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RESEARCH ARTICLE

Outcome comparison between transcatheter closure and surgical closure of atrial septum defect

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Introduction: Atrial septal defect (ASD) is a common congenital heart defect found in both children and adults, with potential serious complications if not addressed. Transcatheter device closure is a less invasive alternative to surgical correction, particularly for patients not suitable for the former.

Materials and Method: Patients and Methods: The study included 114 individuals treated at Ibn Al-Bitar Cardiac Surgery Center from June 2023 to July 2024. Patients with secundum ASD could choose between transcatheter or surgical closure, meeting specific defect criteria except for complex cases requiring surgery. Patients received information on risks, outcomes, and selected their preferred method. Surgical closures used cardiopulmonary bypass, while transcatheter procedures utilized the Amplatzer Septal Occluder.

Results: In comparison to surgical intervention, transcatheter closure demonstrated faster procedure times, no requirement for ICU admission, and shorter hospital stays. It achieved a higher success rate (97.8% vs. 91.3%) with fewer complications. Surgical procedures were more prone to complications such as wound infections and pneumonia, whereas device embolization was exclusive to the transcatheter cohort. Additionally, residual ASD occurrences were reduced in the transcatheter group

Conclusion: Transcatheter closure emerges as a safer, more efficient, and minimally invasive alternative to surgical repair for appropriate secundum ASD cases. However, surgical intervention remains vital for complex scenarios, highlighting the importance of meticulous patient selection and tailored interventions to enhance results. Additional research is warranted to evaluate the extended effects over time.

Keywords: atrial septal defect, surgery, device

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Introduction

Congenital malformation of the heart is one of the leading causes of death during infancy[1], ASD is one of the congenital heart disease; it occurs in 10 % of children and often occurs following an aortic bicuspid valve in adult patients [2] .Undiagnosed ASD can lead to various complications like arrhythmias of the atrium, paradoxical embolization, cerebral abscess, right ventricle volume overload with late failure, and irreversible pulmonary hypertension, causing right-to-left shunting in Eisenmenger syndrome, often showing no symptoms until adulthood [3].

In most patients with ASDs secundum, percutaneous transcatheter device closure serves as a superior option to surgical repair. Surgical intervention is advisable for individuals with secundum ASD who are not eligible candidates or unable to undergo percutaneous repair[4].

Historically, repairing ASDs involved a median sternotomy, but over time, minimally invasive techniques such as robotic procedures have become more common [5].

In cases of secundum, primum, and sinus venosus ASD repair, surgical treatment typically involves the use of a pericardial or Dacron patch closure. It is generally advised against opting for primary closure (suture closure) of the defect [5,6].

For individuals with secundum ASDs meeting specific anatomic criteria, Percutaneous device closure provides a different option to surgical closure [7]. Three devices approved by US Food and Drug Administration and CE-mark are currently accessible for percutaneous ASD closure [8].

Severe and fixed pulmonary hypertension is typically a reason to avoid closing an ASD. Nevertheless, advancements in managing patients with pulmonary vascular disease, coupled with innovative percutaneous closure methods, may render ASD closure viable in such cases [9,10].

Recently, researchers have been using multiple imaging modalities to increase diagnostic efficacy [11].

Aim of study

The goal of our research was to evaluate the safety and effectiveness of percutaneous device closure for ASD II in comparison to the outcomes of simultaneous surgical repair within a single medical facility.

Materials and methods

The study examined 114 patients who had surgery or device closure for secundum ASD to see how well the procedures went and what the results were hospitalized at Ibn al-bitar tertiary center for cardiac surgery. The study period ranged from June 2023 to July 2024, and patients underwent early or late follow-up. Inclusion criteria for both groups had to meet certain criteria: a solitary secundum ASD (up to a 30 mm diameter for the device group and no size limit for the surgery group), a Qp/Qs ratio of one and half to one in a left-to-right shunt, or patients with a small defect but a his-

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tory of paradoxical embolism. The study excluded patients with concomitant cardiac abnormalities (ventricular septal defect, tetralogy of Fallot, pulmonary stenosis) that needed surgical treatment, as well as patients with other forms of ASD (foramen primum, sinus venosus, etc.).

This study also excluded patients with multiple defects that were not suitable for closure using a device or those located in areas that were deemed too risky for the intervention, such as near the superior vena cava, atrioventricular valve, coronary sinus, or pulmonary veins. Patients who met the inclusion criteria for both procedures were given the choice to select their preferred procedure. Prior to making their decision, they were fully informed about the potential risks associated with each group, such as the risk of embolization with the interventional group and a higher rate of complications with the surgical group.

Depending on the anatomical features and the size of the defect, different surgical methods were used to close it.

The Occluder septal type from Amplatzer was used; the Amplatzer device was selected as the only FDA approved occluder available in our center. Access to the femoral vein is typically achieved on the right side, utilizing a 6 to 8 Fr sheath size. Heparin was given to achieve an activated clotting time (ACT) of over 200 seconds during device deployment, along with intravenous ceftriaxone (dose of 50mg/kg). To ensure normal pulmonary vascular resistance, right heart catheterization was performed. The defect was sized using ballooning size. As long as the defect had sufficient rims more than 5 mm, a device 2 mm larger than the stretched balloon diameter was selected. In the case that the superior/anterior rim had insufficient strength, a device with a diameter of 4 mm was chosen over the diameter of the balloon. The occluder was anchored with a guide wire over the left or right upper pulmonary vein, and its situation was confirmed using fluoroscopy and echocardiography. After confirmation, the device was released.

The patients were followed up post-procedures, at discharge time, after one month and six months.

Results

This study is a prospective study at Ibn Al-Bitar specialized center for cardiac surgery in Baghdad, from June 2023 to July 2024. Our study involved 114 patients who were diagnosed with ASD secondum.

The comparison shows demographic and clinical data for patients choosing surgical or device closure for secundum atrial septal defect (ASD). the average age of patients opting for device closure was slightly higher. This suggests that device closure is feasible and safe for a broader age range, including both younger and older patients (Table 1).

Our study illustrates that the device procedure is less invasive, has shorter procedure times, does not require ICU stay, and results in a reduced overall hospital stay compared to surgical closure. Additionally, it indicates a higher success rate and fewer remaining ASDs with the device procedure (Table 2).

Device closure has fewer complications than surgical closure overall. Nonetheless, device embolization is a specific risk with this method (Table 3-5).

Discussion

ASDs make up 10% of all heart malformations in children [2]. Without correction, they can result in early death due to congestive heart failure[12]. The risk of pulmonary arterial hypertension is higher in people with ASD and left-to-right shunts [13]. Both children and adults presented with pulmonary hypertension. These findings were seen

Table 1. Discrepancies of clinical and demographic information between the surgical and device closure groups

Data	Device procedure	Mean	SD	Surgical procedure	Mean	SD
Total	91			23		
Age	4 - 77 YEARS	40.00	21.07	10 - 66 YEARS	38.00	16.17
Size of ASD	4 - 30 mm	17.00	7.51	22 - 40 mm	31.00	5.20

Table 2. Surgical closure and device closure groups were compared for their operation and postoperative results.

Post op	Surgical procedure	Mean	SD	Device procedure	Mean	SD
procedure duration	2-4hr	3	0.58	20 minutes	0.33	0.00
ICU admission duration	2-4 days	3.00	0.58	0	0	0
Hospital stay duration	2-7 days	4.50	1.44	1-2 days	1.50	0.29

Table 3. Complications of ASD closure

complications	Surgical procedure	%	Device procedure	%
Wound Infections/Groin Hematoma	3	13%	0	0
Pneumonia	4	17.39%	0	0
Pericardial Effusion	0	0	0	0
Pleural Effusion	4	17.39%	0	0
Pneumothorax	1	4.35%	0	0
Device Embolization	0	0	2	2%
Reopening	1	4.35%	0	0
Device Endocarditis	0	0	0	0
Arrhythmias	6	26.09%	2	2.20%
Readmission within 30 days	4	17.39%	1	1.10%

Table 4. Success scores

	Surgical	%	Device	%
Residual ASD	4 from 23	17.3%	2 from 91	2.2%
Success closure	21from 23	91.3%	89 from 91	97.8%

Table 5. P values and confidence intervals

Variable	95% Confidence interval	P value
Procedure duration	(2.48, 2.86 hrs)	0.043 S
Hospitalization	(2.54, 3.46 days)	0.0029 S
ICU staying	(2.76, 3.24 days)	<0.001 S
Success rate differences	(-18.5, +5.5%)	0.379 Ns
Rate of complication differences	(19%, 57%)	0.0274 S
Difference of residual ASD	(-0.9%, +3.1%)	0.0167 S

on echocardiograms, and the patients' outcomes improved with treatment [14].

Our study, like the study by Chambault et al. (2022), found that transcatheter ASD closure has fewer complications and shorter hospital stays than surgical closure, with no significant variance in mortality rates [15]. According to the research conducted by Rigatelli et al. (2021), who agree with our study, by comparing surgical methods, transcatheter closure of secundum atrial septal defects showed lower in-hospital mortality, perioperative stroke, and post-procedural atrial fibrillation [16]. Our study, like that of Kodaira et al. and colleagues (2017), showed that transcatheter closure achieved high success rates with no fatalities and fewer adverse events when contrasted with minimally invasive surgical methods [17].

The study conducted by Kotowycz et al. (2013) disagrees with our study; it was observed that there was no notable variance in long-term mortality rates between surgical and transcatheter ASD closures, indicating that the advantages of transcatheter procedures may not have a lasting impact on survival rates [18]. Our study disagrees with a study by Qiu et al. (2019); transcatheter closure is less invasive, but surgical repair might be more suitable for specific patients, particularly those with larger or more intricate defects, signifying the need for a personalized approach in selecting the appropriate procedure [19]. The study by Honghiranrueng et al. (2024) also contradicts our findings, emphasizing that while transcatheter ASD closure is generally safe, it may result in adverse outcomes such as new-onset atrial fibrillation and pulmonary hypertension in specific cases. This highlights the crucial role of careful patient selection and ongoing monitoring [20].

Patient treatment choice was based on informed preference rather than randomization, and introducing a selection bias was one of our study limitations, in addition to one type of septal occluder device.

Further extended follow-up studies are necessary to assess the outcomes and complications in these patients.

Conclusion

Transcatheter device closure for secundum atrial septal defects (ASDs) is considered safer, more efficient, and associated with faster recovery times compared to surgical interventions. It achieves higher success rates and fewer complications, making it the preferred option for eligible patients. However, surgical repair remains crucial for complex cases, highlighting the importance of careful patient selection. Further long-term studies are necessary to assess outcomes and complications in specific subgroups.

Authors contribution

MRH – Conceptualization, Data curation, Investigation, Methodology, Project administration, Resources, Software, Supervision, Visualization, Writing editing

NYA – Data curation, Formal Analysis, Funding acquisition, Methodology, Project administration, Software, Supervision, Validation, Writing – original draft

MYA – Data curation, Formal Analysis, Funding acquisition, Methodology, Project administration, Software, Supervision, Validation, Writing – original draft

NNA – Conceptualization, Data curation, Investigation, Methodology, Project administration, Resources, Software, Supervision, Visualization, Writing editing

Conflict of interest

None to declare.

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