



Comparison of the Results of Secundum Atrial Septal Defect Closure by Transcatheter and Open-Heart Surgery in the North West of Iran

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Abstract

Objectives: Atrial septal defect (ASD) is one of the congenital diseases of the heart, which causes large cases of ASD requiring therapeutic interventions. In the event of a large defect of the atrial wall of the heart, the amount of blood shunted from the left atrium is noticeable and the amount of pulmonary blood flow increases, which can be associated with several symptoms and complications such as respiratory distress, recurrent infections, pulmonary artery hypertension, and large cavities. The right side of the heart is accompanied with failure, thus this abnormality needs treatment. The closure of secundum ASD as one of the congenital heart diseases can be conducted by transcatheter or open-heart surgery. Given the above-mentioned explanations, the present study was conducted to compare the two above-mentioned methods.

Materials and Methods: In general, 60 patients treated with open-heart surgery (n=30) and transcatheter (n=30) were evaluated in this study. The two groups were compared in terms of success rate, hospitalization time, hospitalization costs, and complications such as infection, bleeding, arrhythmia, cardiac block, endocarditis, and the need for post-operative re-intervention.

Results: Both groups were effectively treated with either of these two methods. The mean age of surgical patients was significantly ($P=0.003$) lower than those treated with transcatheter. Although the group treated with open-heart surgery had higher amounts of bleeding, arrhythmia, infection, heart block, hospitalization costs, and re-intervention, these differences were not statistically significant. During the study, none of the patients had endocarditis and none died as well. Finally, patients treated with transcatheter had a mean (standard deviation) duration of the hospitalization of 4.3 (± 1.39) days, which was significantly lower ($P<0.001$) than the surgical method 11.1 (± 4.6).

Conclusions: Both trans-catheterization and open-heart surgery treatments are effective in treating patients with secondary ASD although the use of the transcatheter method is less risky and more cost-effective due to the findings in comparison with the open-heart surgery method. However, care should be taken in choosing the patient for this therapeutic intervention. In addition, patients treated with trans-catheterization had a shorter duration of hospitalization, which could be important in terms of family relocation to other family members and the system of treatment. Eventually, due to the high rate of bleeding from patients of young age in both groups, preclinical tests should be performed before the surgery in this age group in order to improve therapeutic techniques.

Keywords: Secundum atrial septal defect, Transcatheter, Amplatzer, Open-heart surgery

Introduction

Atrial septal defect (ASD) is considered as a common congenital heart disorder and accounts for about 10-5% of all cases. In addition, it is more common in women than men, and secundum in the region of foramen oval is regarded as its most common type. This abnormality in most cases is asymptomatic at early ages but the amount of blood shunt from the left atrium to the right is significant if there is a large defect and the amount of pulmonary blood flow increases, causing pulmonary arterial hypertension and the enlargement of the right chambers of the heart. For this reason, this abnormality requires treatment (1). An old and traditional ASD2 treatment is an open-heart surgery that requires sternotomy or thoracotomy and cardio-pulmonary bypass during the surgery, with its own complications and surgery scars (2, 3). In this study, all

the methods of rehabilitative surgery were considered and all patients under treatment with different techniques from many years ago were also investigated. Physicians have concluded that many of ASD2s can be treated with intravenous catheters and occluder devices that in case of limited but experienced personnel and equipment have promising results (4) compared to the open-heart surgery. Considering the complications of the open-heart surgery and the results of the transcatheter method (5-7), this study was the first one to compare the early results of these two methods in the northwest of Iran. It should be noted that the therapeutic indications in both methods are the same and the difference in treatment choice is based on the taste of the physician according to the latest scientific information.

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Materials and Methods

The present study was designed as a retrospective analytic descriptive study, and the choice of treatment relied on the physician's own taste and according to the latest scientific data. This study evaluated the treatment records of patients with ASD2 at any age treated with either open-heart surgery or transcatheter during 2011-2015. One group of patients was treated with trans-catheterization and the other group underwent cardiac open surgery. The information from these patients' files was entered in pre-prepared forms, and these two groups were compared in terms of success rate, hospitalization time, arrhythmia, cardiac block, endocarditis, and the need for post-operative re-interventions. The obtained data from reviewing patient's treatment records were statistically analyzed by SPSS 22 and an independent t-test and the Pearson chi-square test were used for quantitative and qualitative variables, respectively.

Results

A sample of 60 patients were randomly selected and examined, including 30 cases who were treated with transcatheter and 30 others who underwent surgery. The transcatheter occlusion of ASD was first described by King et al in 1976. Afterward, many studies reported the satisfactory results of transcatheter closure for ASD using several types of devices. Further, the Amplatzer Septal Occluder (ASO) was first introduced into clinical practice by Masura et al in 1997, followed by a publication from Bialkowski et al in 2003 (8,9). Furthermore, Behjati et al (10) from Iran reported good results and effective procedure of the transcatheter closure of ASD using ASO. Septal occluder, as a self-centering and self-occlusion device, was made from nitinol wire mesh. The device comprises a left atrial retention disc, self-centering stent, and right atrial disc. Similar devices of Lifetech were implanted in 3 patients. During the procedure, the devices were attached to the delivery cable with a screw at the end of the device. In this study, 27, 20, and 13 patients were under the age of 5, in the age range of 5-10 years, and over 10 years, respectively, and the youngest patient was 4 months old. Moreover, the mean age of the transcatheter and surgical groups was 115.77 (± 69.77) and 59.97 (± 63.704) months, respectively; this age difference due to the statistical independent t-test was significant ($P=0.003$). Of 30 transcatheter patients, 10 were males and 20 cases were females. Additionally, 12 and 18 out of 30 patients in the surgical group were males and females, respectively, and this difference was not significant based on the statistical Chi-square test ($P=0.395$), the details of which are presented in Table 1. In addition, the average cost was 1742039.2 (± 31805.4) and 2002511.5 (± 365606.9) Tomans in transcatheter and surgical groups, respectively, which was not significant based on the statistical independent *t* test ($P=0.148$). Conversely, the mean time of hospitalization in transcatheter and

surgical groups was 4.30 (± 1.29) and 11.10 (± 4.6) days, respectively, which was significant based on a statistical independent test ($P=0.001$). Of the 30 patients in the surgical group, one patient had an infection at the site of surgery but none of the patients in the transcatheter group were infected (Table 2), this difference was not significant based on the statistical Pearson chi-square test. Similarly, 13 out of 30 patients in the transcatheter group and 17 out of 30 patients in the surgical group had a packed cell transfusion after the surgery although this difference was not significant based on the statistical Pearson chi-square test ($P=0.219$), the related data are summarized in Table 3. Based on the results (Table 4), none of the patients in the transcatheter group had arrhythmias or heart block although 2 patients undergoing surgical treatment were affected but this difference was not significant based on the statistical Pearson chi-square test ($P=0.150$). In the surgical group, 2 patients needed re-treatment, but none of the 30 patients in the transcatheter group required any re-treatments although this difference was not significant based on the chi-square test ($P=0.554$). The mean age of 30 patients in the surgical or transcatheter group with packed cell transfusion was compared with that of 30 patients who had no bleeding. The mean age of patients with and without bleeding was 66.6 (± 47.6) and 109.2 (± 89.3) months, respectively, which was significant

Table 1. Patients' Characteristics - Gender

Procedure	Gender		Total
	Male	Female	
Transcatheterization	10	20	30
Surgery	12	18	30
Total	22	38	60

Table 2. Complications From ASD Device Closure

Procedure	Infection		Total
	Yes	No	
Transcatheterization	0	30	30
Surgery	1	29	30
Total	1	59	60

Table 3. Complications From ASD Device Closure-Packed Cell Transfusion

Procedure	Bleeding		Total
	Yes	No	
Transcatheterization	13	17	30
Surgery	17	13	30
Total	30	30	60

Table 4. Complications From ASD Device Closure- Intervention Need

Procedure	Intervention Need		Total
	Yes	No	
Transcatheterization	1	29	30
Surgery	2	28	30
Total	3	57	60

Table 5. Patients' Characteristics – Group Statistics

	Packed Cell Transfusion	N	Mean
Age (month)	Yes	30	66.53
	No	30	109.20
Cost (toman)	Yes	30	1440000
	No	30	1720000
Admission time (day)	Yes	30	8.03
	No	30	7.37

based on the statistical independent t-test ($P=0.025$), the relevant details of which are provided in Table 5. However, there were no significant differences in bleeding and non-bleeding patients in terms of costs or hospitalization time ($P=0.597$ and $P=0.567$, respectively).

Discussion

Due to the nature of ASD2 disease and the need for its definitive treatment and the advancement of techniques and medical tools in addition to the old and conventional open-heart surgery method, it is possible to use artificial devices (blockers) with the transcatheter method which represents promising results (7,11). The Amplatzer Septal Occluder is one of the commonly used devices in this regard. Previous reports demonstrated that this device is safe and easy to use with a high success rate (12-15). In their study conducted in Kuala Lumpur Children's Center in Malesia, Putra et al reported significantly different results regarding the two therapeutic methods of ASD2 (12). In general, 60 patients treated with ASD2 were included in the present study, including 30 patients who were treated with the surgical method and 30 other cases who were treated with transcatheter, and all patients were treated successfully. During the follow-up of these 60 patients after receiving treatment, echocardiography was performed to control the defect and residual leakage from the restored hole although no leakage was reported in any of them. The mean age of patients in the open-heart surgery group was significantly lower compared to the transcatheter group ($P=0.003$). This statistical difference indicates that in patients with a lower age requiring treatment, the size of the hole and the amount of the left shunt to the right one is greater than the weight and body surface of the patient and symptoms appear earlier, and thus this method requires the development of equipment and facilities in this age group. In a study conducted by Du et al (13) in America and 29 different treatment centers in the states of California and Florida, the complications and hospitalization time of patients treated with transcatheter were significantly lower compared to those undergoing an open-heart surgery despite the fact that both methods were effective in ASD2 treatment, which is consistent with the results of the present study. The average cost in patients undergoing transcatheter treatment was not significantly different from that of the open surgical method. Conversely, O'Byrne et al compared the costs of the open-heart surgery and transcatheter method in patients with ASD2 and

concluded that using the transcatheter method is highly cost-effective (14). However, the prevalence of ASD was more common in girls in comparison to boys in this study. In addition, there was no significant statistical difference between the two groups in terms of sexual differentiation. In our study, both transcatheter and open-heart surgery methods were effective in treating patients with ASD2. Although patients undergoing surgical treatment had higher amounts of bleeding, arrhythmias, heart block, treatment costs, infection rate, and the need for more therapeutic re-intervention compared to the transcatheter-treated group, these differences were not statistically significant, probably because of the low number of patients. Contrarily, patients undergoing the transcatheter method had significantly shorter hospitalization time compared to those undergoing surgery, which can be important and notable in terms of being away from family members, the imposition of problems on other family members, and the treatment system. These results are in line with those of Molaei et al at Shahid Rajaei Heart Center in Tehran. In the other study by Siddiqui et al in Pakistan, complications and hospitalization time in the transcatheter method were less in comparison with the surgical method and similar to the results of the present study, but the cost of treatment in the transcatheter method, contrary to the present study, was slightly more than the surgical method (15,16). Although there was no significant difference in the amount of bleeding in the two groups, patients with bleeding complications during the surgical treatment or transcatheter demonstrated a significant difference in the mean age from non-bleeding patients. This indicates that it is necessary to perform precise preoperative examinations in this age group and to improve the technique and therapeutic methods, but there was no significant difference in terms of the cost of treatment or hospitalization time.

Conclusions

Considering the results of the previous studies and the present study, the closure of secundum ASD by transcatheter and occludes is comparable to the traditional surgical method and is an appropriate alternative to the open-heart surgery in centers equipped with the necessary equipment and the trained and experienced team even in developing countries.

Suggestions

1. The use of the transcatheter therapeutic method as an effective method for the treatment of patients with ASD2 due to fewer complications and treatment cost and hospitalization time;
2. Correct and accurate selection of patients for therapeutic catheterization;
3. Improvement of equipment and trained staff for performing this therapeutic method (transcatheter) at earlier ages;

4. Performing examinations and more precise evaluations to prevent bleeding in patients with ASD2;
5. The need for designing separate studies with a larger sample size for a closer look at the complications of each treatment method.

Conflict of Interests

Authors have no conflict of interests.

Ethical Issues

Not applicable.

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References

1. Sachdeva R. Atrial septal defects. In: Allen HD, Shaddy RE, Penny DJ, Feltes TF, Cetta F, eds. *Moss & Adams' Heart Disease in Infants, Children, and Adolescents*. 9th ed. Philadelphia: Wolters Kluwer; 2016:739-756.
2. Rosengart TK, Stark JF. Repair of atrial septal defect through a right thoracotomy. *Ann Thorac Surg*. 1993;55(5):1138-1140. doi:10.1016/0003-4975(93)90020-i
3. Bleiziffer S, Schreiber C, Burgkart R, et al. The influence of right anterolateral thoracotomy in prepubescent female patients on late breast development and on the incidence of scoliosis. *J Thorac Cardiovasc Surg*. 2004;127(5):1474-1480. doi:10.1016/j.jtcvs.2003.11.033
4. King TD, Mills NL. Nonoperative closure of atrial septal defects. *Surgery*. 1974;75(3):383-388.
5. King TD, Thompson SL, Steiner C, Mills NL. Secundum atrial septal defect. Nonoperative closure during cardiac catheterization. *JAMA*. 1976;235(23):2506-2509.
6. O'Laughlin MP. Catheter closure of secundum atrial septal defects. *Tex Heart Inst J*. 1997;24(4):287-292.
7. Thanopoulos BD, Laskari CV, Tsaousis GS, Zarayelyan A, Vekiou A, Papadopoulos GS. Closure of atrial septal defects with the Amplatzer occlusion device: preliminary results. *J Am Coll Cardiol*. 1998;31(5):1110-1116. doi:10.1016/s0735-1097(98)00039-4
8. Masura J, Gavora P, Formanek A, Hijazi ZM. Transcatheter closure of secundum atrial septal defects using the new self-centering amplatzer septal occluder: initial human experience. *Cathet Cardiovasc Diagn*. 1997;42(4):388-393.
9. Bialkowski J, Kusa J, Szkutnik M, et al. [Percutaneous catheter closure of atrial septal defect. Short-term and mid-term results]. *Rev Esp Cardiol*. 2003;56(4):383-388.
10. Behjati M, Mirhosseini SJ, Hosseini SH, Rajaei S. Transcatheter closure of atrial septal defect with amplatzer device in children and adolescents: short and midterm results; an Iranian experience. *Iran Pediatr*. 2011;21(2):166-172.
11. Rao PS. Transcatheter closure of atrial septal defect: are we there yet? *J Am Coll Cardiol*. 1998;31(5):1117-1119. doi:10.1016/s0735-1097(98)00065-5
12. Putra ST, Djer MM, Idris NS, Samion H, Sastroasmoro S. Transcatheter closure of atrial septal defects in a center with limited resources: outcomes and short term follow-up. *Iran J Pediatr*. 2015;25(6):e3906. doi:10.5812/ijp.3906
13. Du ZD, Hijazi ZM, Kleinman CS, Silverman NH, Larntz K. Comparison between transcatheter and surgical closure of secundum atrial septal defect in children and adults: results of a multicenter nonrandomized trial. *J Am Coll Cardiol*. 2002;39(11):1836-1844. doi:10.1016/s0735-1097(02)01862-4
14. O'Byrne ML, Gillespie MJ, Shinohara RT, Dori Y, Rome JJ, Glatz AC. Cost comparison of transcatheter and operative closures of ostium secundum atrial septal defects. *Am Heart J*. 2015;169(5):727-735.e722. doi:10.1016/j.ahj.2015.02.010
15. Molaei A, Meraji SM, Nakhostin Davari P, Aarabi Moghadam MY, Shah Mohammadi A. Assessment of the results of secundum atrial septal defect closure by two methods: surgery (right thoracotomy) and intervention (transcatheter Amplatzer Septal Occluder). *Iran Heart J*. 2010;11(2):55-58.
16. Siddiqui WT, Usman T, Atiq M, Amanullah MM. Transcatheter versus surgical closure of atrial septum defect: a debate from a developing country. *J Cardiovasc Thorac Res*. 2014;6(4):205-210. doi:10.15171/jcvtr.2014.013

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