Antegrade or Retrograde Catheterization Across a Ventricular Septal Defect

Hideshi TOMITA, MD
Shigeto FUSE, MD
Shunzo CHIBA, MD

Abstract

The success rate and the most suitable catheter tip for crossing over various types of ventricular septal defects (VSDs) were examined as a preliminary study for transcatheter closure of VSD.

The 18 consecutive patients with various types of VSD were aged from 1 to 95 (mean [± SD] 13±22) months. Body weight was 3.7 to 25.0 (8.0±5.1) kg. Two-dimensional echocardiography showed that the maximal diameter of the defects ranged from 1.0 to 12.0 (7.5±3.1) mm. There were 10 patients with perimembranous defects, 4 with outlet defects, 2 with muscular defects, and 2 with tetralogy of Fallot with perimembranous defects. An angiographic balloon catheter, or an original or modified Judkins right coronary catheter could be passed through the VSD antegradely or retrogradely in 16 of 18 patients. In only two patients, with a small VSD of 2.0 and 1.0 mm, the catheter could not cross over the defect. The catheter entered the ascending aorta antegradely in 12 cases.

The Judkins right coronary catheter is most suitable for crossing a VSD either antegradely or retrogradely.

J Cardiol 1997; 30 (5): 265–271

Key Words
Heart catheterization, Heart septal defects (ventricular septal defect), Interventional cardiology, Judkins right catheter

INTRODUCTION

Current progress in catheter interventional techniques is facilitating transcatheter closure of congenital cardiac defects. However, transcatheter closure of ventricular septal defect (VSD) remains challenging[1–3]. Closing of any defect by catheter intervention requires the catheter to cross over the defect. Passing across a VSD is a much less common procedure than crossing an atrial septal defect or patent ductus arteriosus[4].

We examined the success rate, and the most suitable shape of the catheter tip for crossing various types of VSD.

SUBJECTS AND METHODS

Eighteen consecutive patients with various types of VSD were aged from 1 to 95 (mean [±SD] 13±22) months. Body weight was 3.7 to 25.0 (8.0±5.1) kg.

Two-dimensional echocardiography showed that the maximal diameter of the defects ranged from 1.0 to 12.0 (7.5±3.1) mm. Ten patients had a perimembranous defect, including a pouch formation of the septal leaflet in one, and three were complicated by slight anterior malalignment. There were four patients with outlet defects, two with muscular defects, and two with tetralogy of Fallot with perimembranous defects.

During routine cardiac catheterization to evaluate the indications for surgical treatment, we examined the feasibility of the crossing VSD either antegradely or retrogradely using either an angiographic balloon catheter, or the original Judkins right coro-

札幌医科大学 小児科：〒060 札幌市中央区南 1 条西 16 丁目
Department of Pediatrics, Sapporo Medical University, Sapporo
Address for reprints: TOMITA H, MD, Department of Pediatrics, Sapporo Medical University, South-1 West-16, Chuo-ku, Sapporo 060
Manuscript received June 3, 1997; revised July 31, 1997; accepted August 1, 1997

Selected abbreviations and acronyms

VSD=ventricular septal defect

nary catheter (2.0 or 2.5) or a modification (3.0).

Informed consent for this study was obtained from the parents.

RESULTS

In 16 of the 18 patients an angiographic balloon catheter or an original or a modified Judkins right catheter could be passed through the VSD within 15 min. If these catheters could not be passed through the VSD in 30 min, we discontinued the trial.

An angiographic balloon catheter introduced antegradely passed through the defect without balloon inflation in two cases of muscular defect (**Fig. 1**), and in three cases of perimembranous defect. The catheter was easily introduced to the left ventricle by clockwise rotation and pushing at the apical or the perimembranous portion in the right ventricle. To introduce the catheter to the aorta, the catheter tip was deflected in the left ventricle using a guide wire. Once the catheter tip was turned to the left ventricular outflow, balloon inflation brought it to the aorta. The original or modified Judkins right catheter was used successfully to cross the outlet and all other perimembranous defects, two retrogradely and the others antegradely (**Table 1, Figs. 2, 3**). In two patients (cases 15 and 16) with a small outlet defect of 2.0 and 1.0 mm, the catheter failed to cross the defect either antegradely or retrogradely.

In the antegrade approach to an outlet defect, the catheter could be passed across the defect by directing the tip of catheter posteriorly to face the ventricular septum in the right ventricular outflow using a Radifocus® guide wire (Terumo, Tokyo). In the retrograde approach, the catheter could be advanced across the outlet or perimembranous VSD by turning the catheter tip anteriorly in the left ventricle, similar to inserting the Judkins catheter in the right coronary artery. In the antegrade approach to perimembranous defects, advancing the catheter with a clockwise rotation in the right ventricular inflow easily introduced the catheter into the left ventricle and ascending aorta (**Figs. 1, 3**).

The angiographic balloon and the original or modified Judkins catheter entered the ascending aorta in 12 of the 14 cases in which the VSD could be passed antegradely.

The shape of the catheter is suitable for crossing the VSD either antegradely or retrogradely, so we devised a modified catheter from a Judkins right catheter 3.0 (**Fig. 4**; Cathex, Tokyo). This modification has a deeper angulation at the distal curve than the original to make it more suitable for passing through the defect. The proximal portion of this catheter is made of polyurethane with stainless steel mesh, but the distal 40 mm is elastic without a braid, so that it is safe and easy to handle in the ventricle. There are four side holes in the distal end, with the softened catheter tip tapered to 0.032 inch in inner diameter, which permits safe left ventriculography or aortography with the antegrade approach.

There was no complication associated with crossing the VSD, and the catheter was easily stabilized in the left ventricle. Although transient ventricular arrhythmias, that did not need any treatment, sometimes occurred following ventriculography using the end hole catheter, a modified catheter with side holes and softened catheter tip enabled safer, good quality left ventriculography than that achieved using the end hole catheter.

DISCUSSION

Most ducts can be closed by devices such as coils, the Rashkind occluder, buttoned device, *etc*., and around 60% of atrial septal defects may be candidates for transcatheter closure[5]. Various devices have been developed to close an atrial septal defect by catheter intervention, and animal experimental work has investigated transcatheter suture closure of atrial septal defects[6]. Although there are a few reports of VSD closure by these devices[1-3], the methodology is still challenging. All of these devices basically have a similar structure, that is a double disc structure, so a catheter must be passed through the defect before closing the VSD.

Our results show that it is possible to cross most VSDs with a maximum diameter of larger than 5 mm measured by echocardiography. As most VSDs that need to be closed are usually larger than 5 mm, these defects have the minimal requirement of transcatheter closure. One exception is the outlet defect that is decreased in size by the herniated right coronary cusp. As shown in our study, the defect in this condition is often too small to allow the catheter to pass.

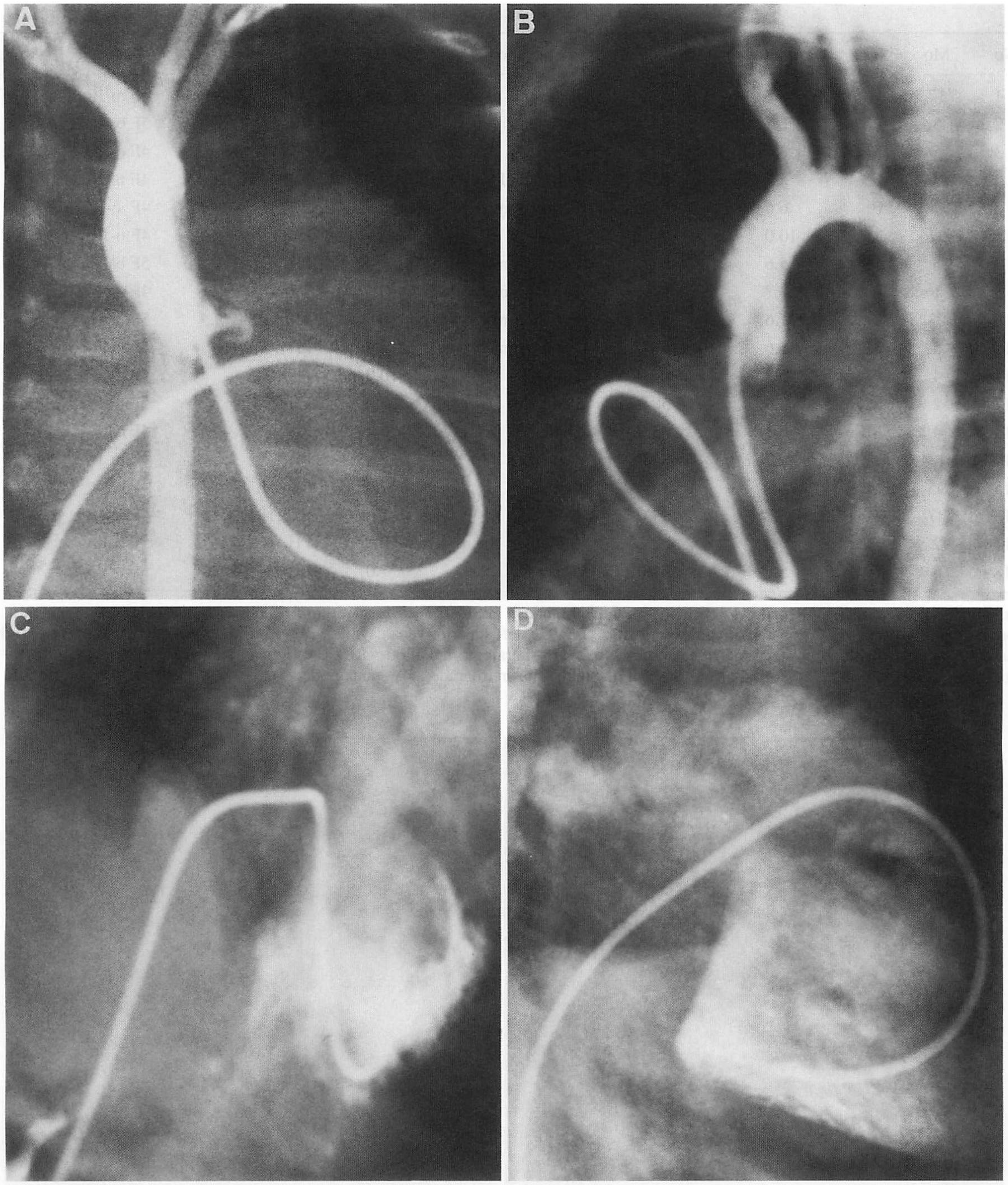

Fig. 1 Antegrade aortography and left ventriculography through muscular defect using an angiographic balloon catheter (case 13)

A, B : Frontal and lateral projections of aortography.
C, D : Left anterior oblique of 45 degrees with cranial angulation of 30 degrees, and right anterior oblique of 30 degrees by left ventriculography.

Table 1 Clinical characteristics

No.	Mo	Sex	Weight (kg)	Height (cm)	Location	Size (mm)	Complication	Catheter	Route
1	17	F	8.6	77.5	Perimem	6.0	PH	4F m-JR	R
2	5	F	6.5	64.5	Perimem	5.0	PH, PDA	5F balloon	A
3	5	M	6.1	64.5	Perimem	10.0	LSVC, MR	4F o-JR	A
4	10	F	5.8	63.8	Perimem, PSL	5.0	PDA, PH, Down	4F m-JR	A
5	7	F	6.6	67.8	Perimem-mal	8.5	PH	4F o-JR	A
6	22	M	10.0	85.0	Perimem	5.0	RVOTO, RAA	4F o-JR	A
7	5	M	5.6	63.0	Perimem-mal	9.0	PH	5F balloon	A
8	1	F	3.7	50.4	Perimem-mal	10.0	TF	4F o-JR	A
9	23	M	11.6	86.6	Perimem-mal	10.0	TF, RAA	5F m-JR	A
10	5	M	5.6	63.0	Perimem-mal	9.0	PH	5F balloon	A
11	4	F	5.3	63.0	Perimem	10.0	PH	5F m-JR	A
12	2	M	4.3	58.0	Perimem	12.0	PH	5F m-JR	A
13	4	M	5.1	63.0	Outlet	10.0	PH	4F o-JR	A
14	18	M	10.7	84.0	Outlet	6.0	PH	4F m-JR	R
15	95	M	25.0	128.0	Outlet	2.0	RCCH, AR	4F o-JR	—
16	37	M	13.8	93.0	Outlet	1.0	RCCH	4F m-JR	—
17	2	F	3.8	57.3	Muscular	10.0	PH	5F balloon	A
18	3	F	5.9	61.0	Muscular	7.0	PH	5F balloon	A

Mo=months; F=female; M=male; Perimem=perimembranous; PSL=pouch formation of septal leaflet; mal=malalignment; PH=pulmonary hypertension; PDA=patent ductus arteriosus; LSVC=left superior vena cava; MR=mitral regurgitation; RVOTO=right ventricular outflow tract obstruction; RAA=right aortic arch; TF=tetralogy of Fallot; RCCH=right coronary cusp herniation; AR=aortic regurgitation; m=modified; o=original; JR=Judkins right; R=retrograde; A=antegrade.

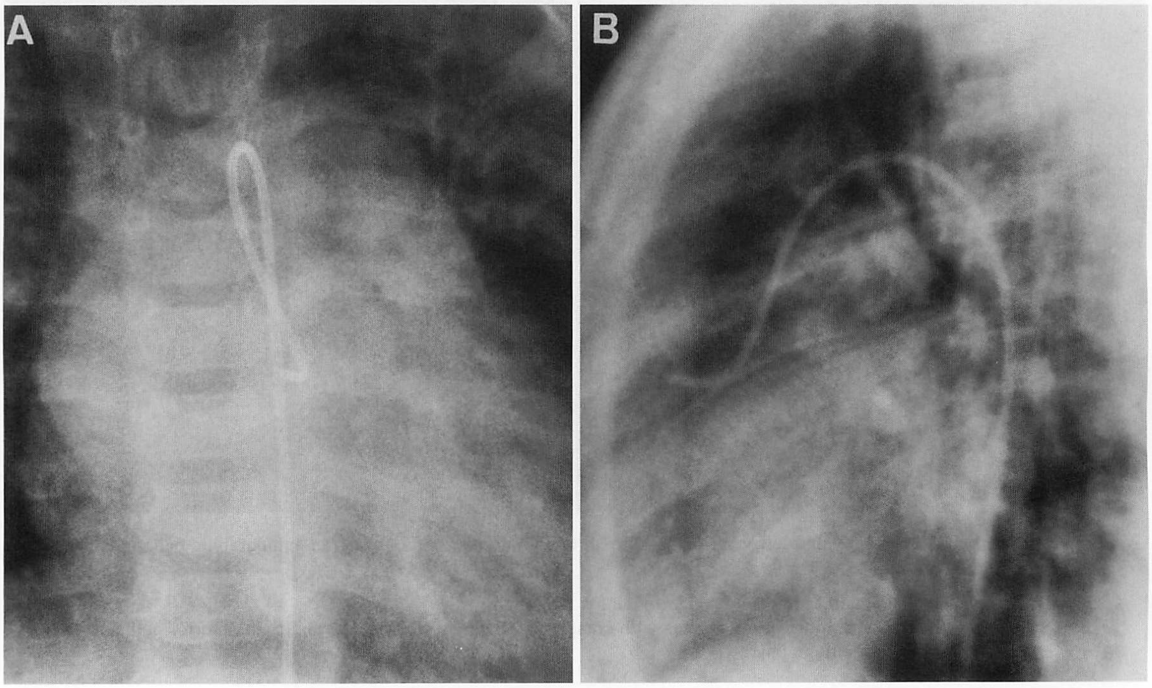

Fig. 2 Retrograde crossing using a modified Judkins right catheter through an outlet defect (case 11)
The catheter tip was in the right ventricle as confirmed by pressure study and test injection.

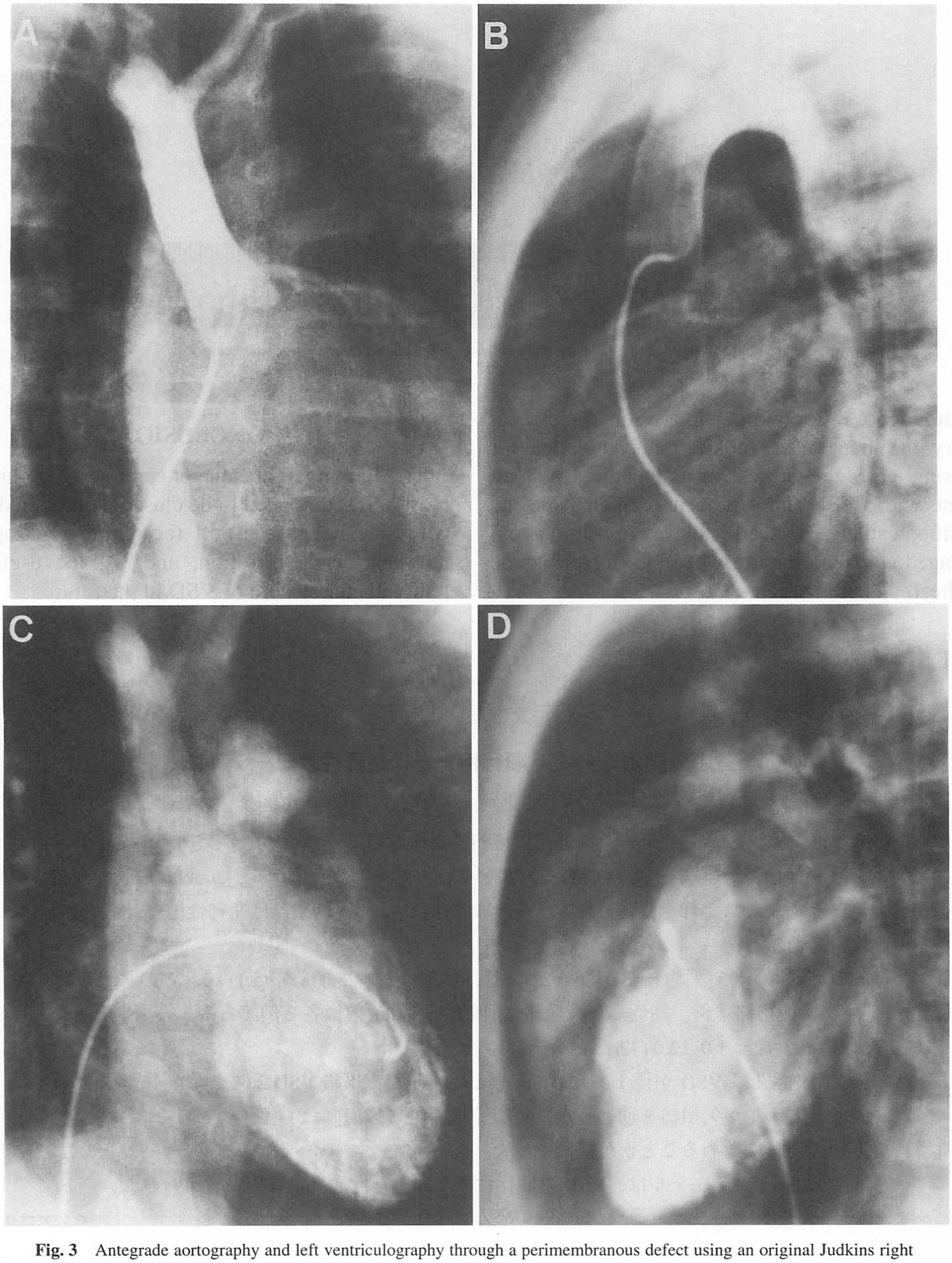

Fig. 3 Antegrade aortography and left ventriculography through a perimembranous defect using an original Judkins right catheter (case 6)

A, B : Frontal and lateral projections of aortography.
C, D : Frontal and lateral projections of left ventriculography.

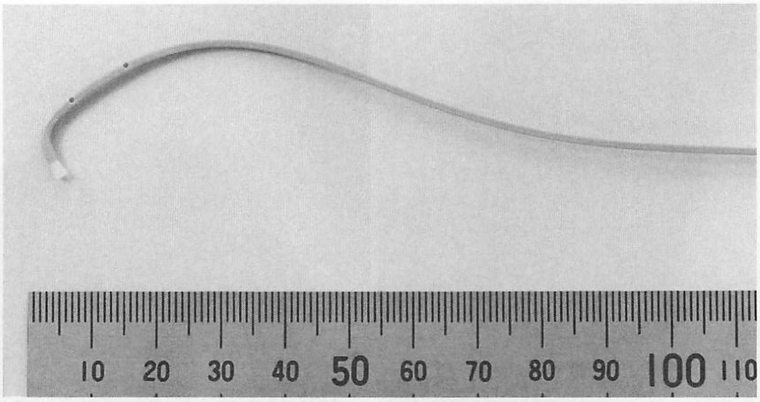

Fig. 4 Modified Judkins right catheter with side holes and soft catheter tip

Although a little modification is sometimes necessary, the shape of the Judkins catheter is ideal for crossing a VSD regardless of its location. In small infants with a VSD and without a foramen ovale, the modified catheter with side holes is useful to avoid damage to the femoral artery by omitting retrograde left heart catheterization.

CONCLUSION

The Judkins right catheter can be passed through most VSDs that need to be closed. A modified type with side holes is useful for omitting retrograde left heart catheterization, and will be useful in transcatheter closure of VSD in the future.

要　　約

心室中隔欠損を介する順行性または逆行性カテーテル法

富田　英　　布施　茂登　　千葉　俊三

心室中隔欠損(VSD)のカテーテル通過の可能性を検討し，そのためのカテーテルを作製することを目的として，連続18例のVSDを対象とし，バルーンカテーテル，Judkins右冠動脈造影用カテーテルまたはこれを改良したカテーテルを用い，順行性または逆行性のVSD通過の可否を検討した．

対象の月齢は1–95(平均[±SD] 13±22)ヵ月，体重は3.7–25.0(8.0±5.1) kg，VSDの部位は膜様部10例，流出路4例，筋性部と膜様部欠損を伴うFallot四徴各2例である．心エコー図によるVSDの最大径は1.0–12.0(7.5±3.1) mmであった．

右冠尖が逸脱し，VSDが径1.0，2.0 mmへと縮小した流出路VSD 2例を除く16例で，いずれかのカテーテルが欠損口を通過した．VSDを順行性に通過した14例中12例では，カテーテルを上行大動脈に進めることが可能であった．

右冠用Judkinsカテーテルは，VSDの順行性または逆行性通過に有用と考えられた．

J Cardiol 1997; 30 (5): 265–271

References

1) Lock JE, Block PC, McKay RG, Bain DS, Keane JF: Transcatheter closure of ventricular septal defects. Circulation 1988; **78**: 361–368
2) Bridges ND, Perry SB, Keane JF, Goldstein SAN, Mandell V, Mayer JE Jr, Jonas RA, Casteneda AR, Lock JE: Preoperative transcatheter closure of congenital muscular ventricular septal defects. N Engl J Med 1991; **324**: 1312–1317
3) Rigby ML, Redington RM: Primary transcatheter umbrella closure of perimembranous ventricular septal defect. Br Heart J 1994; **72**: 368–371

4) Monma K : Catheterization of the left ventricle and the aorta through VSD with new preformed transvenous catheters. Heart 1981; **13** : 595–599 (in Japanese)
5) Ferreira SMAG, Ho SY, Anderson RH : Morphological study of defects of the atrial septum within the oval fossa : Implication for transcatheter closure of left-to-right shunt. Br Heart J 1992; **67** : 316–320
6) Koike K, Kobayashi T, Kyo S, Kobayashi J, Taketazu M, Omoto R : Transcatheter surgical suture closure of atrial septal defect. Circulation 1996; **94** (Suppl II) : II-56