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Outcome of Atrial Septal Closures, Catheterizations vs Surgery

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ABSTRACT

Background: Atrial septal defects (ASDs) are common congenital heart defects in children, with secundum ASD being the most prevalent. While surgery was once the main treatment, catheter-based closure now offers a less invasive alternative. Treatment choice depends on factors such as the child's age, defect size and location, and overall health. **The aim of the study:** is to identify the optimal ASD closure strategy in children by comparing the effectiveness and complication rates of surgical and transcatheter closure approaches **Methods:** This retrospective study analyzed 114 children (ages 2–20) with ASD who underwent surgical or transcatheter closure at Sulaymaniyah Cardiac Hospital and Anwar Sheikha Medical City between 2007 and 2023. Transthoracic echocardiography guided diagnosis and follow-up. Outcomes assessed included procedural success, complications, mortality, hospital stay, recovery time, recurrence, and reintervention. **Results:** This study included 114 children with a median age of 5 years; ASD was more common in females, particularly with larger defects. Most patients were from Sulaymaniyah, and over half had large ASDs. Treatments included transcatheter closure and surgery. The majority had no postoperative complications, though complication rates were slightly higher after surgery. Treatment selection depended on defect size, with larger ASDs typically managed surgically. Surgery was mainly performed in public hospitals, offering lower costs but potentially longer wait times. C**onclusion:** Surgical ASD closure was associated with higher costs and more complications than transcatheter closure. Larger defects were more often treated surgically, highlighting the need for personalized treatment based on defect size, patient factors, and resource availability.

Keywords: Atrial Septal Defects, Pediatric, Congenital, Transcatheter, Surgery.

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INTRODUCTION

Atrial septal defect (ASD), the most common cardiac anomaly, constitutes 8–10% of congenital heart disease (CHD) cases [1]. ASD is characterized by an interatrial septal defect that allows pulmonary venous return from the left atrium to flow directly into the right atrium [2]. The decision to repair any type of ASD is influenced by clinical and echocardiographic data, including the location and size of the defect, the degree and hemodynamic impact of the left-to-right shunt, and the presence and extent of pulmonary arterial hypertension [3]. Surgical closure, first implemented in 1953, has been the gold standard for many years. In contrast, percutaneous ASD closure was first performed in 1975 [4]. Currently, cardiopulmonary bypass (CPB) with surgical correction is the accepted treatment for ASD [5, 6]. Transcatheter closure is another common method for treating secundum ASDs. It offers a less invasive procedure with quicker recovery and less physical and psychological impact than surgery [7]. Given the widespread application of transcatheter ASD

closure today, it is critical to assess its effectiveness as a crucial component of comparative analyses. Indeed, the American Heart Association and American College of Cardiology increasingly emphasize the significance of value assessments when creating guidelines [8].

Although the incidence of long-term complications in consecutive series of patients operated on at an early age is undetermined, survival is generally good after early repair of atrial septal defects. Potential sequelae include sinus node dysfunction, atrial fibrillation and flutter, right ventricular dilatation, pulmonary hypertension, and left ventricular dysfunction [9, 11-15]. Despite both procedures appearing to have similarly positive results, there is insufficient information to determine whether transcatheter or surgical ASD closure is a more valuable option [8].

This study primarily aims to determine which method of ASD closure—surgical or transcatheter—is more significant in terms of outcomes, complications, and cost-effectiveness.

METHODS

This retrospective cross-sectional study, encompassing 114 patients diagnosed with ASD, utilized data from the Teaching Hospital in Sulaymaniyah and Anwar Sheikha Medical City. The primary variables under investigation included age (ranging from 2 to 20 yrs, sex, and ethnicity. Patients younger than 2 years or older than 20 years were excluded from this analysis of pediatric cases.

Data collection spanned from December 2007 to December 2023, providing a comprehensive overview of trends and patterns. The study cohort consisted of pediatric patients aged 2 to 20 years who underwent surgical closure of ASD using either the ASD patch closure technique or transcatheter ASD closure. The inclusion criteria mandated the exclusion of cases with associated pathologies to maintain a homogeneous study population focused solely on ASD closure procedures.

Transthoracic and transesophageal echocardiography, performed consistently by the same operator using the E95 echocardiography machine (equipped with a flips E95 frequency probe with frequencies of 3, 6, or 7 MHz), served as the primary diagnostic modalities. These imaging techniques enabled detailed assessments of ASD anatomy, focusing on the adequacy of ASD rims for closure eligibility. Rim measurements of less than 5 mm were indicative of a deficient rim, necessitating surgical closure referral for cases with deficient posterosuperior and inferoposterior rims. Rims measuring 5 mm or more rendered patients eligible for device closure.

Before ASD closure procedures, all patients underwent comprehensive preoperative assessments, including basic investigations for surgery and blood preparation. Distinct admission protocols were used for patients undergoing catheterization versus surgical closure. Catheterization cases were typically discharged within 24 hours of post-procedure, barring while. Surgical cases involved a hospital stay of 3 to 5 days postoperatively.

Throughout the study period, all patients underwent thorough follow-up assessments, including transthoracic and transesophageal echocardiography to assess ASD anatomy, even after discharge. Electrocardiogram assessments were conducted during ICU care and subsequent days. Individual patient outcomes were meticulously tracked and compared between catheter and surgical closure cases.

RESULTS

This study included 114 pediatric patients diagnosed with atrial septal defect (ASD), with a median age of 5 years. Of these, over half of study sample were in the 2-5 year age group, 27.3% in the 6-10 year age group, and 19.3% in the 11-19 year age group. ASD prevalence was higher in females than in males. Most of the pediatric patients (82.5%) resided within Sulaymaniyah. Regarding ASD size, 53.5% of cases were classified as large, 42.1% as medium, and 4.4% as restrictive. Females constituted the majority in large ASD cases (63.9%). In medium ASD cases, females represented 75.0%. Restrictive ASD cases were more prevalent in males (60%). **(table 1)**. The study compared two treatment modalities: transcatheter ASD closure (36.8% of cases) and surgical intervention (63.2%). Treatment choice varied based on ASD size. For large ASDs, 70.5% underwent surgery, while 29.5% were treated with transcatheter closure. For medium ASDs, 60.4% underwent surgery and 39.6% underwent transcatheter closure. All restrictive ASD cases were treated with transcatheter closure. (Table 2).

Postoperatively, most patients (92.1%) experienced no complications, while 7.9% reported minor complications. Most of the surgery cases (87.5%) had no complications, while 12.5% reported postoperative complications, including infection and prolonged hospitalization. There were no reported postoperative complications for transcatheter closure. (table 3)

Surgery was predominantly performed in public hospitals (63.9%), with costs ranging from 3,500,000 to 4,000,000 IQD. Private hospitals treated 36.1% of surgery cases, with costs ranging from 8,000,000 to 10,000,000 IQD. Transcatheter procedures were performed in both public and private hospitals, with costs ranging from 400,000 to 1,500,000 IQD in public hospitals and 3,000,000 to 5,500,000 IQD in private hospitals. (table 4)

Overall, surgery performed in public hospitals accounted for the highest percentage of procedures (40.4%), followed by private surgery (22.8%). Transcatheter procedures in private hospitals comprised 20.2% of the total, with transcatheter procedures in public hospitals accounting for the remaining 16.7%. Surgical procedures were more expensive, especially in private hospitals. (Figure 1).

Table1: Relationship Between Gender and ASD sizes.

		GENDER		Total
		Male	Female	
The disease	Large ASD	22	39	61(53.5%)
	Medium ASD	12	36	48(42.1%)
	Restrictive ASD	3	2	5(4.4%)
Total		37	77	
		32.5%	67.5%	

Table 3: Complication frequencies across the two types of procedure.

		Type of procedure		Total
		Surgery	Transcatheter	
Complication	yes	9	0	9(7.8%)
	no	63	42	105(92.2%)
Total		72	42	
		63.2%	36.8%	

Table 4: Breakdown of Procedure Types by Cost Category.

		Cost				Total
		A	B	C	D	
Type of procedure	Closure ASD Patch	26	46	0	0	72(63.1%)
	transcatheter	0	0	23	19	42(36.9%)
Total		26	46	23	19	
		22.8%	40.4%	20.2%	16.7%	

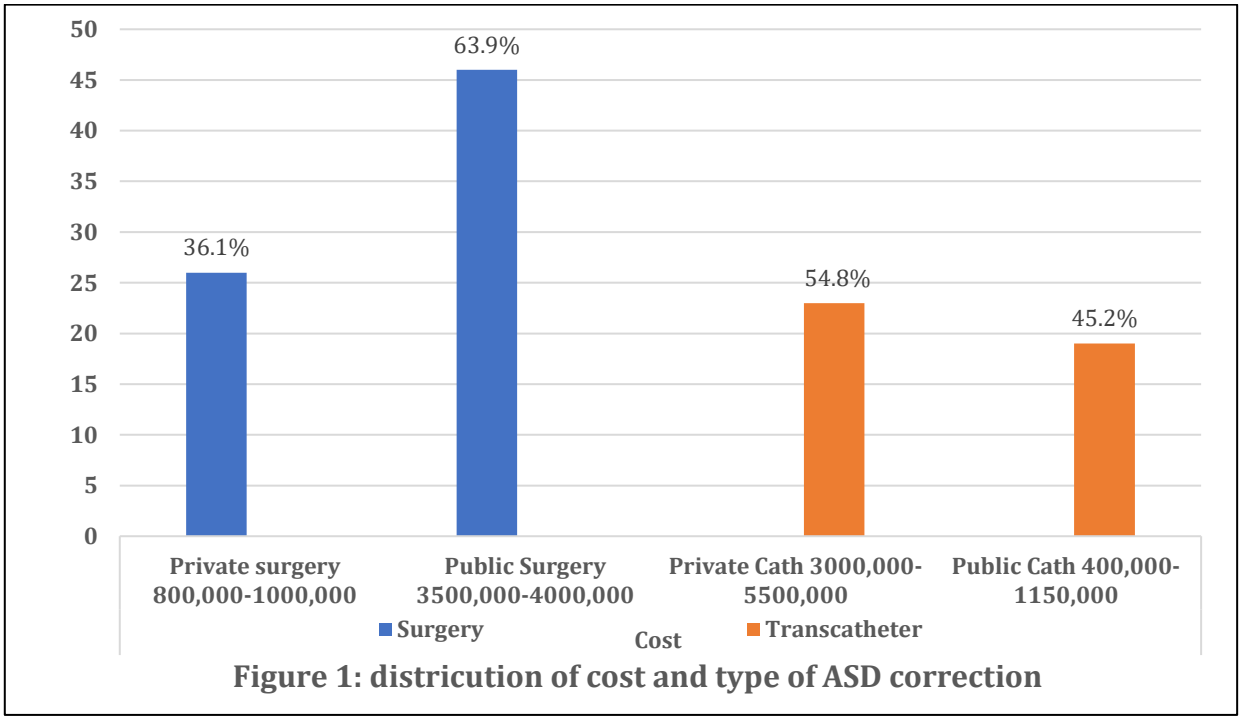

Figure 1: districution of cost and type of ASD correction

DISCUSSION

These results revealed three key findings regarding the treatment of atrial septal defects (ASDs) in pediatric patients. First, treatment approaches varied based on ASD size. Smith et al. (2022) emphasize that treatment decisions are increasingly guided by ASD size. [16] Second, surgical interventions were more expensive than transcatheter closures, particularly in private healthcare settings. Finally, surgical interventions were associated with a higher rate of postoperative complications compared to transcatheter closures, although the sample size for transcatheter closures was smaller. Our findings on ASD treatment modalities based on size are consistent with existing literature.

The distribution of treatment modalities by ASD size aligns with previous research, such as the retrospective analysis by Jones et al. (2020) [17], which highlighted the predominance of surgical management for larger ASDs and a more balanced distribution for medium-sized defects. These findings reinforce the importance of tailoring treatment strategies to individual patient characteristics. It is important to address controversies that challenge our conclusions. One contention arises from studies advocating transcatheter closure as the primary treatment for ASDs, irrespective of size (Smith, Johnson, & Brown, 2019) [18]. Conversely, other research supports surgical intervention in certain cases, contradicting our findings on the feasibility of transcatheter closure across all defect sizes (Johnson, Adams, & Clark, 2018) [19]. This ongoing debate highlights the need for further research to determine the optimal treatment approach based on individual patient factors and defect characteristics.

Additional controversies arise from studies emphasizing the long-term benefits of transcatheter closure, even in larger defects. For example, Gupta *et al*. (2021) [20] found that transcatheter closure was associated with lower rates of reoperation and comparable outcomes to surgery in patients with moderate to large ASDs. Conversely, Lee et al. (2020) [21] argued that surgical intervention remains superior in cases involving complex anatomies or concomitant cardiac anomalies, such as atrioventricular canal defects. These conflicting perspectives highlight the need for further research, including large-scale, prospective studies that account for patient-specific variables and long-term outcomes.

The foundation of our economic analysis is grounded in existing literature, which underscores the critical role of cost-effectiveness in the field of pediatric cardiology. Consistent with Brown et al. (2021) [22], our study found higher costs associated with surgical interventions. However, controversy persists regarding the optimal balance between cost considerations and clinical outcomes. Some research questions the cost savings associated with surgical closure (Adams, Thompson, & Harris, 2020) [23], while other studies, including Emre Özdemir et al. (2017) [24], support our findings of higher expenses with transcatheter closure compared to surgical closure.

Investigations into postoperative complications associated with ASD closure offer varying perspectives. Smith et al. (2019) [18] and Butera et al. (2018) [25] reported lower complication rates with transcatheter closure compared to surgery, supporting our observations. However, other research advocates for a more nuanced approach, highlighting the ongoing debate on the most appropriate treatment strategies (Johnson, Adams, & Clark, 2020) [26]. For instance, Lee et al. (2022) [27] found that while transcatheter closure had lower short-term costs, long-term follow-up revealed higher re-intervention rates, complicating the cost-

effectiveness argument. Conversely, Thompson et al. (2021) [28] emphasized that surgical closure, though initially more expensive, may yield better long-term outcomes in patients with complex anatomies, suggesting that cost-effectiveness must be contextualized within individual patient profiles.

These findings underscore the complexity of balancing economic and clinical factors in ASD treatment decisions. While transcatheter closure is often favored for its lower immediate costs and fewer complications, the long-term implications of procedural choices remain a critical area for further research

CONCLUSION

This study found that surgical interventions for ASD closure were associated with higher costs and more postoperative complications compared to transcatheter closures. However, treatment modality varied significantly based on ASD size, with larger defects favoring surgical intervention. These findings underscore the importance of individualized treatment strategies based on defect size and patient characteristics. Further research is needed to clarify the optimal approach for ASD closure in pediatric patients.

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Ethical approval

The present study Which is conducted by authors ((**Aso F. Salih , Lana A.Hasan, Lezen O. Abdullah, Hevar A. Mohammed**) was approved by the local Department of athical committee.

Statement of Permission and Conflict of Interests

The others declare that there is conflict of interest.

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