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BLADE ATRIAL SEPTOSTOMY: EXPERIENCE WITH 18 PATIENTS*

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SUMMARY: Çeliker A, Bilgiç A, Alehan D, Özkutlu S, Özer S. (Cardiology Unit, Department of Pediatrics, Hacettepe University Faculty of Medicine, Ankara, Turkey). Blade atrial septostomy: experience with 18 patients. Turk J Pediatr 1996; 38: 459-466.

Blade atrial septostomy was performed in 18 patients, including 14 with transposition of the great arteries, three with tricuspid atresia and one with severe mitral stenosis and ventricular septal defect. The patients' ages ranged from 25 to 210 days (mean: 108 ± 64 days), and weights ranged from 3.0 to 6.0 kg. Following blade septostomy, partial arterial pressure of oxygen (PaO_2) increased from an average of 22 ± 3.3 mmHg to 38.9 ± 7.6 mmHg ($p < 0.001$), and prompt clinical improvement was observed in the majority of patients. Significantly decreased atrial pressures (from 8.16 ± 6.1 to 3.93 ± 2.2 mmHg, $p < 0.01$) and significantly enlarged inter-atrial openings (from 1.6 ± 0.9 to 7.5 ± 1.8 mm, $p < 0.001$) were achieved with successful blade atrial septostomy. Blade atrial septostomy is an effective and life-saving procedure in patients who require nonrestrictive inter-atrial communication. *Key words: blade atrial septostomy, cardiac catheterization.*

An adequate inter-atrial opening is essential for survival in certain varieties of congenital heart diseases. Transposition of the great arteries, tricuspid atresia, mitral atresia, total anomalous pulmonary venous retum, pulmonary atresia with an intact interventricular septum, and double-outlet right ventricle with a restrictive ventricular septal defect are the main congenital heart diseases where inter-atrial mixing is obligatory or beneficial[1]. Atrial septostomy with a retractable knife blade was first performed by Parks et al.[2,3] to create an atrial septal defect in patients in whom balloon atrial septostomy was not possible or adequate. Later the clinical use and efficacy of blade atrial septostomy was established in various studies[4,5]. The aim of this retrospective study was to review the indications and results of blade atrial septostomy.

Material and Methods

The medical records of patients with blade septostomy performed between September 1989 and February 1994 were reviewed. The decision for blade septostomy was made according to echocardiographic findings (buldging of the inter-atrial septum, inadequate or no inter-atrial opening).

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The procedure was performed by cut-don technique in six patients, and by percutaneous technique through the femoral vein in 12 patients. The patients were sedated with premedication and given local anesthesia before cardiac catheterization. After catheterization and angiocardiography, a long sheath was introduced into the left atrium using a guide wire and a regular NIH catheter.

When the sheath and the regular catheter were in the left atrium, the catheter was removed, leaving the tip of the sheath in the left atrium. Then the blade septostomy catheter was passed through the sheath into the left atrium. The blade component was opened in the left atrium and the catheter was pulled into the right atrium. These procedures were repeated at various angulations to ensure an adequate inter-atrial opening. After blade septostomy, balloon atrial septostomy was performed as described previously, to enlarge the created inter-atrial opening[6]. After the procedure, a control echocardiographic study was performed to measure the dimensions of the created inter-atrial opening. Students' paired t test was used for statistical analysis.

Results

Blade atrial septostomy was performed in 18 patients (9 male and 9 female). The mean age of the patients was 108 ± 64 days, with a range of 25-210 days, and the mean weight was 4.4 ± 1.0 kg with a range of 3.0 to 6.0 kg.

Patients with transposition of the great arteries (TGA) comprised the largest group that underwent blade atrial septostomy (14 patients). Of the TGA patients, seven had no associated cardiac lesion while the other seven did. Among the latter, five patients had a small ventricular septal defect (VSD), one patient had a small atrial septal defect and one had pulmonary artery stenosis. Three cases had tricuspid atresia. Two of them had associated VSD, while the third had complex cardiac anomalies (dextrocardia, situs inversus totalis, large VSD, malposition of the great arteries, infundibular pulmonary stenosis, and absence of the right pulmonary artery). The last patient had parachute mitral valve, severe mitral stenosis and VSD (Table I).

Successful blade atrial septostomy and clinical improvement were achieved in 16 patients. Control echocardiographic study revealed a significantly enlarged inter-atrial opening. Before the procedure, seven patients had restrictive inter-atrial openings of two to three milimeters in diameter, while the remaining had patent foramen ovale. After the procedure, the inter-atrial openings were enlarged significantly to a diameter of 7.5 ± 1.8 mm ($p < 0.001$, Fig. 1). In Figure 2 an adequate inter-atrial opening achieved after blade atrial septostomy is demonstrated.

Table I: Some Clinical and Hemodynamic Parameters of the Patients

Patient	Cardiac Lesion	Age (Days)	MAP (mm Hg) LA (B)	MAP (mm Hg) LA (A)	IAO (mm) (B)	IAO (mm) (A)	PaO_2 (mm Hg) (B)	PaO_2 (mm Hg) (A)
1	TGA	210	6	4	1	6	24	47
2	TGA	30	18	5	3	4	29	42
3	TGA, VSD	75	14	10	3	8	19	28
4	TGA	38	NR	NR	2	8	24	42
5	TGA, VSD, PH	90	7	3	1	3	21	32
6	TGA, VSD	25	10	6	2	5	26	48
7	TGA	210	9	6	2	9	22	42
8	TGA, VSD, PS	75	4	4	1	7	22	40
9	TGA	60	1	1	1	NR	NR	NR
10	TGA	60	NR	NR	2	7	20	34
11	TGA	45	6	3	1	5	18	18
12	TGA, VSD, PH	120	4	2	1	8	18	24
13	TGA, ASD, PH	120	16	5	4	9	26	38
14	TGA, PS	120	2	2	2	7	20	42
15	Mitral stenosis, VSD	180	20	5	1	10	NR	NR
16	Tricuspid atresia, VSD	180	6*	2*	1	9	22	38
17	Tricuspid atresia, VSD	90	6*	3*	1	8	21	38
18	Tricuspid atresia, Complex cardiac anomaly	210	14*	6*	2	8	18	28

ASD: Atrial septal defect.
(B) : Before septostomy.
LA : Left atrium.
NR : Not recorded.
PDA: Patent ductus arteriosus.
PS : Pulmonary artery stenosis.
VSD: Ventricular septal defect.
(A) : After septostomy.
IAO : Inter-atrial opening.
MAP : Mean atrial pressure.
PaO_2: Partial pressure of arterial oxygen,
PH : Pulmonary hypertension.
TGA : Transposition of the great arteries.
* : Right atrial pressure.

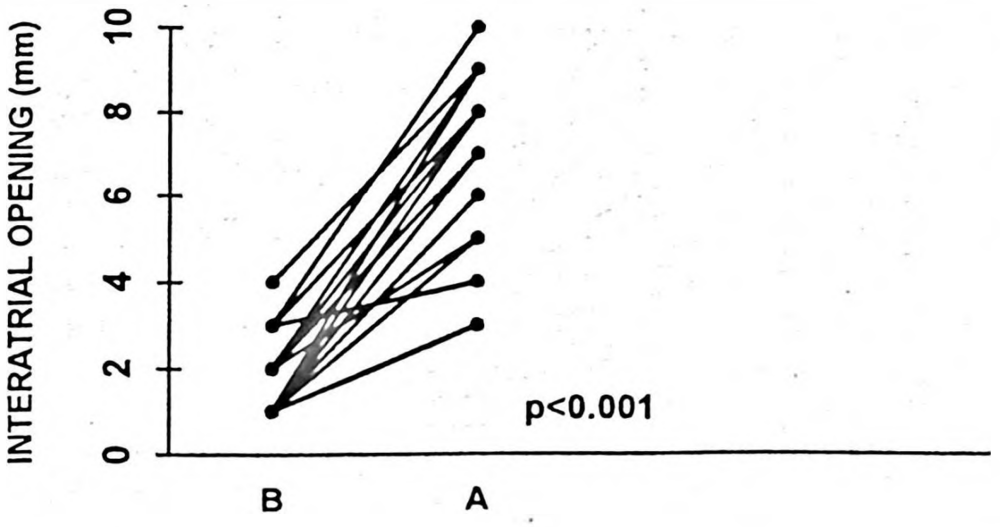
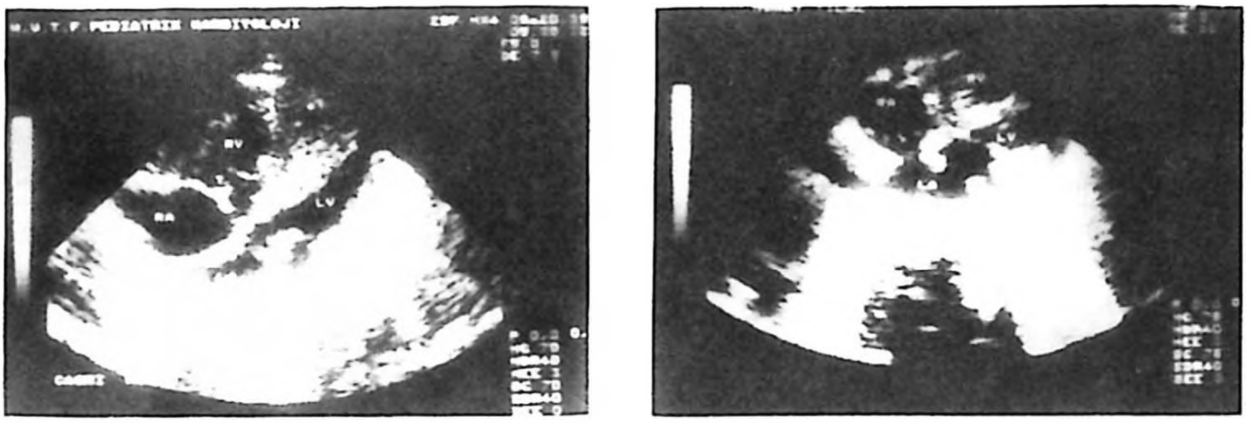


Fig. 1: Changes in the diameter of the inter-atrial opening before and after blade atrial septostomy. B: Before septostomy, A: After septostomy.



(A) (B)

Fig. 2: Two-dimensional echocardiogram demonstrating an intact inter-atrial septum (A). After the blade atrial septostomy procedure, an adequate inter-atrial opening was obtained (B). LA: left atrium, LV: left ventricle, M: mitral valve, RA: right atrium, RV: right ventricle, T: tricuspid valve, Arrow: interatrial opening.

Parallel to the echocardiographic findings, in the TGA and mitral stenosis group, the mean left atrial pressure decreased significantly from 9.0 ± 5 mmHg to 4.2 ± 2.2 mmHg ($p < 0.001$, Fig. 3). Similarly, in patients with tricuspid atresia, the right atrium pressure was reduced from 8.6 mmHg to 3.6 mmHg ($p < 0.05$).

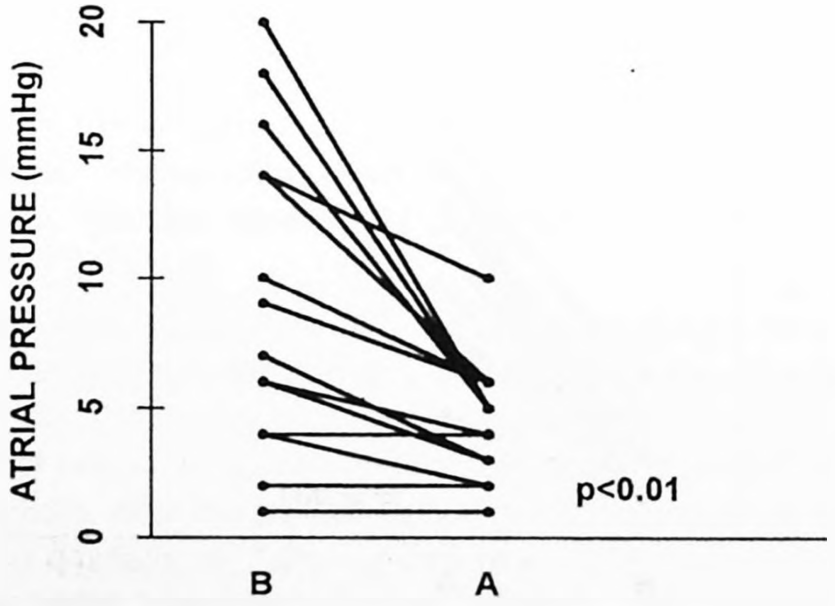


Fig. 3: Changes in the left atrial pressure before and after blade septostomy in patients with transposition of the great arteries or mitral stenosis. B: Before septostomy, A: After septostomy.

The partial arterial pressure of oxygen (PaO_2) is a valuable parameter that reflects the efficacy of blade atrial septostomy. In patients with TGA, a significant increase in PaO_2 was observed following septostomy owing to good interatrial mixing (from 22 ± 3.2 mmHg to 36.3 ± 8.3 mmHg, $p < 0.001$, Fig. 4).

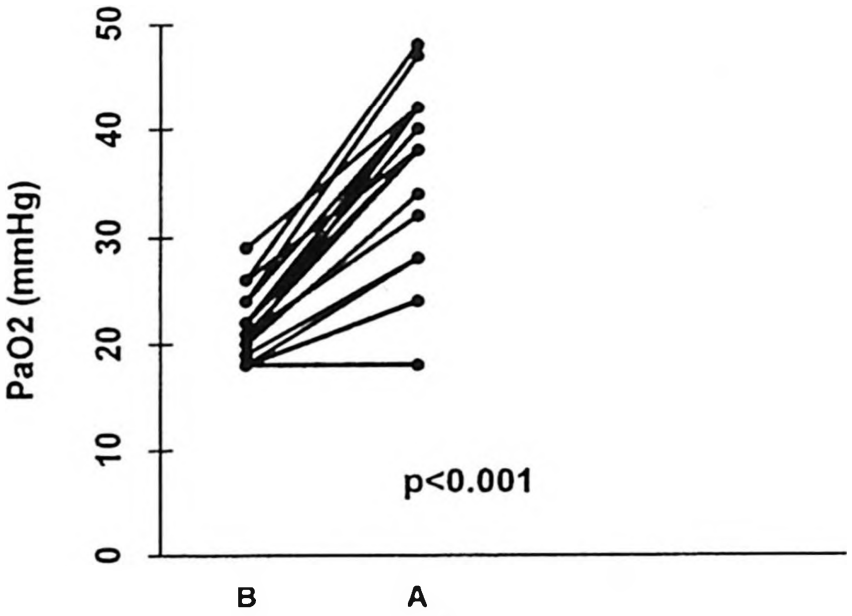


Fig. 4: Changes in the partial arterial pressure of oxygen (PaO_2) before and after blade atrial septostomy. B: Before septostomy, A: After septostomy.

Complications: There were two early deaths after the procedure. One was a seven-month-old male with TGA. During septostomy he became severely acidotic and bardycardic, and in spite of intensive care he died 24 hours after the procedure. The other patient had TGA, VSD and severe pulmonary hypertension, and the procedure was terminated because of severe bradycardia. Although he had bradycardia during the procedure, his heart rate increased to normal levels after septostomy, and subsequent echocardiography revealed an inter-atrial opening of three milimeters. He died seven days after the procedure before an operation could be performed. Therefore we believe that his death might not be directly related to blade septostomy but could be attributed to severe pulmonary hypertension.

Transient rhythm problems were the most frequently observed complications. Among them bradycardia was observed in three patients and ventricular fibrillation in one patient. One of the patients with bradycardia had an additional respiratory arrest for a brief period. One patient had rectal bleeding, which was presumed to be related to hypoxemia and necrotizing enterocolitis and was managed successfully.

Follow-up: Four of the patients lost contact with us. The remaining 12 patients were followed up for four to 48 months (mean: 13.9 ± 10 months). Among them four patients had a complete repair (Senning operation). One patient with tricuspid

atresia had palliative surgery (modified Blalock-Taussig shunt). Closure of VSD was performed in the patient who had parachute mitral valve, mitral stenosis and VSD. Pulmonary banding was performed in one patient who had pulmonary hypertension in addition to TGA and VSD. One patient with TGA died seven months after septostomy due to pulmonary infection and respiratory failure. Another patient with TGA died one month after septostomy. Three patients have not yet had surgery.

Discussion

During recent years, improved noninvasive diagnostic techniques have lessened the indications for diagnostic cardiac catheterization, while therapeutic catheter procedures are being used increasingly. Nowadays, the interventional workload is about 15 percent of total catheter procedures in larger pediatric cardiology centers, compared with only one to two percent only five years ago[7-9]. Balloon atrial septostomy, described in 1966 by Rashking and Miller[10], was the first clinically useful catheter-directed therapy. It has improved the survival rate of patients with TGA from 20 to more than 85 percent. Blade atrial septostomy was developed by Park et al.[2] in 1975 to supplement balloon septostomy in patients in whom the septum was too thick to be torn by balloon septostomy alone. Blade septostomy is generally considered to be appropriate for patients who are more than four to six weeks old and who require nonrestrictive inter-atrial communication.

Blade atrial septostomy has been shown to be effective in various reports[4, 5, 11, 12]. Equalization or reduction of the pressure gradient between the two atria, enlargement of the inter-atrial opening and an increase in systemic oxygen saturation are the most important indicators of success in the septostomy procedure[13]. In our study, all three of the criteria were met. Significant clinical improvement was noted in all of our patients. Patients with TGA and mitral stenosis showed a significant increase in PaO_2 and a significant decrease in left atrial pressure in response to blade atrial septostomy. Post-septostomy echocardiographic studies revealed a significantly enlarged inter-atrial opening. Although an inter-atrial opening larger than 10 mm was regarded as a criterion for improvement, we obtained favorable results in our patients with an inter-atrial opening of 7.5 milimeters. Our results show that while evaluating a patient and the success of the procedure, all the parameters (PaO_2, atrial pressures, clinical findings, size of the inter-atrial opening) should be taken into consideration, and that an opening of less than 10 mm may also be effective.

Balloon atrial septostomy is unlikely to provide long-term palliation, however blade septostomy may be very effective in providing adequate long-term palliation. In the collaborative study of Park et al.[13] excellent long-term results were obtained in 84 percent of patients with blade septostomy. Ali-Khan et al.[14] also reported

repeat septostomy procedure in only four of the 45 patients. Similarly, in our patients, long-term follow-up results were very good, and none of our patients underwent a repeat septostomy. However, it should be kept in mind that during the follow-up period these patients may show clinical deterioration and a repeat procedure may be required.

Our study has shown that blade atrial septostomy is a relatively safe procedure. Rhythm problems were the most frequently encountered problems that have not been stressed before. Most of the complications observed in our patients were transient and improved without any permanent sequelae. However, patients who undergo blade septostomy should be observed carefully, since most of them are clinically unstable and potentially prone to serious complications, as reported in various reports.

Recently, in a preliminary report a new approach was presented for creating inter-atrial communication in older infants by using a stationary fixed-diameter angioplasty balloon[15]. However, for the moment, blade atrial septostomy is the treatment of choice for creating an inter-atrial opening in older infants, since the safety and effectiveness of this new approach have yet to be established.

In conclusion, blade atrial septostomy is a relatively safe, effective and life-saving procedure in patients who require nonrestrictive inter-atrial communication.

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