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## Cine Angiocardiographic Features in Straddling Atrioventricular Valve

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## 房室弁騎乗のシネ心血管造影像

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房室弁騎乗は房室弁が心室中隔に跨る先天性心奇形である。弁口の騎乗と弁下組織の両心室への付着からなり、双方を認めるものは完全型、一方のみを認めるものは不完全型と分類される。

1977年より79年までの3年間に国立循環器病センターにおいて剖検または手術により確認された房室弁騎乗の7例についてそのシネ心血管造影像を解剖学的所見と対比し検討した。

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7例の解剖学的分類は完全型三尖弁騎乗2例と完全型僧帽弁騎乗2例、不完全型僧帽弁騎乗2例、完全型両房室弁騎乗1例である。三尖弁騎乗の合併奇形はファロー四徴症と房室弁交叉兼心室中隔欠損兼動脈管開存兼大動脈縮窄症である。僧帽弁騎乗の合併奇形はTaussig-Bing型兩大血管右室起始症2例と三尖弁閉鎖症、心室中隔欠損症で、不完全型の2例は弁下組織が右室に付着する末梢型である。両房室弁騎乗は流出路心室を伴う単心室で主心室と流出路心室に両房室弁が騎乗してい

る。

造影は同時2方向シネ撮影で行い、両心室の造影を5例に行い、心房造影を4例に追加した。

完全型5例6房室弁のうち5弁において騎乗を示す所見を得た。それらは、1) 心室中隔を越えて存在する陰性弁口像、2) 心室中隔を越えて他方の

心室内で動く弁尖像、3) 一つの心房から両心室へ同時に流入する陽性または陰性ジェット流などである。これらの所見は心室中隔が正接像として造影される場合に容易に得られた。両房室弁騎乗の右房室弁と不完全型僧帽弁2弁ではこれらの所見は得られなかった。

### Abstract

Cine angiogram of seven patients with straddling atrioventricular valve was reviewed. At autopsy and operation straddling of the tricuspid valve was detected in two patients, straddling of the mitral valve in four patients and straddling of both valves in one patient. Ventriculography was done in all patients and atriography was added in four patients by biplane cine technique. Angiographic findings are as follows; 1) negative round shadow of orifice of the valve overriding the ventricular septum or opening in the other ventricle; 2) movement of the valvular leaflet in the opposite ventricle over the ventricular septum; 3) positive or negative stream pouring simultaneously from one atrium into both ventricles.

### Introduction

Atrioventricular valve straddling is the congenital cardiac malformation in which the atrioventricular orifice overrides the ventricular septum and/or the part of the chorda is attached to the opposite ventricle. Since the first presented case by Lambert (1952)<sup>1)</sup> many reports have appeared on this subject<sup>2)~16)</sup>. Each author has his own definition and/or classification, and still some disagreement remains whether the term "straddling" can be used in a patient with common atrioventricular valve or with atresia of one valve.

Bharati et al.<sup>15)</sup> classified this anomaly into three categories; 1) complete straddling, in which the atrioventricular orifice overrides the ventricular septum and part of the chorda is attached to the opposite ventricle; 2) basal type of incomplete straddling, in which there is only overriding of the orifice; 3) peripheral type of incomplete straddling, in which only part of the chorda is attached to the opposite ventricle.

Surgical correction of atrioventricular valve straddling becomes complicated due to overriding leaflet and chordal attachment to the opposite ventricle. Preoperative diagnosis is therefore important.

This paper reviews cine angiocardigraphic findings of 7 patients with atrioventricular valve straddling including one patient with tricuspid atresia to attribute to the preoperative diagnosis of this malformation.

### Materials and Methods

Seven patients with atrioventricular valve straddling were identified by autopsy or at operation from 1977 to 1979 at the National Cardiovascular Center. Three were male and four were female. Six patients were autopsied and one patient is alive after radical operation (Table 1)

Classification was done according to the Bharati's classification. Thus there were 2 patients with complete straddling of the tricuspid valve, 2 with complete straddling of the mitral valve, 2 with peripheral type of incomplete straddling of the mitral valve and one with complete straddling of both atrioventricular valves. In six patients except for a patient with single ventricle, their atrioventricular connections were concluded as concordant because their straddling valves were connected to the opposite ventricles which received the other valves less than 50%<sup>17)</sup>.

Selective ventriculography was performed in all patients and atriography was added in 4 patients, by biplane cine technique with 90 frames per second.

Table 1 Materials of straddling atrioventricular valve

Case	Age	Sex	Diagnosis*	Straddling A-V valve	Annular straddling
1	6m	M	Tetralogy of Fallot	Tricuspid valve	(+)
2	4m	F	VSD, PDA, Coarctation of aorta, Criss-cross heart	Tricuspid valve	(+)
3	26y	F	DORV	Mitral valve	(+)
4	23y	M	DORV, Tricuspid atresia	Mitral valve	(+)
5	1y	F	DORV	Mitral valve	(-)
6	1y	F	VSD	Mitral valve	(-)
7	5m	M	Single ventricle (A type**) Pulmonary atresia, PDA	Right A-V valve Left A-V valve	(+) (+)

\*Diagnosed by autopsy (Case 1—6) or at operation (Case 7) 1977—1979 National Cardiovascular Center

\*\*According to Van Praagh's classification<sup>19)</sup>

## Results

In two patients with complete straddling of the tricuspid valve, the negative tricuspid orifice shadow appeared in the lateral projection of left ventriculography to override the ventricular septum or to open partially into the opposite ventricle. In one of these patients, a concaved right border of left ventricle was observed in the frontal view of left ventriculography. In two patients with complete straddling of the mitral valve and in one patient with single ventricle with straddling of both atrioventricular valves, the mitral or the left atrioventricular valve leaflet appeared to swing over the ventricular septum and the negative or positive jet stream to pour from the left atrium into both ventricles. In two patients with incomplete straddling angiography did not reveal these manifestations. In the patient with single ventricle, the right atrioventricular valve straddling was not defined by cine angiography. The angiographic findings of straddling were easily defined, when the ventricular septum was projected tangentially.

## Case Reports

### 1) Complete straddling of the tricuspid valve

Case 1. 6m. Male. Tetralogy of Fallot (Fig. 1)

Autopsy revealed that the tendon apparatus of the septal leaflet of the tricuspid valve were inserted into the left ventricle through the posterior ventricular septal defect (VSD) and were attached to the posterior ridge of the left ventricle. In the frontal projection of left ventriculography the right border of the left ventricle became concave by the opening of the tricuspid valve in diastole. In the lateral projection, a filling defect corresponding to the tricuspid orifice was observed in the left ventricle in diastole.

Case 2. 4m. female. Criss-Cross heart, VSD, Coarctation of Aorta, PDA (Fig. 2)

Specimen revealed that parts of the septal and posterior leaflets of the tricuspid valve were inserted into the left ventricle through the posterior VSD and the right ventricle was small. In the lateral projection of left ventriculography, the right ventricle was situated above the left ventricle with tricuspid orifice overriding the ventricular septum which was seen tangentially.

### 2) Complete straddling of the mitral valve

Case 3. 26y. Female. Double outlet right ventricle (Taussig-Bing type) (Fig. 3)

In the specimen the anterior mitral valve leaflet was divided by the cleft. Part of the leaflet herniated into the right ventricle and was attached to the right ventricle. In the lateral projection of right ventriculography the anterior mitral leaflet was found to swing over the ventricular septum.

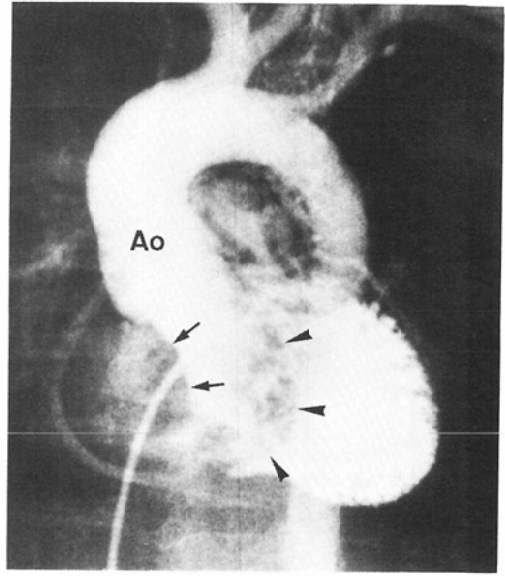
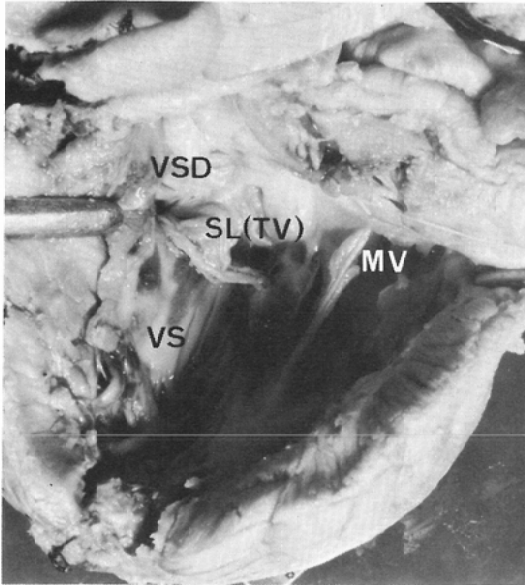
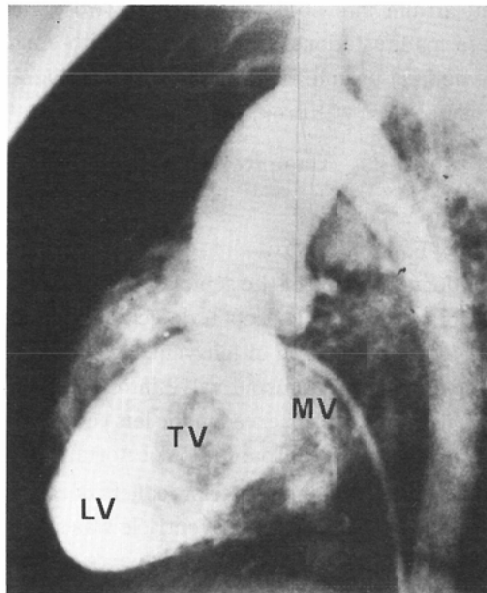


Fig. 1 Case 1.

a) Anatomic specimen. Septal leaflet (SL) of tricuspid valve (TV) is inserted into left ventricle through the ventricular septal defect (VSD) and is attached to the posterior ridge in left ventricle.

b) Frontal projection of left ventriculography. concave right border (arrows) of left ventricle is noted in diastole. Arrow heads: mitral orifice.



c) Lateral projection. Tricuspid valve (TV) is seen as a filling defect close to the mitral valve (MV) in the left ventricle (LV).

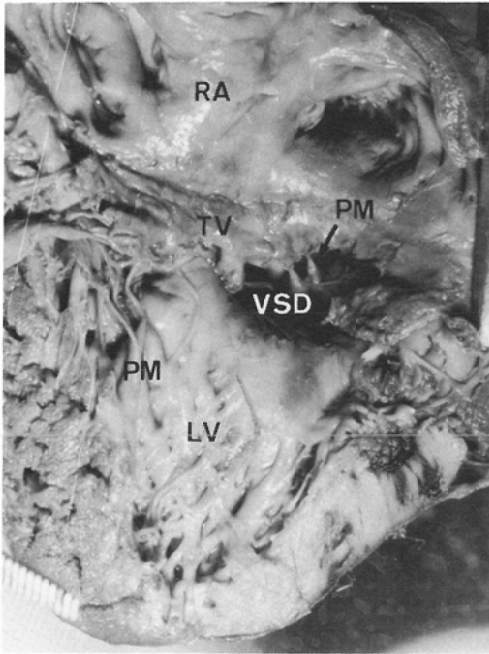


Fig. 2 Case 2.

a) Anatomic specimen. Part of the septal and posterior leaflet is attached to the left ventricle (LV). PM: papillary muscle.

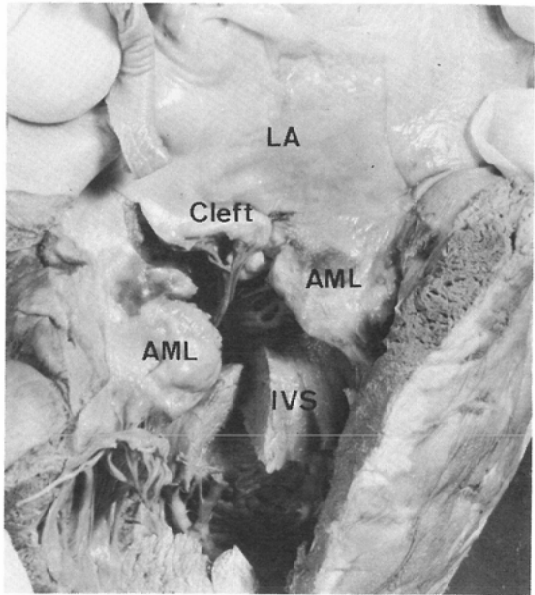
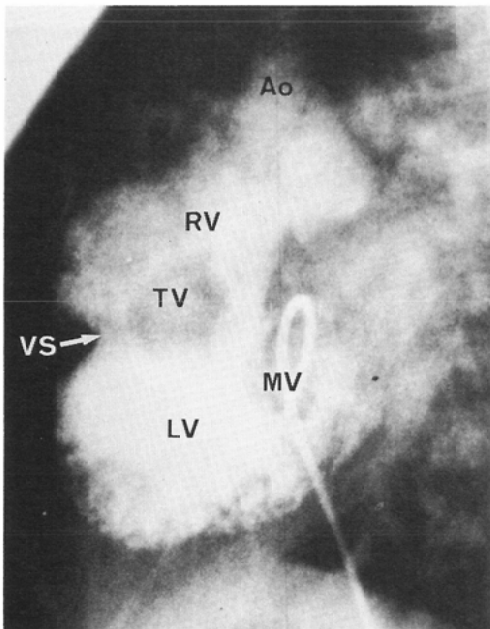
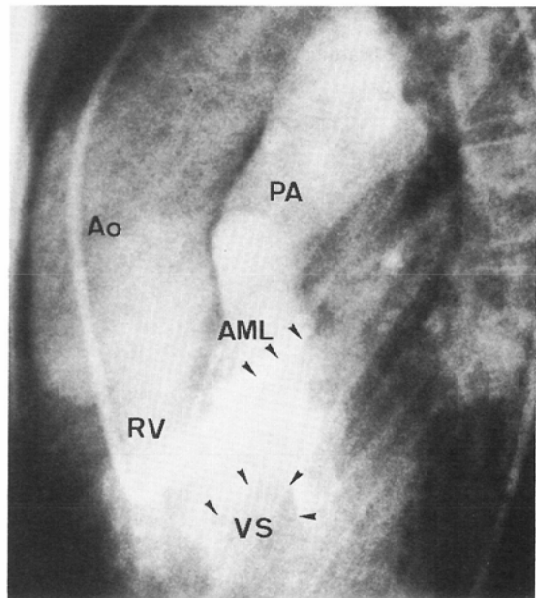


Fig. 3 Case 3.

a) Anatomic specimen. The anterior mitral leaflet (AML) is divided into two parts and the chordae around the cleft are inserted in right ventricle. Left ventricle is hypoplastic.



b) Lateral projection of left ventriculography. Tricuspid valve (TV) overrides the horizontal ventricular septum (VS).



b) Lateral projection of right ventriculography. Anterior mitral leaflet (AML) is seen to swing over the ventricular septum (VS).

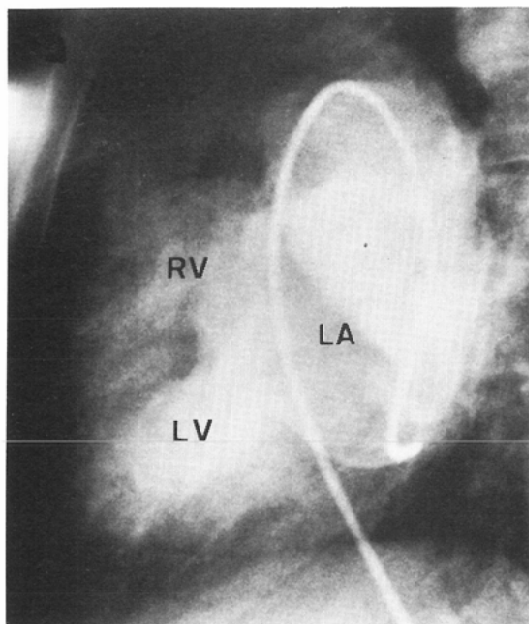


Fig. 4 Case 4.

Lateral projection of left atriography. Contrast media is seen to pour simultaneously into both ventricles from left atrium.

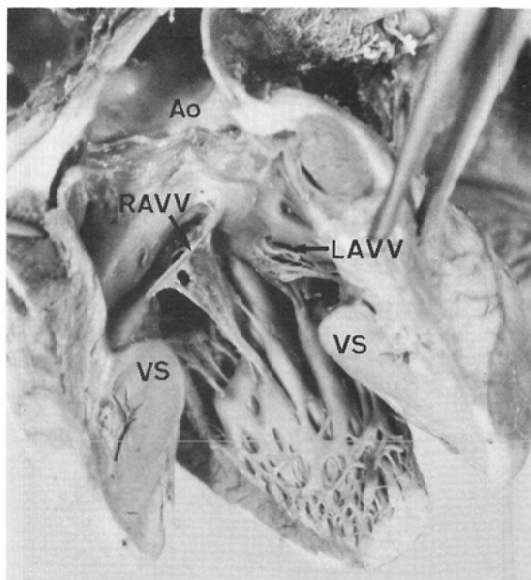


Fig. 5 Case 5.

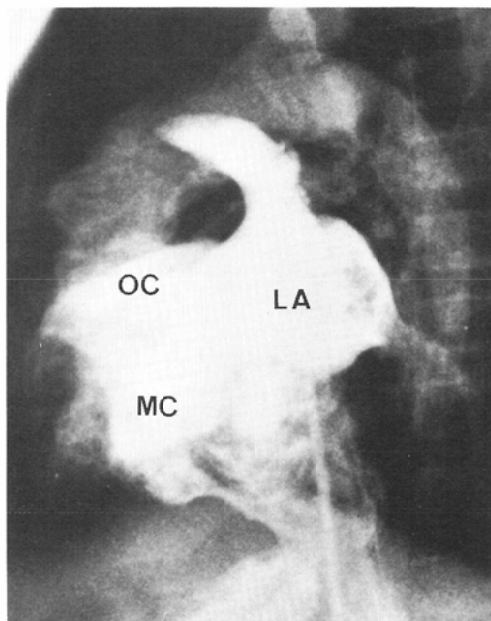
a) Anatomic specimen. Chordae of the anterior commissure side of both atrioventricular valves are attached to the trabeculated zone of outlet chamber and chordae of the posterior commissure side are attached to the posterior wall of the main chamber. RAVV: right atrioventricular valve. LAVV: left atrioventricular valve.

Table 2 Angiocardiographic findings in straddling A-V valve

Findings	Tricuspid V*	Mitral V**
Negative orifice shadow over the septum or in the other ventricle	2	—
Concaved right border of LV	1	—
Movement of valvular leaflet over the septum	—	3
Positive jet or negative jet into both chambers	—	3
Papillary muscle movement in the other ventricle	—	1
No finding	1	2

\*including right A-V valve

\*\*including left A-V valve



b) Lateral projection of left atriography. Contrast medium pours directly into both chambers (outlet chamber and main chamber) from the left atrium. OC: outlet chamber. MC: main chamber.

Case 4. 23y. Male. Tricuspid atresia, Double outlet right ventricle (Fig. 4)

In the lateral projection of left atriography, the contrast medium passed into both ventricles at the same time and a filling defect caused by the papillary muscle was observed in the right ventricle to move synchronously with the mitral valve.

3) Complete straddling of both atrioventricular valves

Case 5. 5m. Male. Single ventricle with outlet chamber, Pulmonary atresia (Fig. 5)

The anterior commissures of both atrioventricular valves were attached to the trabeculated zone of the outlet chamber and the chorda of the posterior commissures arose from the papillary muscles of the posterior wall of the main chamber in specimen. In the lateral projection of left atriography, the contrast medium passed directly into both chambers from the left atrium. At ventriculography the right atrioventricular valve straddling could not be observed.

### Discussion

As has been described previously, in the heart with two atrioventricular valves the tricuspid valve straddles the ventricular septum through the posterior ventricular septal defect not associated with primum atrial septal defect. The straddling is shown commonly in the septal leaflet, and may also be found in the anterior or posterior leaflet. In the heart with mitral valve straddling, the anterior leaflet is divided into two parts by the cleft, and herniates through the anterior ventricular septal defect into the right ventricle to which chordae around the cleft are attached.

There have been a few papers in which angiocardiographic diagnosis of atrioventricular valve straddling is dealt with. Libertson et al.<sup>8)</sup> showed the tricuspid valve straddling by the simultaneous streaming of contrast medium into both ventricles from the right atrium in right atriography. LaCorte et al.<sup>9)</sup> and Aziz et al.<sup>8)</sup> showed it in the left anterior oblique view of left ventriculography by the deviation of the tricuspid orifice shadow towards the left ventricle. Freedom et al.<sup>14)</sup> showed mitral valve straddling by simultaneous contrast filling of both ventricles from the left atrium in the lateral projection of left atriography. Aziz et al.<sup>8)</sup> showed mitral valve straddling of DORV (Taussig-Bing type) by the bulging of the anterior mitral leaflet to the right ventricular outflow tract in the lateral projection of left ventriculography.

Referring to the above mentioned descriptions and to the presented experience the following conclusions can be made regarding the diagnosis of various type of straddling.

The projection and the site of injection of contrast medium, are considered to be of much importance to clarify the morphology of this anomaly.

The diagnosis of straddling is relatively simple when the ventricular septum is projected tangentially at ventriculography. The angled view is needed to observe the atrial and ventricular septum tangentially. In this malformation, however, there are some difficulties in obtaining a proper angled view because of deviation of the ventricular septum. As the tricuspid valve straddles the septum through the posterior VSD, and the posterior wall attachment of the ventricular septum deviates to the right side of the crux, the relationship between the position of the tricuspid valve and the septum is probably best demonstrated in the left anterior oblique and cranial tilting view (four chamber's view).

For demonstrating atrioventricular valve straddling it is fundamentally necessary that the contrast medium is injected in the opposite ventricle of the straddling valve. At ventriculography the relationship between the atrioventricular orifice and the ventricular septum could be observed. If straddling is suspected, atriography of the same side as the straddling valve is helpful for the diagnosis because the contrast jet stream from the atrium to the opposite ventricle can be observed.

Complete straddling can usually be defined by the observation that the atrioventricular orifice is overriding the septum or the leaflet is swinging over the septum. On the other hand incomplete straddling of peripheral type is suspected by a deviation of the atrioventricular orifice or the jet stream from the atrium to



the opposite ventricle. These findings are, however, not so well distinguished from the findings obtained in the normal atrioventricular valve heart.

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