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Abstract

Objective: Cardiac echinococcosis is an extremely rare disease, seen worldwide. Some clinical characteristics are unknown, and treatment modalities are unclear.

Methods: 41 patients diagnosed with cardiac or pericardial echinococcosis underwent surgery. We evaluated the patients echocardiographically in 8 different categories: cardiac echinococcosis lesions located within the heart, imaging appearance of each lesion, activity of the cysts, mode of cardiac echinococcosis, and number of cardiac lesions per patient. The surgical technique was reevaluated according to the intraoperative echocardiographic findings, especially according to the mode of the lesion.

Results: The hydatid cysts were located in the ventricular wall in 34 cases, the right atrium in 2, the noncoronary sinus Valsalva of the aorta in 1, between the aorta and the pulmonary bifurcation in 1, and in the pericardium alone in 4 cases. In 1 case, septal rupture occurred and the patient died. Relapse was seen in 1 patient who was operated on due to multiple ventricular and pericardial cysts; this patient underwent a second operation 6 years and 8 months after the initial surgery.

Conclusion: Recent echocardiographic developments and application of intraoperative echocardiography enables a detailed classification for extirpation, and allows successful treatment.

Keywords

Antinematodal agents, cardiac surgical procedures, heart, echinococcosis, pericardium

Introduction

Cardiac echinococcosis (CE) is a serious life-threatening disease. Although very rare, it is seen all over the world.^{1,2} Published studies and case reports related to CE are limited, and a lot of questions remain unanswered. The purpose of this study was to examine our experience of the management and localization of different CE.

Patients and methods

Surgery for cardiac and/or pericardial echinococcosis was carried out in 41 patients from 1977 to June 2009. There were 22 females and 19 males, with ages ranging from 9 to 73 years (mean, 36 years). A new cardiac classification has been devised, based on recent developments in echocardiographic evaluation. In the 29 cases diagnosed since 1994, this classification was used for evaluation and treatment. After the initial echocardiography examination, abdominal ultrasonography and

whole-body computed tomography were used to detect further possible sites of involvement. Once CE was diagnosed, albendazole therapy was initiated and cardiac surgery was planned.

All patients underwent transthoracic echocardiography; 12 of them also underwent transesophageal echocardiography (TEE) preoperatively. Intraoperative epicardial echocardiography (IOEE) and intraoperative TEE were performed in the last 29 patients. Transthoracic echocardiography was undertaken postoperatively in all cases to evaluate the early and late complications of surgery, except in one patient who died. This modality was also used every 6 months in

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the first postoperative year and annually thereafter to assess CE recurrence. The following steps were followed to evaluate the echocardiographic variables for CE: location of CE lesions within the heart, imaging appearance of each lesion (unilocular, multilocular, solid, or semisolid), activity of the cysts (active, transitional, or inactive), mode of ventricular myocardial echinococcosis (most were located within the ventricle), and number of cardiac lesions (unilocal, multilocal, widespread). General echocardiographic findings are listed in Table 1. In addition, the relationship between the lesions and the cardiac chambers and vascular structures, presence of blood flow within the lesions, and postoperative status were assessed.

The surgical technique used was modified according to the location of the cysts, using the classification previously published by our clinic.³⁻⁵ This classification (Figure 1) was used to plan elective surgery. A median sternotomy was performed in all cases, except for one in which a posterolateral thoracotomy was used. Planning of the operation was reassessed following pericardial sectioning. From 1994, TEE and IOEE were used during this reassessment in all patients. The surgical technique was modified according to the location of the cysts and their complications. In one patient, a right atrial cyst was removed with its atrial wall attachment, under cardiopulmonary bypass (CPB). In another patient, a ruptured and calcified cyst was located between the noncoronary sinus of Valsalva and the right atrium. The cyst was removed under CPB, and the aortic cusps were resected. The aortic root was repaired using a Dacron patch, and the aortic valve was replaced with a 25-mm bileaflet mechanical prosthesis. One patient diagnosed with a subdiaphragmatic abscess and a recurrent hepatic cyst, was found to have a hydatid cyst that crossed the diaphragm and ruptured into the pericardial cavity. The cyst was aspirated and the germinative membrane was extracted transdiaphragmatically. In 2 patients diagnosed with tamponade, the cysts were extracted after pericardiotomy without CPB. Operative treatment is summarized in Table 2.

In the first 6 cases CPB, moderate hypothermia, and cardioplegic arrest were used. Following cardioplegic arrest, the cysts were reached via a left ventriculotomy in 6 patients. The ventriculotomy was closed primarily in all patients except one who required a polytetrafluoroethylene patch. In the 7th patient, the cyst was removed from a beating heart on CPB. In subsequent years, a new approach for the extraction of ventricular myocardial hydatid cysts was advanced.⁴ During the operation, the location of the cysts, their relationship to the cardiac chambers, and the blood flow within the cysts were evaluated using TEE or IOEE.⁴ An off-pump technique was used for

type B, D, E, G and K (Figure 1). The affected area was encircled with polyvinylpyrrolidone iodine impregnated gauzes. Diagnostic aspiration was applied to check and identify the contents (Figure 2). Provided there was no communication between the cyst cavities and the cardiac chambers, polyvinylpyrrolidone iodine solution was injected into the cysts to inactivate the scolices. The fluid content of the cysts was aspirated, and the cavity was carefully opened. Multiple daughter cysts were removed. Daughter cysts were best mobilized with different sized meal spoons. The area was irrigated. We excised the epicardium covering the cyst cavity and left the cavity open. Four patients with type C (F), D, and H required CPB. In one of them, a ventricular septal type C (maybe F) cyst causing obstruction of the left ventricular outflow tract was extracted via aortotomy. In the other patients, the type D cysts were small and very close to the first obtuse marginal artery. The cysts could only be reached using cardioplegic arrest to avoid opening the ventricular cavity and damaging the coronary artery. In the 3rd patient, 2 cysts were examined by IOEE. The posterolateral type G cyst was removed off-pump, and the inferior cyst (type H) was removed under crossclamping because of the presence of a communication between the cyst and the left ventricular cavity. In the 4th patient, the first right ventricular 4 × 4-cm type B cyst was removed on a beating heart. A type C cyst was then discovered by echocardiography posterior to the initial cyst, lying beneath the annulus of the tricuspid valve. This cyst was removed via the right atrium under crossclamping, and the tricuspid valve was repaired. Only in these 2 patients was capitonnage of the cavities performed. The 22nd case was a 73-year-old man with coronary artery disease, who had widespread hydatid disease. All the hydatid cysts were extirpated, and the occluded left anterior descending artery was bypassed using the left internal mammary artery, without CPB.

Albendazole is more effective than mebendazole. The dosage of albendazole is 15 mg·kg⁻¹ per day, taken in 2 divided doses after meals for 4 weeks. We give a 2-week rest before starting another 4-week course. Optimal cyst eradication can be achieved with 1 preoperative and 3 postoperative courses. The aim of preoperative albendazole is to decrease the number of living parasites before surgery. In practice, it is not possible to inactivate all the parasites with albendazole. We increase the number of postoperative albendazole courses if the preoperative treatment was short, living parasites were encountered at the operation, and if the cysts were extensive. Some patients took albendazole up to the 5th postoperative year. The other criteria to determine the duration of postoperative albendazole treatment are the titer of the echinococcus

Table 1. Preoperative echocardiographic findings in 41 patients with cardiac echinococcus.

Case No.	Location	Appearance	Activation	Mode	Site
1	Lateral LV	Unilocular		B	Single
2	Lateral LV	Unilocular		B	Single
3	Lateral LV, pericardium	Multilocular		E	Single
4	Apex, pericardium	Multilocular		B, E	Single
5	Apex, septum, pericardium	Multilocular		B, E	Single
6	Apex, septum	Unilocular		B (exitus)	Single
7	Lateral LV	Unilocular	Active	B	Single
8	Posterolateral LV	Unilocular	Active	B	Single
9	Lateral LV	Unilocular	Inactive	G	Single
10	Anterior RV	Multilocular	Active	B	Single
11	Anterolateral LV, apex	Unilocular	Active	B	Single
12	Posterolateral LV	Unilocular	Active	B	Single
13	Posteroinferior LV	Solid	Transitional	B	Single
14	Anterolateral LV	Unilocular	Active	D	Single
15	Anterior RV, septum	Unilocular	Active	B	Single
16	Anterior RV	Unilocular	Active	B	Single
17	Pericardium	Multilocular	Active	E	Multiple
18	Anterior RA	Unilocular	Active		Single
19	Posterolateral LV	Solid	Inactive	D	Single
20	Apex	Unilocular	Active	B	Single
21	Septum	Unilocular	Transitional	B	Single
22	Apex, anterolateral LV, posterolateral LV, pericardium	Multilocular	Active	B, E	Widespread
23	Inferoposterior LV, inferior ventricular septum	Unilocular	Active		Single
24	Apex, posterolateral LV, pericardium	Multilocular	Transitional	B, E	Multiple
25	Apex, anterolateral LV, inferior LV, behind aorta, pericardium	Multilocular	Transitional	B, E	Multiple
26	Posterolateral LV, inferior LV	Solid	Inactive	B	Single
27	Anterior RV, septum, RVOT	Unilocular	Active	B	Single
28	Anterior RV, lateral LV, pericardium	Multilocular	Transitional	B, E, F	Widespread
29	Subaortic septum	Unilocular	Active	F, C	Single
30	Apex, anterolateral LV, behind pulmonary vein, pericardium	Multilocular	Transitional	B, E	Multiple
31	RA, pericardium	Multilocular	Inactive		Single
32	Between RA and aortic sinus of Valsalva				Single
33	Anterior mediastinum, pericardium	Multilocular	Active	E	Single
34	Pericardium	Unilocular	Active	K	Multiple
35	Pericardium	Multilocular	Active	K	Single
36	(1) Inferior LV, beside RA, pericardium (2) Recurrence behind LA and pulmonary vein	(1) Multilocular (2) Unilocular	(1) Active (2) Active	B, E (primary) E (relapse)	(1) Multiple (2) Single
37	Anterior RV, septum	Unilocular	Active	B, D	Multiple
38	Posterolateral LV (subepicardial), inferior LV (subendocardial)	Unilocular	Inactive	G, H	Multiple
39	Anterior RV	Bilocular	Active	B, C	Single
40	Inferoposterior LV, inferior ventricular septum	Unilocular	Active	B	Single
41	Posterolateral LV, between arcus aorta and pulmonary bifurcation	Multilocular	Mixed	B, E, G	Multiple

LA: left atrium; LV: left ventricle; RA: right atrium; RV: right ventricle; RVOT: right ventricular outflow tract.

hemagglutination test and the level of anti-echinococcus immunoglobulin M. Albendazole treatment should continue until these measurements revert to normal.

Five- and 10-year recurrence-free survival and expected mean non-recurrence survival times were calculated using Kaplan-Meier survival analysis. Statistical analysis was performed using Statistical

Package for Social Sciences software (SPSS, Inc., Chicago, IL, USA).

Results

Of these 41 patients, 18 (44%) resided in rural areas and the other 23 had only lived in urban areas.

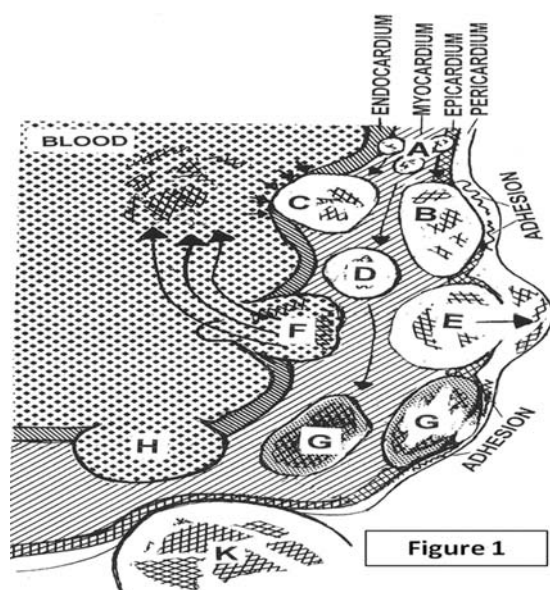


Figure 1. Modes of myocardial echinococcosis. (A) Scolices forming cysts. (B) Cyst growing towards the pericardial cavity (27 cysts). (C) Cyst growing towards the ventricular cavity (2 cysts). (D) Cyst not protruding towards the ventricle or pericardial cavity (3 cysts). (E) Rupture of cyst into the pericardial cavity (13 cysts). (F) Rupture of cyst into the pericardial cavity, but it still containing daughter cyst (2 cysts). (G) Degenerated cyst (3 cysts). (H) Cyst previously ruptured into ventricular cavity (1 cyst). (K) Extrapericardial cyst pushing and deforming the heart (2 cysts).

Table 2. Operative treatment in 41 patients with cardiac echinococcosis.

Location/treatment	No. of cysts
Ventricular cyst	34
With crossclamping	10
With crossclamp and PTFE graft	1
Beating heart, on-pump	1
Off-pump	21
Off-pump LIMA-LAD graft and cystectomy	1
Right atrial cyst	2
With crossclamp	1
Beating heart, on-pump	1
Ruptured sinus of Valsalva	1
Aortic repair and aortic valve replacement	1
Pericardial cyst only	4
Off-pump	4 + 1*

*Recurrence.

LAD: left anterior descending coronary artery; LIMA: left internal mammary artery; PTFE: polytetrafluoroethylene.

Twenty-four (58.5%) patients had primary CE with no other organ involvement, whereas the other 17 had cysts located in other organs as well. Involvement of the lung was seen in 9 patients, of the liver in 6, of the

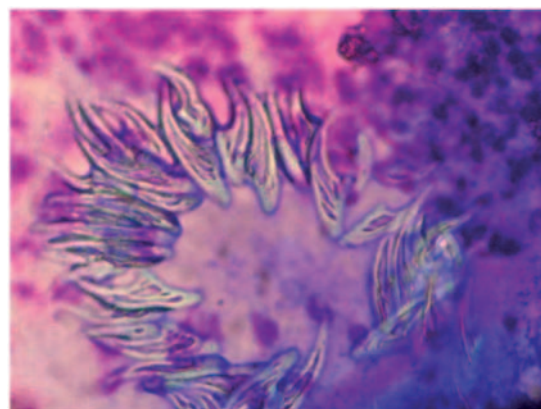


Figure 2. "Hydatid Sand". Scolices are seen in the sediment of the active cyst. Sediment is stained by hematoxylin-eosin. Scolices were alive, as the sample was taken before polyvinylpyrrolidone iodine injection. Dead scolices show positive staining by eosin.

spleen in 3, of the cranium in 2, of the lumbosacral vertebrae in 1, and of the kidneys in 1. Three patients had previously undergone lung surgery for hydatid cysts (8.3 and 2 years earlier), 2 had previously undergone liver surgery (14 and 3 years earlier), 1 had undergone surgery of the lumbar vertebrae for hydatid cyst (5 months earlier), 1 had undergone cerebral surgery twice for hydatid cyst (9 years, and 10 days previously). The indirect hemagglutination test for echinococcosis was positive in 27/41 (66%) cases. The patients with solid, multilocular, and unilocular cysts, were 100% (3/3), 71% (12/17), and 52.4% (11/21) seropositive, respectively. The preoperative symptomatic findings were dyspnea in 23 patients, chest pain in 19, palpitations in 13, syncope in 6, and weakness in 4. There was one death in the postoperative period. In this case, the septal cystic cavity did not communicate with the ventricular cavity, and it was closed primarily. The ventriculotomy was sutured using Teflon strips. Hemodynamic collapse occurred, and the patient died in the intensive care unit. Autopsy showed septal rupture at the suture line used to close the cystic cavity, due to the thinness of the wall and tight suturing.³ Each patient was summoned for a check-up at 2 and 6 months postoperatively and annually thereafter. In the early stages of the experience (first 12 cases), some delay occurred (follow-up period, 1–13 years), but the last 29 patients were followed up closely from 1992 onwards. One case of relapse was seen. The patient who was operated on for multiple left ventricular and pericardial cysts was reoperated on in the 68th postoperative month.⁴ Subsequently, there has been no recurrence for 100 months. Currently, 25 cases have been classified according to the New York Heart Association as class I, and 3 cases have been classified as class II. The median duration of follow-up was 49 months (range, 1–168 months). The expected lifespan

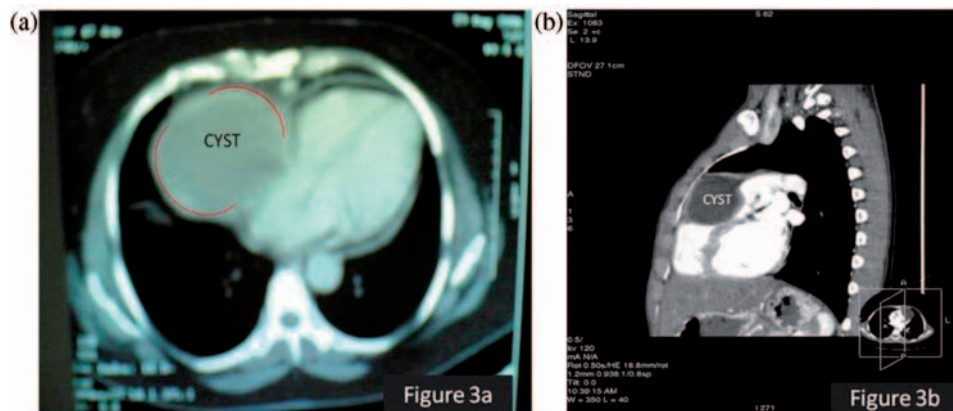


Figure 3. (a) Thoracic computed tomography: large right atrial cyst causing tamponade. (b) Thoracoabdominal computed tomography: large right ventricular and infundibular type B cyst compressing the right ventricular outflow tract.

in cases without recurrence was estimated as 146 months (95% confidence interval: 134.7–157.3). Five- and 10-year disease-free survival was found to be 100% and 92%, respectively.

Discussion

Hydatid disease has always been more common in countries where large numbers of sheep and cattle are raised, but increased travel and immigration has made this condition a serious worldwide public health problem.^{6,7} Echinococcosis affects all parts of the human body, including the bone marrow, eye, brain, kidney, and spermatic cord.^{10–14} The cysts may also be found in all parts of heart.³ Scolices are carried via the blood or lymphatics to the end-organs. In less than 2%, scolices are directed to the coronary circulation, settling down in the heart and forming cysts.² Cardiac disease may occur due to the activity of the scolices and their migration or metastasis. As 58.5% of cases did not involve any other organs, this supports the idea that metastasis was less than expected. Scolices of intestinal origin have difficulty in reaching the heart because they must pass through the hepatic system first. So primary cardiac cysts are surely ingested via the respiratory system.

When scolices reach the myocardium, cyst formation starts. At this stage, the cysts are very small and cannot be detected by any apparatus (Figure 1A). In the course of time, the cysts grow towards the epicardium (Figure 1B) or the endocardium (Figure 1C). In most cases, the cysts grow towards the epicardium because of intracavitary tension. Sometimes, the cysts do not protrude in any direction and become stagnant (Figure 1D). If the cysts become inactive, they may lose their fluidity and degenerate in time (Figure 1G). Degenerated cysts may mimic tumors on echocardiography.⁵ Subendocardial cysts protruding towards the ventricular cavity may rupture under sheer stress (Figure 1F). This may cause an anaphylactic reaction

and sudden death or peripheral emboli.^{15–17} If a patient with a type F cyst survives, the cardiac problem may resolve (Figure 1H). However, in one of our patients, a large inferior ventricular type H cyst caused problems with the anchoring of the mitral papillary muscle (case no. 38). In another case (case no. 39), capitonnage of the cyst was performed to repair the tricuspid annulus. Frequently, the cysts grow towards the epicardium, dissect that layer from the myocardium, and protrude towards the pericardial cavity. In some cases, the pericardium adheres to the epicardium over the cyst (Figure 1B). Besides dissecting the epicardium from the myocardium, a cyst may compress the small coronary arteries and increase compliance. In some patients, the cysts may rupture into the pericardial cavity and create pericardial cysts (Figure 1E). Sometimes, liver, lung, anterior mediastinal, or large pericardial cysts may compress the heart (Figure 1K) and cause tamponade (Figure 3(a)). Some cysts may cause subaortic or subpulmonary infundibular obstruction (Figure 3(b)). The titer of the echinococcosis hemagglutination test and the level of anti-echinococcus immunoglobulin M give us information about past or present hydatid disease. Only 66% of patients have positive hemagglutination tests.

Classic cystic CE lesions appear as well-defined echolucent structures on echocardiographic images, whereas those that have become solidified, calcified, or degenerated can be hyperechogenic, and thus mimic semisolid or solid mass lesions. It is possible to get more detailed images with TEE and IOEE, but currently, there is no echocardiographic classification system for cardiac echinococcosis. A scheme was published based on the World Health Organization ultrasonographic classification of cystic echinococcosis.^{18–20} We improved the scheme to assist the surgical facilities, and applied it to all cases. A new part was added to the guide for treatment: modes of ventricular myocardial echinococcosis (A–H). Unilocular cysts originate from

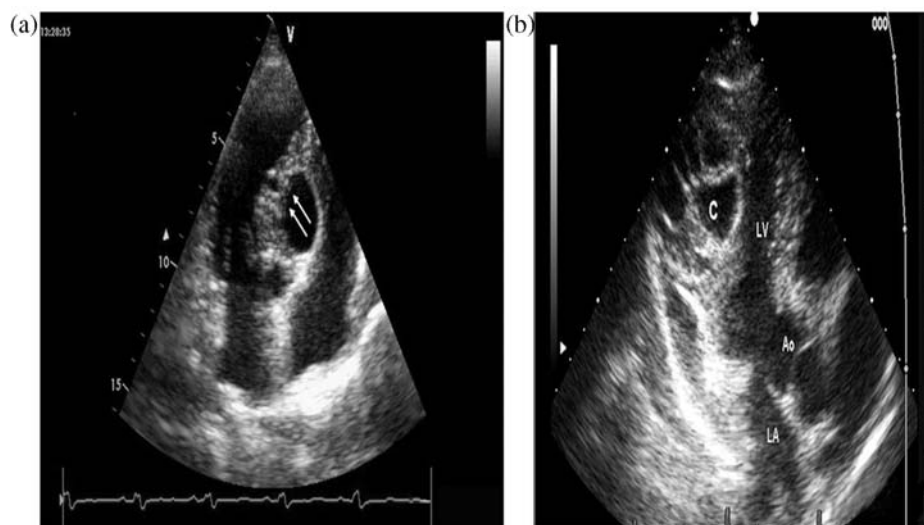


Figure 4. (a) Transthoracic echocardiography: unilocular active type C cyst located in the subaortic interventricular septum, causing left ventricular outflow tract obstruction (case no. 29). (b) Intraoperative epicardial echocardiography: multilocular (multilobular or multifocal) or unilocular active type B cyst located at the apical posterolateral and inferior wall of the left ventricle. The cyst is protruding into the pericardium, deforming the left ventricular cavity.

a single scolex. Exogenous development of the cyst may result in evagination of the cyst wall, producing multilocular cysts. Endogenous development and enlarging daughter cysts may cause multilocular images; mostly, daughter cysts with thin walls cause unilocular images. IOEE with a 10-MHz transducer may help to visualize daughter cysts. Enlarging type A cysts located in the same place may join, forming a multilocular cyst. The cysts may lose their fluidity and give rise to semisolid or solid images. Solid or semisolid cysts may be misinterpreted as tumors. A cystic lesion is identified as active if echocardiography findings indicate that it is a fertile unilocular or multilocular cyst (Figure 4(a) and (b)).¹⁸ Unilocular echinococcal cysts are oval or round and have a well-defined double-layered cyst wall composed of an outer thick laminated membrane and a less substantial inner germinal membrane (pericystium). Transitional cysts can also be partially or fully solidified, as reflected in increased echogenicity of the cyst fluid. Typically, the viscosity of the cyst content increases as the lesion degenerates. Sometimes an echinococcal cyst will solidify as a result of antiparasitic drug therapy. A cystic lesion is identified as inactive if echocardiography indicates that no daughter cysts are present, if the lesion features heterogeneous degenerative structures, or if it appears as a hyperechoic mass.¹⁸ Intraoperative views of active, transitional, and inactive cysts can be seen in Figure 5(a)–(c).

We have previously reported that preoperative cardiac CT can sometimes demonstrate additional cardiac cysts.¹⁸ In the last patient (case no. 41), thoracic CT showed an additional cyst between the arcus aorta and the pulmonary bifurcation, which was not seen

on transthoracic echocardiography or TEE (Figure 6). Intraoperative echocardiography and extirpated surgical material verified this finding. In addition, a tomographic search of the body is helpful for the diagnosis of other organ involvement. The known curative treatment for hydatid cyst is surgical extraction. Cardiac hydatid cysts must be treated surgically. Inactive degenerated cysts of the heart must also be extracted. Inactive cysts destroy cardiac performance by deforming the geometry, increasing compliance, compressing the coronary arterioles, and ruining and obstructing the valves. We cannot be completely sure that the cysts are totally inactive. The cysts may contain active and inactive daughter cysts, as seen in case no. 41 (mixed type). Mixed cysts are different from transitional cysts and contain young active daughter cysts and older degenerated cysts at the same time. Transitional cysts begin to degenerate (Figure 5(b)) but carry a contamination risk. The surgical plan is reevaluated following the pericardial incision, using TEE and IOEE. To decide the technique of resection, the anatomic features of the cyst must be documented in detail. In practice, it is not possible to diagnose 0.3–5-mm type A cysts. The cysts grow in time and cause recurrence years after the operation. In one of our patients, although albendazole had been prescribed for 5 years, we observed a recurrence 68 months after the operation. Type C cysts, which protrude towards the intraventricular cavity, are seen as bulging masses on echocardiography. These cysts are under sheer stress and carry a high risk of rupture. They should be resected after the aorta is clamped under CPB, through ventriculotomy, atriotomy, or aortotomy, according to their location

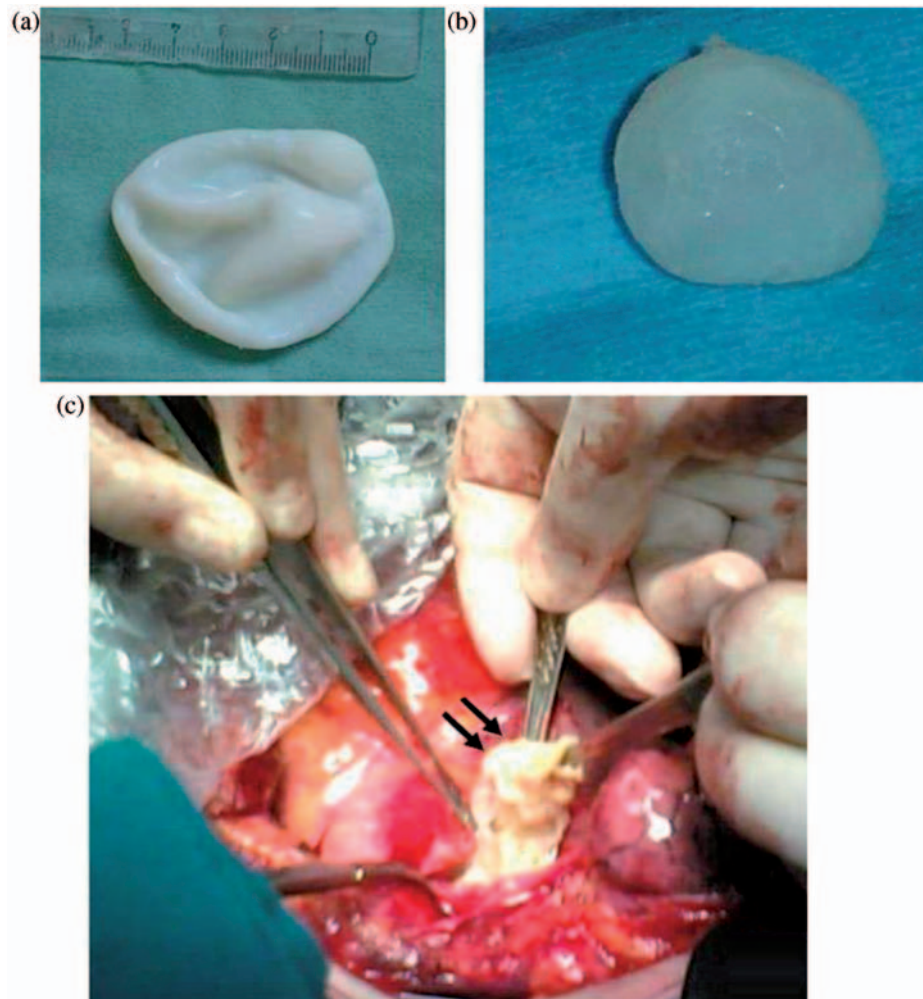


Figure 5. Intraoperative extraction of (a) active, (b) transitional, (c) inactive degenerated cysts.

and relationship. Cysts protruding towards the pericardial cavity (type B, E, and G) are seen more frequently than the other types, and these cases are good candidates for off-pump surgery. Cysts that do not protrude (type D) are difficult to approach. Aspiration of the ventricular cyst content eases the surgical treatment. If there is difficulty in echocardiographic diagnosis, needle aspiration may provide clues. If there is a true connection between the cystic cavity and blood stream, needle aspiration may confirm this. Initial aspiration of some cystic fluid followed by injecting iodine into the cyst will kill the scolices. Distension may be reduced by aspiration and this eases the manipulation and surgical dissection.

Opening the cystic cavities and removing them with their extensions is preferred. There are 3 reasons for leaving the cavities open: plication of large cavities immobilizes large areas of myocardium and causes myocardial disfunction; sutures may cut the myocardial edematous tissue while contracting, and cause intrapericardial bleeding; and after capitonnage, the remaining

scolices (if any) will be squeezed towards the cardiac chambers while growing. If the cavity is covered and closed with a graft, an enclosed space is produced, which is prone to abscess formation. Also, it is not practical to fill a large pouch with substances such as biological glue because this impedes the contraction of neighboring myocardium. In 2 patients, we had to perform capitonnage of the cystic cavities to anchor a malpositioned mitral papillary muscle (case no. 38) and to reconstruct the tricuspid valve (case no. 39). Scolices are very sensitive to albendazole and chemical detergents, thus they can be easily eradicated, but residual daughter cysts or type A cysts may resist albendazole and cause recurrences. We think that recurrences are mostly due to residual daughter cysts or type A cysts. Optimal cyst eradication can be achieved by albendazole administration: one course preoperatively and 3 postoperatively. In the unstable type C cysts, the preoperative albendazole-loading time is reduced to 3 days. The number of postoperative albendazole courses were increased when the preoperative course was short,

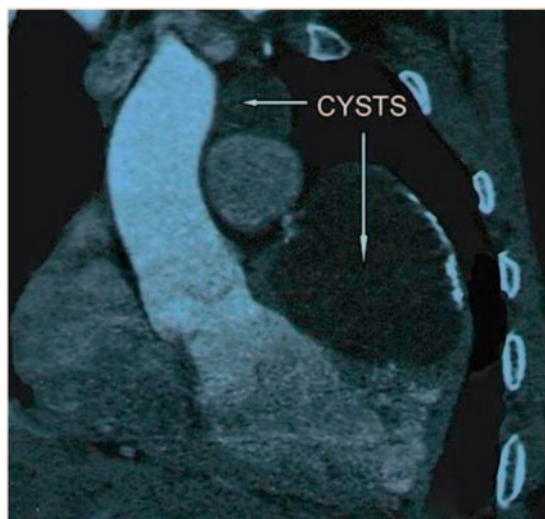


Figure 6. Thoracic computed tomography: large posterolateral left ventricular type B cyst growing towards the pericardial cavity, deforming the left ventricular cavity. The cyst adhered to the pericardium, the adherent area was calcified. In addition, a cyst was seen between the arcus aorta and pulmonary artery bifurcation. The cyst was growing towards the left atrium.

and in patients with active cysts at the time of operation.

Recent echocardiographic developments and routine usage of intraoperative TEE and IOEE, enable successful treatment of echinococcosis. Therefore echinococcosis is regarded as a curable disease. CT scanning is applied for the diagnosis of other organ involvement.

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Conflicts of interest statement

None declared.

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