


Residual shunt after patent foramen ovale closure – a retrospective analysis of outcomes at University Hospital Centre Zagreb


 Kristina Marić Bešić^{1,2*},

 Denis Došen¹,

 Vlatka Rešković Lukšić¹,

 Sandra Jakšić Jurinjak^{1,2},

 Irena Ivanac Vranešić¹,

 Antun Zvonimir Kovač¹,

 Joško Bulum^{1,2}

¹University Hospital Centre Zagreb, Zagreb, Croatia

²University of Zagreb School of Medicine, Zagreb, Croatia

KEYWORDS: patent foramen ovale, residual shunt, device size.

CITATION: *Cardiol Croat.* 2025;20(1-2):27. | <https://doi.org/10.15836/ccar2025.27>

***ADDRESS FOR CORRESPONDENCE:** Kristina Marić Bešić, Klinički bolnički centar Zagreb, Kišpatičeva 12, HR-10000 Zagreb, Croatia. / Phone: +385-91-2336-805 / E-mail: kmaricbesic@gmail.com

ORCID: Kristina Marić Bešić, <https://orcid.org/0000-0002-4004-7271> • Denis Došen, <https://orcid.org/0000-0003-3490-5505> Vlatka Rešković Lukšić, <https://orcid.org/0000-0002-4721-3236> • Sandra Jakšić Jurinjak, <https://orcid.org/0000-0002-7349-6137> Irena Ivanac Vranešić, <https://orcid.org/0000-0002-6910-9720> • Antun Zvonimir Kovač, <https://orcid.org/0000-0001-6276-4450> Joško Bulum, <https://orcid.org/0000-0002-1482-6503>

Introduction: Patent foramen ovale (PFO) closure is a widely performed procedure with a success rate exceeding 98%. However, residual right-to-left interatrial shunting can persist in up to 30% of cases^{1,2}. The occurrence and size of residual shunts are influenced by the anatomical characteristics of the PFO and the dimensions of the implanted closure device³. We aimed to evaluate the incidence of residual shunting, and its correlation with the size of the Amplatzer occluder device at the University Hospital Centre (UHC) Zagreb.

Patients and Methods: A retrospective analysis was conducted on all patients who underwent PFO closure at the UHC Zagreb to date. The study assessed implantation success rates, device sizing, echocardiographic follow-up methods and frequency, and the detection of residual shunts. Statistical analysis was performed using the Chi-square test and Cramer's V test.

Results: Between August 2016 and December 2024, a total of 104 PFO closures were attempted, with 100 (96.2%) successfully implanted. Various sizes of Amplatzer occluder devices were used: 65 patients (66%) received smaller devices: 18/25 mm or 25/25 mm, while 33 patients (34%) received larger ones: 25/30 mm, 25/35 mm or 30/30 mm. Size data was unavailable for 2 cases. During the first year of follow-up, residual shunts were assessed in 41 patients (39.4%) using TTE/transesophageal echocardiography (TEE) with color Doppler and in 59 patients (56.7%) using TTE with a bubble test. Residual shunting was detected in 18 patients (18.3%) exclusively with the TTE bubble test, 78% with larger devices. TTE with bubble test beyond one year was performed in 14 (out of 19) patients. A persistent residual shunt was found in 11 patients (10.6%), again in 73% patients with larger devices. A statistically significant difference was observed in the occurrence of residual shunting among different device sizes (Chi-square, $p < 0.001$), with a higher likelihood of residual shunting as device size increased (Cramer's $V = 0.577$, $p < 0.001$).

Conclusion: PFO closure outcomes at our center align with data from literature. The findings confirm that larger closure devices are associated with a higher likelihood of residual shunting. TTE with bubble test is superior to Doppler-based methods in detecting residual shunting and therefore important for follow-up assessments.

RECEIVED:

February 4, 2025

ACCEPTED:

February 14, 2025



LITERATURE

- Deng W, Yin S, McMullin D, Inglessis-Azuaje I, Elmariah S, Hung J, et al. Residual Shunt After Patent Foramen Ovale Closure and Long-Term Stroke Recurrence: A Prospective Cohort Study. *Ann Intern Med.* 2020 Jun 2;172(11):717-725. <https://doi.org/10.7326/M19-3583>
- Søndergaard L, Kasner SE, Rhodes JF, Andersen G, Iversen HK, Nielsen-Kudsk JE, et al; Gore REDUCE Clinical Study Investigators. Patent Foramen Ovale Closure or Antiplatelet Therapy for Cryptogenic Stroke. *N Engl J Med.* 2017 Sep 14;377(11):1033-1042. <https://doi.org/10.1056/NEJMoal707404>
- Marchese N, Pacilli MA, Inchingolo V, Fanelli R, Loperfido F, Vigna C. Residual shunt after percutaneous closure of patent foramen ovale with AMPLATZER occluder devices - influence of anatomic features: a transcranial Doppler and intracardiac echocardiography study. *EuroIntervention.* 2013 Jul;9(3):382-8. <https://doi.org/10.4244/EIJV9I3A61>