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TRANSCATHETER VS. SURGICAL CLOSURE OF ATRIAL SEPTAL DEFECTS IN ADULTS

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Percutaneous transcatheter device closure of secundum atrial septal defects (ASD) has now largely replaced surgical closure in most centres. The aim of this study was to compare results of transcatheter and surgical ASD closure in adults in Latvia during the years 2002–2014 and to analyse long-term outcomes of transcatheter closure. We analysed data from 334 patients with secundum ASD who underwent ASD closure in Pauls Stradiņš Clinical University Hospital. Patients were included into device or surgical closure groups. In the device group, three follow-ups were made 1, 6, and 12 months after the procedure. No follow-up data were available for surgical arm patients beyond their hospitalisation period. The mean age of patients was 45.3 ± 19.9 years for the device group and 40.0 ± 16.9 years for the surgical group (p = 0.023). The mean secundum ASD size in the device and surgical groups was 14.2 ± 5.6 mm and 28.7 ± 10.0 mm, respectively (p < 0.001). No differences were observed regarding procedure success rates: 99.2% in the device group and 100% in the surgical group (p = 0.451). Periprocedural complications generally were more common in the surgical closure group. The study results show a successful introduction of the percutaneous ASD closure method in Latvia with good early and late outcomes and without significant differences in procedure success rate compared to surgical closure.

Key words: *atrial septal defect, grown-up congenital heart disease.*

INTRODUCTION

Atrial septal defect (ASD) in adults is the most common congenital heart disease (GUCH) after bicuspid aortic valve, accounting for 25–30% of all congenital heart defects (CHDs) diagnosed in adulthood (Marelli *et al*., 2006; Lindsey and Hillis, 2007; Van der Linde *et al*., 2011).

Surgical ASD closure is an effective procedure with low mortality (approximately 1%) in patients without significant comorbidities and with excellent long-term results (normal life expectancy and low long-term morbidity) when performed early (patients < 25 years old and without pulmonary arterial hypertension) (Murphy *et al*., 1990; Roos-Hesselink *et al*., 2003).

Transcatheter device closure has become the treatment of choice for patients with amenable secundum ASD anatomy (Warnes *et al*., 2008; Baumgartner *et al*., 2010; Akagi, 2015), providing similar efficacy and haemodynamic benefits compared to surgery (Du *et al*., 2002; Rosas *et al*., 2007; Kutty *et al*., 2011). Being significantly less invasive, it allows to avoid problems associated with open heart surgery (anaesthesia, thoracotomy, cardiopulmonary bypass, etc.) and is also associated with fewer complications and shorter hospital stay, especially in older adults (Du *et al*., 2002; Rosas *et al*., 2007; Ooi *et al*., 2016).

Nevertheless, transcatheter device closure is associated with specific complications and no known equivalent risk for surgical patients. Device embolisation is the most common complication (prevalence 0.55–0.62%), often requiring surgical retrieval (Levi and Moore, 2004; Moore *et al*., 2013). Another rare, but potentially fatal complication is erosion or cardiac perforation (reported only with certain device types), estimated to occur in 0.1% to 0.28% of all cases and reported as late as eight years after deployment (Amin *et al*., 2004; DiBardino *et al*., 2009; Moore *et al*., 2013; Roberts *et al*., 2013). More rarely, device infection with subsequent endocarditis, nickel allergy, thrombus formation or residual/recurrent defect following device closure can occur

(DiBardino *et al*., 2009; Moore *et al*., 2013). As with surgical closure, ASD device closure after the age of 40 years appears not to affect the frequency of arrhythmia development during follow-up (Attie *et al*., 2001; Humenberger *et al*., 2011). After device closure, regular follow-up is recommended during the first 1–2 years and then periodically thereafter (Warnes *et al*., 2008; Baumgartner *et al*., 2010).

The aim of this study was to evaluate safety, efficacy, immediate- and short-term results of ostium secundum transcatheter device closure and to compare the results of isolated secundum ASD closure by transcatheter vs. surgical method in adults treated in the Latvian Centre of Cardiology during the period 2002–2014. Further, we analysed the long-term results of transcatheter closure in terms of safety and late complications — erosions, embolisations and arrhythmias.

MATERIALS AND METHODS

Between June 2002 and December 2014 (12.6 years), 259 adult patients (≥18 years old) with secundum ASD underwent percutaneous device closure in Latvian Centre of Cardiology, Pauls Stradiņš Clinical University Hospital (PSCUH). Concurrently, a national registry for ASD transcatheter device closure was created. We also retrospectively collected data on 75 consecutive patients with secundum ASD who underwent surgical closure in PSCUH in the time period from January 2002 until December 2012 (11 years). The study was approved by the PSCUH Ethics Committee.

Patients were enrolled into device or surgical closure groups. Inclusion criteria for both groups included: 1) the presence of a secundum ASD (diameter of ≤ 38 mm for device group; no limit for surgery group); 2) a left-to-right shunt with a Qp/Qs ratio of ≥ 1.5:1 or the presence of RV volume overload. Additional inclusion criteria for the device group was the presence of an > 5 mm rim of surrounding atrial tissue to the coronary sinus, atrioventricular valves and right upper pulmonary vein as measured by echocardiography. Exclusion criteria for both groups were: 1) ostium primum and sinus venosus ASDs, including partial anomalous pulmonary venous drainage; 2) patients with other associated CHDs (e.g., ventricular septal defect, tetralogy of Fallot) or cardiac pathologies (e.g., valvular heart disease, coronary artery disease) requiring surgical or percutaneous repair. The final decision for patient inclusion in either surgical or device group was made by an interdisciplinary heart team consisting of cardiologists and cardiac surgeons.

Before the procedure, all patients had undergone transthoracic (TTE) or transesophageal (TEE) echocardiography and electrocardiography (ECG).

Secundum ASD device closure was performed under local anaesthesia by puncturing and catheterising the right femoral vein. Stretched (stop-flow) diameter of ASD was measured using a sizing balloon. Two types of closure devices were used in this study: AMPLATZER septal occluder (ASO; St. Jude Medical Inc., St. Paul, Minnesota, U.S.) and GORE HELEX septal occluder (HSO; W.L. Gore and Associates, Flagstaff, Arizona, U.S.). The choice of the device used depended on the size and anatomy of the ASD. The size of the device was 2 mm larger than stretched diameter of ASD in case of deployment of ASO and twice stop-flow diameter in case of HSO.

All procedures were performed with continuous fluoroscopic and TEE monitoring. 100 IU/kg heparin i/v was administered to achieve an activated clotting time > 200 seconds at the time of device deployment along with 1 g cefazolin intravenously. Aspirin 100 mg was initiated 24 h before closure and continued for six months after.

All surgical defect closures were performed under general anaesthesia with cardiopulmonary bypass using median sternotomy and right atriotomy to gain access to the right atrium. The defect was closed either by direct suture or by autologous pericardial patch.

A TTE with colour Doppler was used for patients after surgical closure and before discharge for assessment of any residual shunts. For patients who had device closure, a TEE with colour Doppler was done immediately after the procedure. Patients were considered to have a successful ASD closure if there was a complete closure of the defect or no significant residual shunts (colour jet width ≤ 2 mm). In addition, a chest x-ray, an ECG and a physical examination was conducted in both groups within 24 h after the procedure.

Patients in the device closure group underwent physical examination, an ECG and a TTE with colour Doppler at one, six and twelve months after the procedure. We did not have any follow-up data on surgical arm patients beyond their hospitalisation period.

Statistical methods. The Kolmogorov–Smirnov test was used to assess normality of data. Comparisons of continuous data measured at baseline for the study groups were analysed using the Welch's t-test, assuming the possibility of unequal variances. The Mann-Whitney U test was used to compare days of hospitalisation, right ventricular systolic pressure (RVSP), right atrial (RA) volume index, ASD transcatheter device closure procedure time and fluoroscopy time and length of hospital stay between the two groups, because these data were not normally distributed. The Wilcoxon signed-rank test was used to compare two paired samples of nonparametric data. For categorical variables, we used cross-tabulations and the Pearson's chi-squared test, or Fisher's exact test for 2 × 2 tables when one or more of the cells had an expected frequency of less than 5. IBM SPSS Statistics 21.0 and Microsoft Office Excel 2011 was used for data analysis. Data are reported as mean ± SD or median and interquartile range (IQR) as appropriate. A P value of < 0.05 was considered statistically significant.

RESULTS

Baseline data. A total of 334 patients were enrolled in the study: 259 (77.5%) patients with device closure and 75 (22.5%) patients with surgical closure satisfied the inclusion/exclusion criteria and were included as subjects in each arm of the study. Patient baseline characteristics and procedure-related data in both groups are listed in Table 1.

The patients in device group were older than those in surgical group; mean age was 45.3 ± 19.9 and 40.0 ± 16.9 years, respectively, $p = 0.023$. In both groups, most of the patients were women (77.2% of all patients in the device group and 61.3% in the surgical group). There were no significant differences in mean body mass index between the two groups. Arterial hypertension and recurring headaches were more common in the device group and previously diagnosed congestive heart failure was observed more often in the surgical group, although there was no difference in mean left ventricular ejection fraction between the groups. Also, there were no significant differences with respect to presence of other previous/ongoing medical conditions between the patients in the two study arms.

Table 1

COMPARISON OF DEMOGRAPHIC AND BASELINE CLINICAL CHARACTERISTICS BETWEEN DEVICE AND SURGICAL CLOSURE GROUPS

	Device patients (n = 259)	Surgical patients (n = 75)	*p* value
Age, years (range)	45.3 ± 19.9 (18-79)	40.0 ± 16.9 (18-76)	0.023
Females	200 (77.2%)	46 (61.3%)	0.06
BMI, kg/m^2	24.9 ± 5 .3	24.8 ± 5.3	0.921
Medical history			
Arterial hypertension	80 (30.9%)	6 (8.0%)	< 0.001
Diabetes mellitus	7 (2.7%)	3 (4.0%)	0.699
Myocardial infarction	4 (1.6%)	3 (4.0%)	0.193
Congestive heart failure	158 (61.0%)	67 (89.3%)	< 0.001
Supraventricular tachyarrhythmia	48 (18.6%)	12 (16.0%)	0.545
Previous stroke/TIA	12 (4.6%)	0 (0.0%)	0.075
Headaches	26 (10.0%)	2 (2.7%)	0.021
Palpitations	56 (21.6%)	15 (20.0%)	0.762
Vertigo	23 (8.9%)	5 (6.7%)	0.359
Echocardiographic findings			
LV ejection fraction, %	64.3 ± 6.7	62.7 ± 9.6	0.208
Atrial septal aneurysm	44 (17.0%)	5 (6.7%)	0.026
Number of ASD defects:			0.817
One	229 (88.4%)	68 (90.7%)	
Two	24 (9.3%)	6 (8.0%)	
Three and more	6 (2.3%)	1 (1.3%)	
Primary secundum ASD size on TEE, mm	14.2 ± 5.6	28.7 ± 10.0	< 0.001
RA dilatation on TTE (visual assessment)	125 (48.3 %)	65 (86.7%)	< 0.001
RV dilatation on TTE (visual assessment)	134 (51.7%)	63 (84.0%)	< 0.001
RV basal diameter on TTE, mm	42.5 ± 8.9	46.5 ± 8.0	0.789
RVSP, mmHg, median (IQR)	37.0 (30.0–45.0)	45.0 (37.5–60.0)	< 0.001
TR grade, median (IQR)	1 (1–2)	2 (1–2)	0.008

ASD, atrial septal defect; BMI, body mass index; IQR, interquartile range; LV, left ventricle; RA, right atrium; RV, right ventricle; RVSP, right ventricular systolic pressure; TEE, transesophageal echocardiography; TIA, transient ischemic attack; TR, tricuspid regurgitation; TTE, transthoracic echocardiography.

Atrial septal aneurysm was more common in device closure group patients, $p = 0.026$. Signs of right heart volume overload were more frequently observed in the surgical closure group: dilatation of right atrium (RA) and right ventricle (RV) was present in 86.7% and 84.0% of the surgical group patients, respectively, compared with 48.3% and 51.4% of patients in the device group, $p < 0.001$ in both cases. However, right heart dilatation was not significantly more pronounced in the surgical group — mean RV diameter was 46.5 ± 8.0 mm compared to 42.5 ± 8.9 mm in the device group, $p = 0.789$. Nevertheless, surgical group patients had significantly higher median RVSP (45.0 mmHg, IQR 37.5–60.0 mmHg) and median tricuspid regurgitation (TR) grade (grade 2), compared to device group median RVSP (37.0 mmHg, IQR 30.0–45.0 mmHg) and TR grade (grade 1), respectively. These findings could be explained by the significantly larger defects in the surgical group (28.7 ± 10.0 mm) than in the device group (14.2 ± 5.6 mm), $p < 0.001$.

Immediate- and short-term results. In the device closure group most (n = 231, 89.2%) patients underwent closure with ASO, 28 patients (10.8%) had ASD closed with HSO. In one case there was a change from HSO to ASO due to the problems with the positioning of the device; due to a deficient antero-superior (aortic) rim, the HSO was prolapsing to the right atrium creating a significant residual shunt. Generally, ASO was used for closure of significantly larger ($p < 0.001$) ASDs (primary secundum ASD size on TEE — 14.8 ± 5.6 mm), than HSO (ASD size — 9.1 ± 2.0 mm), although the median diameter of HSO was larger than that of ASO because of the technical properties of this device: 25 mm (IQR 20.0–28.75 mm) and 19.0 mm (IQR 15–24 mm), respectively, $p < 0.001$. The comparison of immediate closure results, procedure related data, intra- and periprocedural complications and length of hospital stay between the both study arms is demonstrated in Table 2.

In the surgical closure group, all (100%) patients had a successful operation with only three patients (4%) having insignificant residual shunt postoperatively, whereas success rate in the device group was 99.2%. with two patients (0.8%) having significant residual shunt and 134 patients (51.7%) having insignificant residual shunt.

Mean stretched ASD diameter in the device group was 17.6 ± 5.9 mm. Median percutaneous procedure duration was 45 minutes (IQR 35–60 minutes), median fluoroscopy time was 8.1 minutes (IQR 5.4–12.2 minutes). During surgical

Table 2

COMPARISON OF IMMEDIATE CLOSURE RESULTS, PROCEDURE RELATED DATA, INTRA- AND PERIPROCEDURAL COMPLICATIONS BETWEEN DEVICE AND SURGICAL CLOSURE GROUPS

	Device patients (n = 259)	Surgical patients (n = 75)	*p* value
Successful procedures	257 (99.2%)	75 (100%)	0.451
Insignificant residual shunt	134 (51.7%)	3 (4.0%)	< 0.001
Significant residual shunt	2 (0.8%)	0	
Stretched ASD diameter, mm	17.6 ± 5.9	N/A	-
Procedure time, minutes, median (IQR)	45 (35-60)	N/A	-
Fluoroscopy time, minutes, median (IQR)	8.1 (5.4-12.2)	N/A	-
CPB time, minutes	N/A	61.9±32.3	-
Reperfusion time, minutes	N/A	21.9±9.7	-
Length of hospital stay, days, median (IQR)	2 (2–3)	13 (11–16)	< 0.001
Intraprocedural complications	1 (0.4 %)	0	0.59
Device embolization	1 (0.4 %)	N/A	-
Periprocedural complications			
Reoperation	N/A	4 (5.3%)	-
Stroke/TIA	0	2 (2.7%)	0.05
New-onset cardiac arrhythmias	7 (2.7%)	1 (1.3%)	0.277
Pericardial effusion	16 (6.2%)	22 (29.3%)	< 0.001
Death	0	1 (1.3%)	0.225

ASD, atrial septal defect; CPB, cardiopulmonary bypass; IQR, interquartile range; TIA, transient ischemic attack. N/A = not available/applicable

ASD closure, mean cardiopulmonary bypass time was 61.9 ± 32.3 minutes and reperfusion time — 21.9 ± 9.7 minutes. Median length of hospital stay was significantly longer ($p < 0.001$) in the surgery group (13 days, IQR 11–16 days), in comparison with the device group (2 days, IQR 2–3 days).

While no intraprocedural complications were observed in the surgery group, there was one case of device embolisation immediately after the disconnection of the delivery cable in the device group. The device was retrieved percutaneously by snaring it from the descending aorta by transfemoral arterial approach without any further complications and subsequent ASD closure was successful. Postprocedural new-onset cardiac arrhythmias (most commonly- atrial fibrillation) more often occurred in the device group, although the difference did not achieve statistical significance (7 (2.7%) and 1 (1.3%), respectively, $p = 0.277$)

In general, surgical arm patients more often had periprocedural complications, even though statistical significance was attained only regarding pericardial effusion rate, where nearly a third (29.3%) of surgical group patients developed this complication (although in most cases the effusion was clinically insignificant), compared to 6.2% of patients in the device group, $p < 0.001$. Four surgical group patients required reoperation: one patient developed cardiac tamponade, another patient developed clinically significant bleeding and one patient developed mediastinitis with following clinical deterioration and death. In one case the cause of reoperation is unknown.

Table 3

FOLLOW-UP DATA FOR THE DEVICE CLOSURE GROUP

Parameter	Value
Follow-up time, months; median (IQR)	12 (6–36)
Total follow-up time, person-years	465
Number of patients completed	
30-day follow-up	217 (83.8%)
6-month follow-up	146 (56.4%)
12-month follow-up	145 (56.0%)
RV diameter on TTE, mm	
At 30-day follow-up	34.0±7.7
At 6-month follow-up	34.4±7.6
At 12-month follow-up	34.2±7.3
RV systolic pressure, mmHg, median (IQR)	
At 30-day follow-up	34 (29-38)
At 6-month follow-up	30 (25-37)
At 12-month follow-up	30 (25-35)
Significant residual shunt ≤ 30 days	2 (0.9%*)
Significant residual shunt > 30 days (events per 100 person-years)	1 (0.2)
Insignificant residual shunt ≤ 30 days	59 (27.2%*)
Insignificant residual shunt > 30 days (events per 100 person-years)	32 (6.9)
Cerebrovascular events ≤ 30 days	0
Cerebrovascular events > 30 days (events per 100 person-years)	0
Cardiac arrhythmias ≤ 30 days	20 (9.2%*)
Cardiac arrhythmias > 30 days (events per 100 person-years)	13 (2.8)
Major complications during follow-up period (events per 100 person-years)	1 (0.2)
Device embolisation during follow-up period (events per 100 person-years)	0

RV, right ventricle; TTE, transthoracic echocardiography; * percentage calculated from patients who completed respective follow-up

Follow-up. A total of 217 (83.8%) patients in the device group completed one-month follow-up, 146 (56.4%) patients had six-month follow-up and 145 (56.0%) patients had their evaluation completed at twelve-month follow-up. 119 (45.9%) patients were followed-up for more than 12 months. Median follow-up was 12 months. Total follow-up was 465 person-years. Table 3 demonstrates device group follow-up data.

Comparing data in the device group at baseline and at 30-day follow-up, there was a significant reduction in RV diameter from 42.5 ± 8.9 mmHg to 34.0 ± 7.7 mmHg, respectively ($p = 0.009$); median RVSP also decreased significantly, from 45 mmHg to 34 mmHg, respectively ($p < 0.001$).

No further significant changes ($p = 0.932$) were observed in mean RV diameter at 12-month follow-up when compared to 30-day follow-up; nevertheless, further reduction in me-

dian RVSP was seen, from 34 mmHg to 30 mmHg, respectively, $p = 0.001$. In two cases, there was a significant residual shunting present at 30-day follow-up: one patient underwent successful device closure two years later; the other patient's shunt had decreased at six-month follow-up and was classified as insignificant. Of the 217 patients who completed 30-day follow-up, 59 patients (27.2%) had nonsignificant residual shunt and 20 patients (9.2%) had cardiac arrhythmias (atrial flutter or fibrillation). Of the 146 patients who were followed up at least 6 months, nonsignificant residual shunt was observed in 32 patients (21.9%) and cardiac arrhythmias in 13 patients (8.9%).

There were no known cerebrovascular events or device erosion/embolisation during follow-up period, although one patient required explantation of HSO and subsequent surgical closure six years after initial device closure due to symptoms caused by significant left-to-right shunt through patent foramen ovale (PFO). The shunt resulted from the device stretching the concurrent PFO. Postoperative echocardiography confirmed complete closure.

Changes in secundum ASD closure technique. Analysing ASD closure rate per year, there was a trend towards increase in number of procedures performed percutaneously since the introduction of this method in June 2002, with concurrent decrease in number of surgical closures (Fig. 1). We were not able to obtain any data regarding surgical ASD closure after 2012.

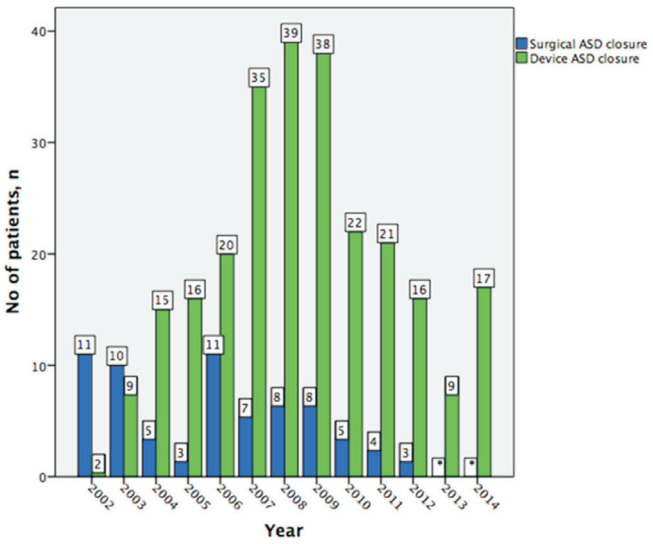

Fig. 1. Patient distribution by year and by procedure type. * – no data.

DISCUSSION

Surgery, once being the only available method of CHD correction and for a long time being the gold standard of treatment for such defects, nowadays is being partially replaced by percutaneous transcatheter treatment, which has become the method of choice for certain CHDs like secundum ASD, which in most cases is amenable to percutaneous closure. Nevertheless, there are several conditions that still require surgery (large defect, deficient rim of surrounding atrial tissue, etc.).

The present study reports the status of secundum ASD percutaneous management in adults in Latvia over a time period of more than 10 years. Study results reflect the changes in management of secundum ASDs. Since the introduction of percutaneous transcatheter treatment in mid-2002, there was an increasing number of patients who underwent device closure, with simultaneous decrease in number of surgical closures, resulting in ratio of device to surgical patients (during 2002–2012 period) of approximately 3 : 1. Although there was a noticeable drop in number of transcatheter procedures performed after 2009, these changes are linked to decrease in prevalence of patients who (before the availability of percutaneous closure) had refused surgery due to its invasive nature, and also to our country's economy status, which influenced the maximum number of these procedures per year.

Patients who underwent surgical closure generally had a more serious baseline condition; they had larger ASDs and, therefore more frequently had signs of volume overload in the right heart and pulmonary vasculature, resulting in increased frequency of symptoms, with these changes occurring at a younger age than in patients in the device group.

The study results confirm that device closure is a safe and effective alternative to surgery when appropriate, as 99.2% of device closures were successful and there was no significant difference in procedure success rate compared to surgical closure, even though insignificant postprocedural residual shunt was observed in ≈ 50% of all device closure cases. However, the shunt was detected in only 27% of patients who completed 30-day follow-up due to device endothelialisation and subsequent spontaneous closure. Device embolisation was observed in 0.4% of all cases, which is similar to previously published data. Also, device closure was associated with fewer periprocedural complications and resulted in a shorter hospitalisation period.

ASD closure had a beneficial influence on patients' hemodynamic status. After one-month volume overload both in right heart and pulmonary vascular bed had significantly decreased, when compared to the baseline.

Regarding long-term safety, there were no life-threatening complications after device implantation. No cerebrovascular events or device erosion/embolisation occurred at any time during the follow-up period, even though there was one late complication requiring surgical intervention.

Study limitations include its retrospective design and relatively large proportion of patients lost to follow-up: 16.2%, 43.6%, and 44% of patients in the device group were lost to follow-up at one-month, six-months and one-year, respectively.This was possibly due to the retrospective long-term design of the study, meaning that a number of patients underwent follow-up at their place of residence, not PSCUH. This was due to the retrospective long-term design

of the study, where some patients were followed-up at their place of residence, and some patients had emigrating. We included in the study analysis only well-documented data from our centre. However, no serious adverse events or death due to device failure were reported to the study authors.

CONCLUSIONS

Our results reflect a successful introduction of the minimally invasive ASD closure method in Latvia with good early and late outcomes and with fewer periprocedural complications and shorter hospitalisation period when compared to surgical closure. However, as currently most commonly used transcatheter devices are not biodegradable and the method is relatively new, further studies are needed to evaluate long-term safety of these devices.

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TRANSKATETRĀLA UN ĶIRURĢISKA ĀTRIJU STARPSIENAS DEFEKTU SLĒGŠANA PIEAUGUŠAJIEM

Perkutāna transkatetrāla ātriju starpsienas *secundum* tipa defektu (ASD) slēgšana aizvieto ķirurģisku slēgšanu vairumā centru. Pētījuma mērķis bija salīdzināt transkatetrālas un ķirurģiskas ASD slēgšanas rezultātus pieaugušajiem Latvijā laikā no 2002. līdz 2014. gadam un analizēt ilgtermiņa rezultātus transkatetrālas slēgšanas grupā. Tika analizēti 334 pacientu dati, kuriem P. Stradiņa Klīniskajā universitātes slimnīcā veikta ASD slēgšana. Pacienti tika iedalīti transkatetrālas un ķirurģiskas slēgšanas grupās. Transkatetrālas slēgšanas grupai tika veikta apsekošana pēc 1, 6 un 12 mēnešiem. Pacientu vidējais vecums bija 45,3 ± 19,9 gadi transkatetrālas un 40,0 ± 16,9 gadi ķirurģiskas slēgšanas grupās ($P = 0.023$). Vidējais *secundum* tipa ASD izmērs transkatetrālas un ķirurģiskas slēgšanas grupās bija attiecīgi 14,2 ± 5,6 mm un 28,7 ± 10,0 mm ($p < 0{,}001$). Netika novērotas būtiskas atšķirības procedūru sekmīgā iznākumā — tie bija 99,2% transkatetrālas slēgšanas un 100% ķirurģiskas slēgšanas grupās ($p = 0{,}451$). Periprocedurālas komplikācijas kopumā bija biežāk sastopamas ķirurģiskas slēgšanas grupā. Pētījums parāda veiksmīgu ASD transkatetrālas slēgšanas metodes pielietojumu Latvijā, uzrādot labus agrīnus un vēlīnus iznākumus un neuzrādot būtiskas atšķirības procedūru sekmīgā norisē, salīdzinot ar ķirurģisku ASD slēgšanu.