Open Access Library Journal
2022, Volume 9, e8713
ISSN Online: 2333-9721
ISSN Print: 2333-9705

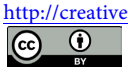
Conventional Median Sternotomy Compared to the Percutaneous Transcatheter Device Closure for Secundum Atrial Septal Defect

Romeo Martial Tchomte*, Elise Wangni, Yi Wang, Eric Christian Tchubessi, Nelly Larissa Djatche Kouakam

Department of Cardiovascular Surgery, Second Affiliate Hospital of Hainan Medical University, Haikou, China
Email: *romeomartial1@gmail.com

How to cite this paper: Tchomte, R.M., Wangni, E., Wang, Y., Tchubessi, E.C. and Djatche K., N.L. (2022) Conventional Median Sternotomy Compared to the Percutaneous Transcatheter Device Closure for Secundum Atrial Septal Defect. *Open Access Library Journal*, **9**: e8713.
https://doi.org/10.4236/oalib.1108713

Received: April 13, 2022
Accepted: May 6, 2022
Published: May 9, 2022



Abstract

Introduction: During the last decades, the percutaneous transcatheter device (PTD) closure for secundum atrial septal defect (ASD) has acquired significant popularity over the conventional median sternotomy (CMS). CMS is the classic approach for ASD closure. The major objective of this study was to determine whether ASD procedure or CMS surgical closure offers a better value proposition for ASD closure. **Method:** A total of 187 patients have been admitted for closure of the secundum ASD either by CMS or PTD in The Second Affiliated Hospital of Hainan Medical University from January 2017 to April 2021. We divided in to two group CMS group (n = 97) and the PTD group (n = 90). In CMS group, we excluded 12 patients, and in PTD group, we excluded 3 patients, we remained with 172 patients. **Results:** In PTD group out of the 87 patients who underwent device closure, 3 (3.44%) of the patients had operations failures and have been done by CMS. In the CMS group the 85 patients. The index data on the duration of the operation, the infused blood products, the duration in intensive care unit, the postoperative hospital length stay, and the morbidity were better in PTD group than in the CMS group. The difference between the two groups was statistically significant ($P < 0.05$). **Conclusion:** Both CMS and PTD for ASD are safe, feasible, and effective. PTD has more advantages in shorter duration of operation procedure, no requirement of blood products transfusion, no thoracotomy, better cosmetic effect, shorter duration in ICU, less morbidity and shorter hospital length of stay. PTD is the better choice for patients if the patients meet most of the appropriate conditions. CMS closure is still the basic operation also as an alternative in PTD failure or contraindication.

Subject Areas

Cardiology, Surgery & Surgical Specialties

Keywords

Atrial Septal Defect, Percutaneous Transcatheter Device, Conventional Median Sternotomy

1. Background

Atrial septal defect (ASD) is one of the most common congenital heart lesions, is described as a hole in the inter atrial septum, that separates the left and right atrium. The hole between the left and right atrium allows an interatrial communication responsible for the shunt of blood between the systemic and pulmonary venous circulation. ASD is a common congenital heart defect, with an estimated birth prevalence of 1.6 per 1000 live births and a 97 % probability of survival into adulthood [1]. Patients with an isolated ASD are often asymptomatic until adulthood. Treatment of ASDs is generally recommended because increased pulmonary blood flow can lead to pulmonary hypertension, which can become irreversible and lead to Eisenmenger syndrome. Other potential complications may arise such as dyspnea, atrial arrhythmias, exercise intolerance, right ventricular dysfunction, paradoxical embolization, and cerebral abscess.

In 1976, Mills and King are the first to use device to close an ASD [2] since then the transcatheter device closure has become an accepted alternative to surgical repair for ostium secundum atrial septal defects (ASDs) [3] During the last decades the PTD closure for secundum ASD has acquired significant popularity and served as an alternative to conventional surgical repair [4]. Recently, transcatheter device closure for ASD has been widely performed in mainland China [5].

The aim purpose of this study, therefore, was to compare the early results, efficacy, safety, closure rates, mortality, morbidity, and complications of PTD closure of secundum ASD with CMS surgical repair results in our hospital.

2. Methods

A total of 187 patients have been admitted for closure of the secundum ASD, in The Second Affiliated Hospital of Hainan Medical University from January 2017 to April 2021. We divided in to two group CMS group (n = 97) and the PTD group (n = 90).

In CMS group, we excluded 12 patients, and in PTD group, we excluded 3 cases in our study (**Figure 1**). We remain with 172 patients out of 187 patients at the start of our study.

The patients were divided into PTD group and CMS group.

Inclusion criteria for both groups included:

1) Echocardiography showed that the diameter of the ASD defect was ≤38 mm.

2) Both groups met the criteria: right ventricular volume overload or left-right

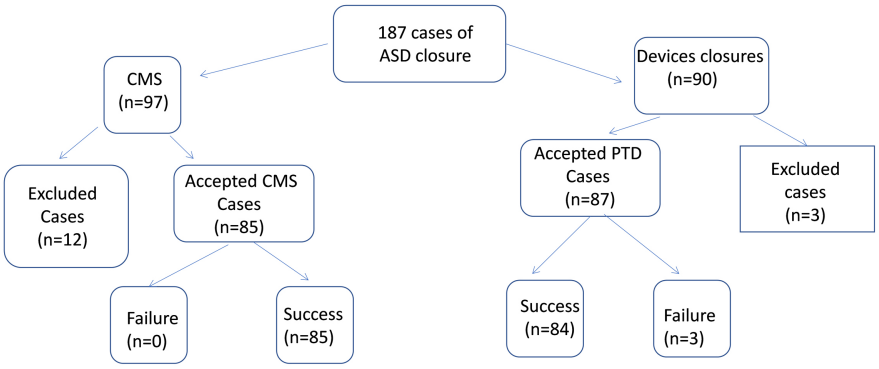


Figure 1. Included/excluded graph of patients studied.

shunt, Qp/Qs ratio ≥ 1.5:1.

3) An additional inclusion criterion for the PTD group was that the echocardiography measured distance from the edge of the atrial septal defect to the right superior pulmonary vein, atrioventricular valve, and coronary sinus was >5 mm. The CMS surgical group is unlimited.

Exclusion criteria for both groups included:

1) The presence of other types of ASD (venous sinus or primitive foramen).

2) The presence of additional cardiac malformations [ventricular septal defect, tetralogy of Fallot, tricuspid regurgitation, pulmonary stenosis, etc. can only be repaired by surgery.

3) Patients who have contraindications to aspirin or other anti-platelet drugs, and patients who underwent surgical closure of atrial septal defect.

This study was approved by the medical ethics committee of the hospital, and all patients were informed of the surgical plan and complications before surgery, and voluntarily signed the informed consent for the surgery.

3. Preoperative Characteristics of Patients

There were 85 patients in the CMS group, 39 males (45.88%) and 46 females (54.11%). The age ranged from 1 to 65 years old, with an average of 24.6 ± 16.53 years old. The average defect size was 22.69 ± 5.77 mm. The average preoperative hospital stay was 6.35 ± 3.42 days. Chronic gastritis was found in 5 cases (5.88%), pulmonary hypertension in 32 cases (37.64%), and hypertension in 5 cases (5.88%).

There were 87 cases in the PTD group, including 42 males (48.27%) and 45 females (51.72%). The age ranged from 2 to 67 years old, with an average of 26.2 ± 19.52 years. The average defect size was 21.49 ± 4.5 mm. The average preoperative hospital stay was 5.55 ± 3.57 days. There were 5 cases (5.74%) of chronic gastritis, 34 cases (39.08%) of pulmonary hypertension, and 5 cases (5.74%) of hypertension (Table 1).

4. PTD Operating Technique Procedure

After successful anesthesia, the patient is placed in the supine position, right

Table 1. Preoperative details of the patients.

	CMS	PTD	P-value
Patients	85	87	
Male	39 (45.88%)	42 (48.27%)	
Female	46 (54.11%)	45 (51.72%)	
Age (years)	24.6 ± 16.53	26.20 ± 19.52	0.561
Defect size (mm)	22.69 ± 5.77	21.49 ± 4.5	0.131
Preoperative hospital stay (days)	6.35 ± 3.42	5.55 ± 3.57	0.135
Chronic gastritis	5 (5.88%)	5 (5.74%)	0.969
Pulmonary hypertension	32 (37.64%)	34 (39.08%)	0.847
Hypertension	5 (5.88%)	5 (5.74%)	0.969

femoral vein puncture, conventional disinfection drape, esophageal ultrasound probe is inserted, 5 to 8 Fr vascular sheath is inserted from the right femoral vein puncture needle. Patients had been given heparin throughout the procedure using adequate dosing to keep the activated clotting time (ACT) greater than 200 seconds, and the sheath is placed along the right femoral vein. Insert the super-hard guide-wire to the right atrium, insert the right heart catheter along the super-hard guide-wire and guide the super-hard guide-wire through the atrial septal defect to the left upper pulmonary vein to establish a track, exit the venous sheath and right heart catheter, and insert the super-hard guide-wire, withdraw the super-hard guide-wire, and deliver the occluder to seal the atrial septal defect. Color Doppler ultrasound shows the position of the occluder, the shape is satisfactory, the traction test is negative (**Figure 2**), and the device is released. Withdraw the conveyor, press the puncture site and bandage, after the operation, remove the tracheal intubation, and return to the ward.

5. Conventional Median Sternotomy Surgical Closure of ASD

In the CMS group, standard median sternotomy was performed, and the usual aortic and bi-caval cannulations were used. Cardioplegia was infused in an antegrade manner via the aortic root cannula, and the ascending aorta was cross-clamped. The right atrium was opened, and the ASD was closed with pericardial patch.

6. Statistical Analysis of Data

Statistical analysis was performed using SPSS for Windows (version 19.0) and quantitative data were expressed as mean ± standard deviation, minimum and maximum ranges where appropriate, Fisher's test was used for categorical variables. A P value less than (<0.05) was considered as indicating statistical significance.

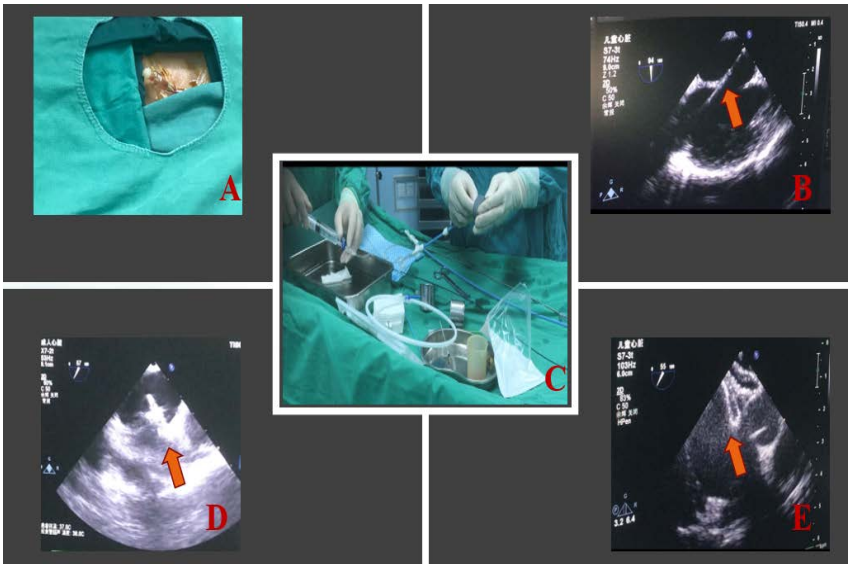


Figure 2. (A) percutaneous puncture of the femoral vein. (B) Insertion of the diagnostic catheter (arrow) through the ASD into the left atrium and introduce an exchange "J" guide-wire into the left atrium. (C) Delivery cable through the loader and screw the device onto the delivery cable. (D) Deployment of the left atrial disc (arrow) and part of the connecting waist. (E) Deployment of the right atrial disc (arrow).

7. Results

Criteria for successful surgery:

CMS surgical success was defined as ASD closure, no residual shunt and no postoperative serious complications, PTD surgical success was defined as device implantation in the proper location, no residual shunt and no postoperative serious complications such as embolism, cardiac perforation, heart erosion, stroke, atrioventricular block.

Post-operative judgment criteria: After each surgery, a transesophageal echocardiogram (TEE) was done to check for any residual shunt or the presence of any hemodynamic abnormality.

The CMS group consisted of 85 patients, 85 (100%) of the patients had been successfully operated on. The mean duration of the operation 205.91 ± 52.76 min (range 130 to 320 min). The mean operation blood loss163.12 ± 125.52 mL, max 500 mL, three patients were implanted with the Pacemaker is demonstrated in (Table 2).

The PTD group consisted of 87 patients, 84 (96.55%) of the patients had devices successfully deployed across the atrial septum, 3 (3.44%) of the patients had operations failures (one of the patients because of the presence of residual shunt after deployment of device, and the others because of the deficient rim). The mean duration of the operation 53.66 ± 28.3 min (range 19 to 156 min). The mean operation blood loss 9.26 ± 9.14 mL, max 50 mL is demonstrated in (Table 2).

Postoperative treatment measures: symptomatic and supportive treatment such as oxygen inhalation, ECG monitoring, fluid supplement and nutritional

Table 2. Operative details of the patients.

	CMS	PTD	P-value
Patients	85	87	
Successful operation	85 (100%)	84 (96.55%)	0.083
Failure of the operation	0 (0%)	3 (3.44%)	
Duration of the operation (min)	205.91 ± 52.76	53.66 ± 28.3	2.849E−48
Operating blood loss (mL)	63.12 ± 125.52	9.26 ± 9.14	3.949E−09
Pacemaker implant	3	0	

support. Special attention was paid to observing the blood supply of the lower limbs, whether there was blood oozing from the wound, pressing the sandbag on the wound for 4 - 6 hours, and keeping the electrolyte stable. Low molecular weight heparin anticoagulation was administered intravenously for 1 - 3 days, and oral aspirin (3 - 5 mg/kg) continued for 6 months to prevent thrombosis after surgery. All patients followed the infective endocarditis prophylaxis instructions for a total of six months after device placement.

The CMS surgical group consisted of 85 patients, we had zero mortality rate, and hundred percent survival rate. The Pericardium mediastinal drainage fluid mean 170.48 ± 117.01 mL, max 730 mL. The Infused blood products mean 159.68 ± 73.17 mL, max 600 mL. The Duration in ICU ranged from 1 day to 4 days, mean was 1.87 ± 0.5 days. The Postoperative hospital length of stay ranged from 5 day to 20 days, mean was 9.33 ± 2.96 days. The Postoperative complications 24 (28.23%), and none of the patients had significant residual shunt, are demonstrated in (**Table 3**).

The PTD group consisted of 87 patients, we had zero mortality rate, and hundred percent survival rate, and we had no Pericardium mediastinal drainage fluid. The Infused blood products mean 90.44 ± 13.79 mL, max 600 mL. The Duration in ICU mean was 1.02 ± 0.34 days, max 2 days. The Postoperative hospital length of stay mean was 4.48 ± 1.73 days, max 10 days. The Postoperative complications 1 (1.14%), only one of the patients had significant residual shunt, is demonstrated in (**Table 3**).

We analyzed the data of the relevant surgical indicators in the two groups. The index-data on the duration of the operation, the infused blood products, the duration in intensive care unit, the postoperative hospital length stays and the morbidity was better in PTD group than in the CMS group. The difference between the two groups was statistically significant ($P < 0.05$).

In the PTD group, there were no cases of device embolization, dislocation, thrombus formation and groin hematoma in patients. In comparison, the incidence of major complications was higher in the CMS surgical group than PTD group. The major complication rate was 1.6% in the device group and 5.2% in the surgical group [3]. There were no PTD or CMS surgical deaths in either group, all patients were discharged in good conditions from the hospital.

Table 3. Postoperative details of the patients.

	CMS	PTD	P-value
Pericardium mediastinal drainage fluid (mL)	170.48 ± 117.01	0	1.158E−08
Infused blood products (mL)	159.68 ± 73.17	90.44 ± 13.79	0.003
Duration in ICU (days)	1.87 ± 0.5	1.02 ± 0.34	8.875E−26
Postoperative hospital length of stay (days)	9.33 ± 2.96	4.48 ± 1.73	1.396E−27
Residual shunt	0	1	
Postoperative complications	24 (28.23%)	1 (1.14%)	4.132E−05
Pericardial effusion	6 (7.05%)	1 (1.14%)	
Pleural effusion	12 (14.11%)	0	
Pulmonary infection	5 (5.88%)	0	
Gastrointestinal bleeding	1 (1.17%)	0	
Survivals	85 (100%)	87 (100%)	

8. Discussion

Even though the CMS patient group had a successful closure, the success rates were not significantly higher than in the patients who underwent transcatheter percutaneous device closure of their ASDs. This is in accordance with a previous report from a single institution with a large experience in surgical and transcatheter device closure of ASD [6].

Our study finding shows that the duration of the operation of the PTD group is much shorter than that of the CMS group. We do not need pericardial mediastinal drainage in the PTD group compared to the CMS group which does and has a significant amount of mediastinal volume drainage. The PTD group required less infused blood products than patients in the CMS group. The duration in intensive care is much shorter for patients in the PTD group compared to the CMS group. The patients in the PTD group had a shorter postoperative hospital length stay than patients in the CMS group, and the PTD group patients had less morbidity after surgery compared to CMS group of patients, all these findings have been also reported in other studies [7]. Successful device implantation rate of ASD closure was 97.9% - 98.7% [8].

Our study describes the advantages disadvantages and complications of both surgical techniques, from previous studies showed that both surgical procedures were all safe and effective for ASD closure with their own advantages and disadvantages. Besides the fact that in both groups we had zero mortality rate, this finding is in accordance with the previous reports in the other studies [9].

There was a thorough analysis of the sample data for both of CMS and PTD ASD closure, and studies comparing transcatheter and surgical repair have been reported [10] Berger F. and his co-workers published a series of 61 patients who underwent ASD surgical repair at a median age of 20 years (0.5 - 74 years) and

61 patients who underwent transcatheter Amplatzer device closure for ASD at a median age of 12 years (0.8 - 77.7 years). Their results showed that similar complete closure and complication rates in both groups, short duration of hospital stay with less morbidity in the device group. The results showed that device closure for ASD was a safe and feasible technique in select patients, this approach has the advantages of a lower cost, better cosmetic results, and less trauma than surgical closure [5]. The relatively lower cost of transcatheter group likely reflects shorter length of hospitalization and shorter/lack of intensive care unit stays, these lead to a subsequent reduction of pharmacy, respiratory, nursing, radiology, laboratory and transfusion costs [11].

In our study, 3.44% of patients within the percutaneous transcatheter device group had a failed procedural attempt for different reasons. Two of these failures were due to the insufficient of the rims, the other because of the significant presence of residual shunt after deployment of device. A residual shunt is a common complication of device closure for ASD, especially for patients with a large ASD, trivial or small residual shunts (<2 mm) occurring immediately after the occluder deployment can be ignored since they usually disappear during the follow-up period [12]. All these patients underwent successful CMS surgical closure of their ASD. Anatomical conditions such as insufficient rims or the presence of abnormal pulmonary drainage are limitations for closure of the ASD device. According to previous reports and clinical observations, occluder dislodgment or embolization is a rare but severe complication of device closure procedures [12]. Therefore, although transcatheter closure of an ASD has similar effectiveness to surgical closure, surgery will still be necessary for patients with ASD not suitable for device closure. The PTD closure is sometimes limited by the weight of the patient and peripheral vascular access.

9. Follow up

There were no PTD or CMS surgical deaths in either group; all patients were discharged in good conditions from the hospital. The follow-up period was 3 - 6 months. All patients underwent a physical examination, and electrocardiography. In both PTD and CMS groups we observed, no significant residual shunt, endocarditis, cerebral embolism, malignant arrhythmia, severe complications or death. In PTD group no cardiac perforation, aortic laceration, cardiac valve distortion, or device dislodgment was observed during the follow-up period.

10. Limitations of This Research

First, this study is limited by its retrospective nature. There may be a selection bias in the data collection, which may have reduced the reliability of the conclusions, the sample size of the study population was small, also this was a single institution study, and a multi-center study is needed to gain further evidence.

Second, we relied on the advanced experience of our domestic and foreign counterparts and our own clinical experience to determine the surgical plan; it is

therefore not a randomized controlled study, but it still has some clinical significance.

Third, the choice of surgical procedures for some patients was decided by the wishes of the patients, their parents or relatives. The cardiovascular surgery department of our hospital also performs ASD closure by intraoperative closure of the device, this group of patients is not included in this study.

fourth, lack of data on mid-term and long-term follow-up. We aim to continue monitoring this group of patients from a multi-angle observation to compare whether there is a difference in medium and long-term efficacy.

11. Conclusion

CMS and PTD for ASD are safe, feasible, and effective. With more advantages like shorter duration of operation procedure, no requirement of blood products transfusion, no thoracotomy, better cosmetic effect, shorter duration in ICU, less morbidity and shorter hospital length of stay PTD for ASD is the best choice for patients, who meet all the appropriate conditions to benefit from this procedure. In case patients do not qualify for PTD procedure, CMS closure can be performed as an alternative.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Van der Linde, D., Konings, E.E.M., Slager, M.A., *et al.* (2011) Birth Prevalence of Congenital Heart Disease Worldwide: A Systematic Review and Meta-Analysis. *Journal of the American College of Cardiology*, **58**, 2241-2247. https://doi.org/10.1016/j.jacc.2011.08.025

[2] Mills, N.L. and King, T.D. (1976) Nonoperative Closure of Left-to-Right Shunts. *The Journal of Thoracic and Cardiovascular Surgery*, **72**, 371-378. https://doi.org/10.1016/S0022-5223(19)40065-2

[3] Du, Z.D., Hijazi, Z.M., Kleinman, C.S., *et al.* (2002) Comparison between Transcatheter and Surgical Closure of Secundum Atrial Septal Defect in Children and Adults: Results of a Multicenter Nonrandomized Trial. *Journal of the American College of Cardiology*, **39**, 1836-1844. https://doi.org/10.1016/S0735-1097(02)01862-4

[4] Moore, J., Hegde, S., El-Said, H., Beekman III, R., Benson, L., Bergersen, L., Holzer, R., Jenkins, K., Ringel, R., Rome, J., Vincent, R. and Martin, G. (2013) Transcatheter Device Closure of Atrial Septal Defects: A Safety Review. *JACC*: *Cardiovascular Interventions*, **6**, 433-442. https://doi.org/10.1016/j.jcin.2013.02.005

[5] Chen, Q., Cao, H., Zhang, G.C., Chen, L.W., Chen, D.Z. (2012) Safety and Feasibility of Intra-Operative Device Closure of Atrial Septal Defect with Intraoperative Minimal Invasion. *European Journal of Cardio-Thoracic Surgery*, **41**, 121-125.

[6] Qiu, H.F., Chen, Q., Hong, Z.N., *et al.* (2019) Transcatheter and Intraoperative Device Closure and Surgical Repair for Atrial Septal Defect. Journal of Cardiothoracic Surgery, **14**, Article No. 136. https://doi.org/10.1186/s13019-019-0957-0.

[7] Qi, H., Zhao, J., Tang, X., *et al.* (2020) Open Heart Surgery or Echocardiographic

Transthoracic or Percutaneous Closure in Secundum Atrial Septal Defect: A Developing Approach in One Chinese Hospital. *Journal of Cardiothoracic Surgery*, **15**, Article No. 212. https://doi.org/10.1186/s13019-020-01216-w

[8] Turner, D.R., Owada, C.Y., Sang Jr., C.J., Khan, M. and Lim, D.S. (2017) Closure of Secundum Atrial Septal Defects with the Amplatzer Septal Occluder: A Prospective, Multicenter, Post-Approval Study. *Circulation*: *Cardiovascular Interventions*, **10**, e004212. https://doi.org/10.1161/CIRCINTERVENTIONS.116.004212

[9] Villablanca, P.A., Briston, D.A., Rodes-Cabau, J., Briceno, D.F., Rao, G., Aljoudi, M., *et al.* (2017) Treatment Options for the Closure of Secundum Atrial Septal Defects: A Systematic Review and Meta-Analysis. *International Journal of Cardiology*, **241**, 149-155. https://doi.org/10.1016/j.ijcard.2017.03.073

[10] Ooi, Y.K., Kelleman, M., Ehrlich, A., Glanville, M., Porter, A., Kim, D., Kogon, B. and Oster, M.E. (2016) Transcatheter versus Surgical Closure of Atrial Septal Defects in Children: A Value Comparison. *JACC*: *Cardiovascular Interventions*, **9**, 79-86. https://doi.org/10.1016/j.jcin.2015.09.028

[11] Mylotte, D., Quenneville, S.P., Kotowycz, M.A., *et al.* (2014) Long-Term Cost-Effectiveness of Transcatheter versus Surgical Closure of Secundum Atrial Septal Defect in Adults. *International Journal of Cardiology*, **172**, 109-114. https://doi.org/10.1016/j.ijcard.2013.12.144

[12] Lee, W.C., Fang, C.Y., Huang, C.F., Lin, Y.J., Wu, C.J. and Fang, H.Y. (2015) Predictors of Atrial Septal Defect Occluder Dislodgement. *International Heart Journal*, **56**, 428-431. https://doi.org/10.1536/ihj.15-065

List of Abbreviations

ASD: Atrial Septal Defect
CMS: Conventional Median Sternotomy
CPB: Cardiopulmonary Bypass
ICU: Intensive Care Unit
PTD: Percutaneous Transcatheter Device
TEE: Transoesophageal Echocardiographic