Right Ventricular Endomyocardial Fibrosis

Diagnosis and Management

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SUMMARY

The clinical course, noninvasive and invasive diagnostic findings in 4 patients (pt) with endomyocardial fibrosis are reported. All patients (16–50 years) were in functional class III–IV (NYHA). Central venous pressure with large a- and v-waves was elevated in all; liver enlargement and peripheral edema were also noticed in all pts, and ascites in 3. An apical 2/6 systolic murmur was present in 2, and a right parasternal pansystolic murmur 2–4/6 with positive Carvallo's sign in all pts. ECG was non-specific and chest x ray showed right atrial enlargement in every case. A right-sided diastolic plateau which was higher than left ventricular end-diastolic pressure was present in all pts. Echo-, angiocardiology and computed tomography of the heart revealed obliteration of the right ventricular cavity, predominantly localized at the apex. Two pts who underwent endocardial resection and tricuspid valve replacement are alive and well after 9 and 8 years, respectively. One pt died early in the postoperative period and one died waiting for surgical therapy. In conclusion, echo-, angiocardiology and computed tomographic findings are diagnostic. A satisfactory differentiation from other cardiac disorders with restrictive hemodynamics and right-sided heart failure is possible.

Additional Indexing Words:
Endomyocardial fibrosis  Restrictive endocarditis  Restrictive cardiomyopathy

ENDOMYOCARDIAL fibrosis is an endemic heart disease in several tropical countries, but rarely found in Western countries. The important finding of the disease is the formation of fibrous tissue on the endocardium and to a lesser extent in the myocardium.

The fibrosis is usually located at the apex of the ventricle with extension...
to the inflow tract. The outflow tract is mostly free of the fibrotic tissue. The involvement of the chordae tendineae is frequent and causes mitral and/or tricuspid insufficiency. The endocardial thickening and myocardial involvement of major heart chambers with partial obliteration of the ventricles leads to decreased ventricular distensibility and impairment of filling.\textsuperscript{21,6,8,9,11,15,16,18-20}

The purpose of this study is to present the diagnostic findings in right ventricular endomyocardial fibrosis, clinical, noninvasive and invasive techniques.

**Patients and Methods**

From 1978–1987 right ventricular endomyocardial fibrosis was diagnosed in 4 cases (16–50 years). All pts were male. All 4 pts were admitted to hospital because of severe right heart failure, one of them with a history of chronic obstructive lung disease. In all pts the history was present for at least 3 years before the last hospital admission. On admission all pts were in NYHA class III–IV.

Physical examination revealed raised central venous pressure with large cv-waves in all and later huge a-waves in 3. The fourth patient had intercurrent atrial fibrillation. Peripheral cyanosis, hepato-splenomegaly and ankle edema were present in all and acites in 3 cases. An apical 2/6 systolic murmur was present in 2, and a right parasternal pansystolic murmur 2–3/6 with nonimpressive Carvallo’s sign in all pts. Blood pressure was normal in all cases. Augmented pulsus paradoxus was absent and Kussmaul’s sign was present in all cases.

ECG was non-diagnostic. In 1 pt atrial fibrillation occurred during hospitalization; right bundle branch block was present in 2 cases and episodes

| Table I. Hemodynamic Data in 4 Cases with Endocardial Fibrosis |
|-------------|---|---|---|---|
| Case | 1 | 2 | 3 | 4 |
| PA | 20/16(18) | 23/18(20) | 28/20 | 20/15 |
| RV | 20/16 | 23/10–18 | 28/8–20 | 20/10–15 |
| RA | 20/16 | 23/18 | 28/20 | 20/15 |
| LV | 110/0–10 | 115/0–10 | 95/0–14 | 90/0–10 |
| AO | 110/60 | 115/70 | 95/70 | 90/70 |
| LV-EF | 45% | 43% | 32% | 32% |
| CI | 2.30 | 2.21 | 2.16 | 2.12 |

PA=pulmonary artery; RV=right ventricle; RA=right atrium; LV=left ventricle; AO=aorta; EF=ejection fraction; CI=cardiac index (l/min/m\(^2\)).
of supraventricular tachycardia in 1. The chest x ray showed mild cardiomegaly without signs of pulmonary congestion in all cases. Cardiothoracic ratio was almost within normal limits, but right atrial enlargement was present in all cases.

Echocardiography was performed in all 4 cases, only M-mode in 2 and 2D- and Doppler-echocardiography in the other two. The 2D-echo was diagnostic and showed partial obliteration of the right ventricle and Doppler revealed tricuspid regurgitation (Fig. 1a–c). The 2D-echocardiographic study demonstrated a funnel- or spade-shaped and constricted right ventricle, a huge right atrium and normal right ventricular outflow tract configuration. The M-mode echocardiogram showed severe paradoxical movement of the interventricular septum. Obliteration of the right ventricular cavity (inflow tract) and endocardial thickening were well documented.

Computed tomography was performed in the last case; pericardial thickening was excluded. A right atrial dilatation was present and there was a hypodense area medial to the right atrium. The right ventricle was seen as a small appendage of the left ventricle (Fig. 2).

Simultaneous right and left heart catheterization and dextro-/levo-cardiography were performed in all cases. The hemodynamic data of a case are given in Fig. 3. The right-sided diastolic pressures including right ventricular end-diastolic pressure were more than 5 mmHg higher than the left ventricular end-diastolic pressure.

Right ventricular angiograms showed that the right ventricles were almost obliterated, being small and funnel-shaped with no trabeculation and

![Fig. 1a. The parasternal long-axis sweep shows a severe paradoxical movement of the interventricular septum (IVS) but poor documentation of right ventricular (RV) endocardial thickening. LV=left ventricle; MV=mitral valve; LVPFW=left ventricular posterior wall.](image-url)
poor contraction in all cases (Fig. 4). There was severe tricuspid regurgitation in all cases with large right atria. The levocardiogram revealed large left ventricles with relatively poor contraction and mild to moderate mitral
Fig. 2. CT of the heart. Slice thickness 8 mm with adjacent slice sequence. Image sequence in rows: On the first image we find a normal anatomy, whereas on the second image a dilatation of the vena cava sup. can be seen. The third and fourth images show the normal main bronchi resp. and the right auricular appendix. On images 5 to 16 an extremely dilated right atrium is visualized with an extension of about $11 \times 10 \times 7.5$ cm. Medial to right atrium, where the right ventricle is expected to occur, a large hypodense defect area is depicted (image 6-8). No right ventricle is visible. On the caudal slices the pericardial thickness is about 6 mm.

Fig. 3. Typical pressure tracings in restrictive endocardial fibrosis of the right ventricle. Note the lack of a restrictive filling pattern in the left ventricular pressure curve. $LV =$ left ventricle (mmHg); $AO =$ ascending aorta (mmHg); $LV-EF =$ left ventricular ejection fraction; $CI =$ cardiac index (l/min/m²).
regurgitation in 3 cases.

There was a typical configuration of the pulmonary artery, right ventricular and right atrial pressure tracings. A square root sign and early diastolic dip with high diastolic plateau were present in all cases. The pulmonary artery, right ventricular and right atrial curves showed nearly identical configurations (Fig. 3). Endomyocardial biopsy was performed in 2 cases. The results are reported as negative.

Blood count showed significant eosinophilia (>9%) in 2 cases. Immunological tests and all other lab-findings were within normal limits except prothrombin time which was pathologic in 2 cases.

Despite vigorous medical treatment, including digitalis and diuretics, the clinical course deteriorated. Three patients underwent surgical treatment. One patient died early in the postoperative period and one died while waiting for surgical therapy.

During surgery a large right atrium and a small right ventricle were seen in all cases. The right ventricular endocardium was extremely thickened and glossy. The parietal surface of the endocardium was partially covered by ragged pieces of myocardial tissue. The dense white endocardial fibrous tissue anchored the papillary muscles and enmeshed the roots of the chordae tendineae.

There were firm adhesions between the right ventricular endocardium, the myocardial fibrotic tissue and the tricuspid valve. In almost all cases the thickened right ventricular endocardium was extensively peeled off together with the deformed tricuspid leaflets. A number 29 Carpentier prosthesis was inserted in 2 cases and a number 27 in 1 case in the tricuspid position. Mitral valve repair was done in 2 cases.

The autopsy of case 4 revealed a small right ventricle 4×3×3.5 cm,
with thickened endocardium (0.6/0.3 cm) in the ventro-septal, ventro-lateral and dorso-caudal areas. The right ventricular outflow tract was free of endocardial thickening. The right atrium was grossly enlarged (10×10×9 cm). The left ventricle and mitral anulus were dilated 6×6×3 cm and 12.6 cm, respectively. The left ventricular endocardium was free of endocardial thickening (Fig. 5). There were no arteriosclerotic changes in the coronary arteries. The endocardial specimen removed during operation consisted of several thick membranous rigid sheets of endocardium with thickness varying from 1.5 to 3 mm. The inner surface of the endocardium was glistening, and mural thrombi were noted in 1 case.

Microscopic sections of various parts of the specimen showed distinct thickening of the endocardium with collagen. With Verhoeff van Gieson elastic stain the appearance was unlike that in endocardial fibroelastosis and sections showed irregular masses of broken elastic fibers instead of proliferating tissue. The thickened areas showed destruction of the original endocard-

Fig. 5. Gross pathology of the patient's heart: interior of the heart, opened right atrium, tricuspid valve and right ventricle. There is a gross endocardial thickening at the body of the right ventricle; the apex is obliterated by a fibrotic mass without superimposed thrombi. The infundibulum is normal sized and does not show marked endocardial thickening.
dium and adjacent superficial myocardium with replacement by vascular fibrous tissue. There were foci of sparse perivascular lymphocytic cell infiltration in the deeper layers of the endocardium. The pathological diagnosis was constrictive endocardial sclerosis in all cases.

In 2 patients the postoperative course was uneventful and the patients had no audible murmur. The congestive heart failure receded and the patients’ general condition improved significantly. Chest x ray showed a conspicuous reduction in heart size. Repeat cardiac catheterization 6 and 8 weeks after operation in 2 patients showed that intracardiac pressures had returned to normal and the right ventricular cineangiogram showed a normal sized chamber with good contraction and no tricuspid regurgitation. A left ventricular cineangiogram showed no mitral regurgitation. The patients were maintained on digitalis and at present are leading fairly normal lives. Two of the patients have been followed for 5 and 6 years. The clinical course remains stable in 1 case and slightly deteriorated in the other. Both cases require medical treatment.

**DISCUSSION**

The clinical presentation of right-sided endomyocardial fibrosis or constrictive endocarditis is right heart failure and constrictive pericarditis. In most cases the heart failure is refractory to medical treatment.

The patient's history, a nonimpressive Carvallo's sign, despite clinical signs of severe tricuspid regurgitation, and a positive Kussmaul's sign without pulsus paradoxus may be helpful in making a clinical diagnosis of right-sided endocardial fibrosis (constrictive endocarditis).

The clinical findings in patients with endocardial fibrosis are similar to those in endomyocardial fibrosis or Loeffler's endocarditis and classification is principally based on the pathological findings.\(^1\),\(^2\),\(^16\),\(^18\) Our patients presented with clinical findings of right heart failure and the hemodynamic studies showed the characteristic findings described for endocardial fibrosis of the right ventricle with tricuspid regurgitation.\(^16\),\(^18\),\(^19\) The right ventricular angiograms, which demonstrated a funnel-shaped and constricted right ventricle, led us to diagnose endomyocardial fibrosis as described previously.\(^18\),\(^19\) The reduced compliance of the right ventricle in our patients resulted in high end-diastolic pressures in this chamber and an increase in right atrial pressures. In the absence of left ventricular involvement, the pulmonary arterial pressure is reported to be normal, as was the case in our patients.\(^15\),\(^18\),\(^19\)

The diastolic dip and plateau, the so-called square root sign, is one of
the most characteristic hemodynamic findings of ventricular constriction. This unique hemodynamic feature in patients with endomyocardial fibrosis of the right ventricle is unilateral, and is attributed to the unilateral nature of cardiac constriction.

The patients with right ventricular endomyocardial fibrosis described in the literature, including our cases, had severe disease of the right ventricle and most of them had little or no constriction of the left heart. In our patients simultaneous measurements of right and left ventricular pressures showed diastolic pressures more than 5 mmHg higher in the right heart than the left heart. This finding is in contrast to the hemodynamic findings of constrictive pericarditis with high but equal diastolic pressures (plateau) in all heart chambers.11)–13)

Although in our cases the left ventricular involvement was not as extensive as the right ventricular lesion, poor contraction of the left ventricles was present. Nevertheless during operation no fibrosis was found in the left ventricular endocardium but in the autopsy case there was increased myocardial fibrosis and lymphocytic infiltration. The overall hemodynamic picture in these cases is compatible with generalized myocardial disease with predominant right ventricular involvement.

The 2D-echocardiographic study demonstrating a funnel- or spade-shaped and constricted right ventricle, a grossly enlarged right atrium and normal right ventricular outflow tract configuration, led us to diagnose endocardial fibrosis of the right ventricle. The M-mode echocardiogram showed severe paradoxical movement of the interventricular septum and obliteration of the right ventricular cavity (inflow tract). The endocardial thickening was poorly documented. Although Hess and his colleagues showed excellent documentation of endocardial fibrosis in M-mode echocardiography, we were not able to document endocardial thickening in time motion echocardiograms in all cases because of a narrow echocardiographic window in the parasternal views. Paradoxical septal motion, endocardial thickening, obliteration of the right ventricular cavity, and a grossly enlarged right atrium were well documented by the 2D-technique. The right ventricular angiogram was absolutely identical to the 2D-echocardiograms and also showed a funnel-shaped and constricted right ventricle.7),9),10),18),17)

Computed tomography in our case showed the right ventricle as a small appendage of the left ventricle and excluded constrictive pericarditis. This noninvasive technique seems to be very helpful for the differential diagnosis of endocardial fibrosis.

The right ventricular endomyocardial biopsy which was done in 2 cases showed nearly normal endomyocardial tissue histologically. This technique
was, at least in our hands, disappointing. This may have been due to the rigid and hard endocardium and some normal areas of endocardium near the outflow tract.

The pathological findings were interpreted as constrictive endocarditis. It seems that the above entity is a variation of endomyocardial fibrosis. The latter lesion is often described in Africans, but to our knowledge no cases have been observed in this area. Though Loeffler's endocarditis presents with similar findings, the reported cases have pronounced eosinophilia during phases of the disease, which was not seen in our cases. The pathological findings have differed from those classically described for endocardial fibroelastosis. In a review of endomyocardial fibrosis it was described as a distinct entity different from Loeffler's endocarditis. Use of the term restrictive cardiomyopathy for the spectrum of the disease has been recommended.

The etiology of the disease in our cases as in most of the published cases in Western countries remains unknown. An important point of emphasis in these cases is successful surgery in 2 cases. In an extensive review of the treatment of cardiomyopathies, the results in obliterative cardiomyopathies were cited as unsatisfactory. Our success with decortication and peeling off the right ventricular endocardium as described by Dubost et al and Cachera et al sheds hope on the management of such patients. Dubost's article reporting the results of this operation in 5 cases is further support that this method can be successfully palliative. Clinically, our 2 cases showed dramatic improvement, heart size was reduced and the patients' functional classification improved significantly.

Hemodynamic studies after operation showed distinct improvement and nearly normal intracardiac pressures; angiograms showed reduction of obliteration and improved ventricular function.

Although the long-term results and future course of the patients are unknown, in view of the extremely poor results of pure medical management in such patients we recommend the above described surgical procedure for most patients whose course is one of deterioration with right- or left-sided obliterative cardiomyopathy. Despite the good results of decortication and peeling off ventricular endocardium, cardiac transplantation can be an alternative treatment in some cases, especially in cases with severe left ventricular involvement. These efforts may perhaps give hope in the management of a potentially incurable heart disease.
REFERENCES