CLINICOPATHOLOGIC CORRELATIONS

Aneurysmalike Formations in Relation to Membranous Ventricular Septum

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SUMMARY
A left ventriculogram may show an aneurysmal protrusion toward the right ventricle in the subaortic area with or without an associated interventricular communication. The pathologic basis for such a finding is variable.

It may well represent an aneurysm of the membranous ventricular septum which may be congenital or acquired. Either variety has the potential of rupturing into the right ventricle. The acquired aneurysms are usually mycotic.

An aneurysm resulting from adhesion of the septal leaflet of the tricuspid valve to the rim of a membranous ventricular septal defect and causing complete or incomplete closure may also yield an aneurysmal formation.

Pouches of the tricuspid valve resulting from excessive tissue, in association with a ventricular septal defect, can also be misinterpreted as an aneurysm of the membranous septum or as incomplete closure of a ventricular septal defect with aneurysm formation.

In some cases, even at pathologic examination, the exact nature is difficult to identify. Separation of a true aneurysm of the membranous septum with adherent tricuspid valve from a spontaneously closed ventricular septal defect with aneurysmalike protrusion in the septal leaflet may not be possible.

Additional Indexing Words:
Aneurysm of membranous ventricular septum
Cleft of tricuspid valve

SOME LEFT ventriculograms, an aneurysmal protrusion toward the right ventricle in the subaortic area may be identified. While some such protrusions represent a congenital aneurysm of the membranous septum, others are acquired aneurysms and still others are related to closed or closing ventricular septal defects or to congenital pouches of the tricuspid valve. In some cases, an interventricular shunt is present. Before considering the various conditions that pertain, a review of the anatomic relations of the membranous septum is worthwhile.

Anatomy of the Membranous Ventricular Septum
The membranous septum lies superior to the base of the muscular part of the ventricular septum and makes union with the origin of the aorta. The septal leaflet of the tricuspid valve arises from the membranous septum. Superior to the attachment of the septal tricuspid leaflet is the atrioventricular portion of the membranous septum, that part which separates the left ventricle from the right atrium. Inferior to the attachment of the septal leaflet of the tricuspid valve is the interventricular portion of the membranous septum. In most instances of aneurysms of the membranous septum or lesions resembling this condition, the interventricular portion of the membranous septum is involved (fig. 1).

Aneurysms of the Membranous Septum
Aneurysms of the membranous septum may be congenital or acquired. A congenital aneurysm of the membranous septum is represented by a
fibrous-walled sac which occupies the interventricular portion of the membranous septum, protruding from the left ventricle into the right ventricle under the septal leaflet of the tricuspid valve. In most instances described, the aneurysm is intact so that no interventricular communication is present (figs. 1a and 2).

In an uncommon situation, a true congenital aneurysm of the membranous septum may rupture leading to an acquired interventricular communication. In the one example at our disposal, there were jet lesions on the right ventricular wall opposite the ostium of the perforation in the aneurysm indicating considerable duration of the interventricular communication (figs. 1b and 3). It is to be anticipated, as with ruptured aortic sinus aneurysm, that in some cases an acute cardiac catastrophe may result from rupture of a congenital aneurysm of the membranous septum.

Acquired aneurysms of the membranous septum are usually consequences of bacterial endocarditis of the aortic valve with secondary involvement by infection of the membranous septum. Such myotic aneurysms may rupture, leading to an acquired communication between the two circulations (fig. 4). It is also possible that a congenital aneurysm may become infected and secondarily ruptured leading to uncertainty as to whether the aneurysm was congenital with secondary infection or primarily a myotic aneurysm with secondary perforation.

**Spontaneous Closure of Ventricular Septal Defect**

In some ventricular septal defects which include the membranous septum, there may be spontaneous closure by adhesion of the septal leaflet of the tricuspid valve to the edges of the ventricular septal defect. As the adherent tricuspid valve protrudes toward the right ventricle by virtue of the higher pressure in the left ventricle, an aneurysmal pocket may form (figs. 1c and 5). These lesions are distinguished by the identification of the septal leaflet as forming the aneurysmal protrusion. In addition to examples of complete closure of ventricular septal defect in this location are cases in which the closure is incomplete allowing some communication at the lower aspect of the adhesion of the tricuspid valve to the related ventricular septum (figs. 1d and 6). In such instances, it may be impossible by radiologic means to distinguish the condition from a ruptured aneurysm.

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*Figure 1*

Main body of illustration is a diagrammatic portrayal of the chambers of the heart and the membranous portion of the ventricular septum (M.S.) The latter lies immediately beneath the origin of the aorta (A.). The septal leaflet of the tricuspid valve (S.T.) takes origin from the membranous septum. Superior to the attachment to the septal leaflet of the tricuspid valve, the membranous septum separates the left ventricle (L.V.) from the right atrium (R.A.). Inferior to the attachment of the septal leaflet of the tricuspid valve, the membranous septum separates the left ventricle from the right ventricle (R.V.). L.A. = left atrium. (a.) Congenital aneurysm of membranous septum. The aneurysm and septal leaflet of the tricuspid valve are distinguished from each other. (b.) Ruptured congenital aneurysm of the septum. (c.) Spontaneous closure of membranous ventricular septal defect by adhesion of septal tricuspid leaflet to the edges of the ventricular septal defect. (d.) Incomplete closure of the membranous ventricular septal defect by the septal leaflet of the tricuspid valve.
Figure 2

Unruptured congenital aneurysm of the membranous septum. (a) Interior of left ventricle (L.V.) and aorta (A). Beneath the aortic valve, the ostium (between arrows) of a congenital aneurysm of the membranous septum is seen. (In fixation of the specimen, the aneurysm has buckled somewhat toward the left ventricle.) (b) Sagittal section through the aorta (A.) and the ventricular septum (V.S.). Immediately beneath the aortic valve, an aneurysmal protrusion (An.) is present representing a congenital aneurysm lying medial to the septal leaflet of the tricuspid valve (S.T.).

While ventricular septal defects that become closed by adhesion of the tricuspid valve usually involve the membranous septum, there are exceptions. Included in these are those muscular ventricular septal defects which lie closely allied with the septal tricuspid leaflet. Adhesion of the latter may close such ventricular septal defects as with membranous defects (fig. 7).

**Pouches of Tricuspid Valve**

The tricuspid valve may be the site of accessory tissue, especially involving the septal leaflet. Such tissue may take on a pouchlike formation and be associated with a ventricular septal defect. If a ventricular septal defect is present, the pouch may be visualized and misinterpreted as an aneurysm or a formation resulting from incomplete closure of the ventricular septal defect. A distinguishing feature usually, however, is that the ventricular septal defect is large. In cases of incomplete closure of a ventricular septal defect yielding a pouchlike protrusion at the base of the ventricular septum, the interventricular communication classically is small.

**Protrusion of Questionable Nature**

There are situations wherein the pathologic examination shows a pouchlike protrusion at the level of the membranous septum but its exact nature is not easy to identify. In some of these cases, the condition is clearly that of a true aneurysm of the membranous septum associated with a cleft in the septal leaflet of the tricuspid valve, the aneurysm protruding between and being adherent to the edges of the cleft (figs. 8 and 9). In other cases, the tricuspid valve is adherent to the ventricular septum and it is not possible to determine whether there is an underlying aneurysm to which the tricuspid valve is adherent or whether...
Figure 3
Ruptured congenital aneurysm of the membranous septum.
(a.) Interior of left ventricle (L.V.) and aorta (A.). Beneath the aortic valve is the ostium (between arrows) of a congenital aneurysm. (b.) Interior of right ventricle (R.V.) and pulmonary valve (P.V.). Medial to the septal leaflet of the tricuspid valve (S.T.) is an aneurysm which has perforated (probe). A.T. = anterior tricuspid leaflet; T.O. = tricuspid orifice. (c.) Sagittal section through aorta (A.) and ventricular septum (V.S.). The aneurysm bulges in relation to the septal leaflet of the tricuspid valve (S.T.). Perforation of aneurysm indicated by probe. Jet lesions (J.L.) involving wall of right ventricle opposite ostium of perforated aneurysm.
Acquired aneurysm of the membranous septum secondary to bacterial endocarditis. (a.) Bicuspid aortic valve with lesions of bacterial endocarditis. An.I = a mycotic aneurysm of the ascending aorta (A.); An.II = ostium of an aneurysm of the membranous septum; L.V. = left ventricle; A.M. = anterior mitral leaflet. 

(b.) The aneurysm of the membranous septum (An.II) has protruded against the septal wall of the right atrium (R.A.). C.S. = coronary sinus ostium. 

(c.) Interior of right atrium (R.A.). Superior to the septal leaflet of the tricuspid valve (S.T.), the aneurysm (An.II) forms a protrusion in the atrial septum lying anterior to the ostium of the coronary sinus (C.S.) and inferior to the foramen ovale (F.O.). (Reproduced from Minn Med, by permission.)
Figure 5

Spontaneous closure of membranous ventricular septal defect. (a.) Left ventricle (L.V.) and aorta (A.). Beneath the aortic valve is a pouchlike protrusion (between arrows). (b.) The right atrium (R.A.) and right ventricle (R.V.). The septal leaflet of the tricuspid valve (S.T.) is adherent to the edges of the ventricular septal defect closing and obscuring the defect.

Figure 6

Incomplete closure of ventricular septal defect by septal leaflet of tricuspid valve. (a.) Left ventricle (L.V.) and aorta (A.). Beneath the aortic valve is a defect (between arrows) showing several openings. (b.) Interior of right atrium (R.A.) and right ventricle (R.V.). The septal leaflet (S.T.) of the tricuspid valve is adherent to the edges of the ventricular septal defect. Interchordal spaces allow some communication to persist.

Circulation, Volume XLVII, May 1973
Two cases of muscular ventricular septal defect spontaneously closed by adhesion of septal leaflet of the tricuspid valve. (a. and b.) Representing one case reported by Simmons and associates, reproduced with permission. (a.) Left ventricle (L.V.) and aorta (A.). A small defect (between arrows) lies inferior to the membranous portion of the ventricular septum. (b.) Low-power photomicrograph of sagittal section through the ventricular septum (V.S.) and the septal leaflet of the tricuspid valve (S.T.). The ventricular septal defect (D.) has been closed by adhesion of the septal leaflet to the edges of the ventricular septal defect. The formation yields an aneurysmal-like protrusion bulging into the right ventricle (R.V.).

(c. and d.) From a second case. (c.) Left ventricle (L.V.) and aorta (A.). Inferior to the membranous portion of the ventricular septum is a defect (between arrows). (d.) Right atrium (R.A.) and right ventricle (R.V.). Adhesion of accessory septal tricuspid tissue to the edges of the ventricular septal defect results in closure of the defect and the presence of a pouchlike formation.
Figure 8
Aneurysm of the membranous septum associated with a cleft in the tricuspid valve. The aneurysm bulges through the cleft and is adherent to the edges of the defect. (a) In a plane different from the level of the cleft, septal tricuspid leaflet is identified. (b) In the plane of the cleft in the tricuspid valve, only the aneurysm is seen. (c) Viewed through the opened tricuspid valve, the aneurysm is seen protruding through a cleft in the septal leaflet of the valve.

Figure 9
Aneurysm of membranous septum associated with cleft in septal leaflet of tricuspid valve. (a) Left ventricle (L.V.) and aorta (A.). Ostium of aneurysm (between arrows) inferior to aortic valve. (b) Right atrium (R.A.) and right ventricle (R.V.). The aneurysm (between arrows) bulges through a cleft in the septal leaflet of the tricuspid valve and is adherent to the edges of the cleft.
the condition is simply that of spontaneously closed ventricular septal defect with aneurysmlike protrusion of the adherent septal leaflet of the tricuspid valve (fig. 10).

References

Figure 10
Protrusions of questionable nature. (a.) An aneurysm of the membranous septum is adherent to the septal tricuspid leaflet. (b.) Aneurysmlike protrusion of septal leaflet of the tricuspid valve which effects spontaneous closure of a ventricular septal defect. (c.) The situation as in a. (d.) The appearance of the opened tricuspid valve.
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Circulation. 1973;47:1089-1097
doi: 10.1161/01.CIR.47.5.1089
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
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