pulmonary hypertension during pregnancy: a case report with literature review. Cardiol Young. 2012;22(5):493-8. doi: 10.1017/S1047951112000492.
18. Soydemir DF, Johnston T, Clarke B. Percutaneous closure of an atrial septal defect during pregnancy using an Amplatzer occlusion device. J Obstet Gynaecol (Lahore). 2005;25(7):715-6. doi: 10.1080/01443610500304307.
19. Halpern DG, Weinberg CR, Pinnelas R, Mehta-Lee S, Economy KE, Valente AM. Use of Medication for Cardiovascular Disease During Pregnancy. J Am Coll Cardiol. 2019;73(4):457-76. doi: 10.1016/j. jacc.2018.10.075.
20. Drugs and Lactation Database (LactMed.) [Internet]. Bethesda (MD): National Institute of Child Health and Human Development; 2006. Clopidogrel. [Cited January 3, 2024]. Available in: https:// www.ncbi.nlm.nih.gov/books/NBK535609/