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Executive office:
Türk Kalp ve Damar Cerrahisi Derneği
Ataşehir Mah., Ataşehir Bulvarı, 48 Ada,
Mimoza 2/2, K: 2, D: 6,
34758 Ataşehir, İstanbul, Turkey
Tel: +90 216 - 456 14 54
Fax: +90 216 - 456 14 54
e-mail: info@tkdcd.org
URL: http://www.tkdcd.org

Editorial Contact Person
Suat Nail Ömeroğlu, MD.
e-mail: suatnail@gmail.com

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Örnek Mah., Dr. Suphi Ezgi Sok., Saray Apt., No: 11, D: 6,
34704 Ataşehir, İstanbul, Turkey
Tel: +90 216 - 317 41 14
Fax: +90 216 - 317 63 68
e-mail: info@baycinartibbiyayincilik.com

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Case Report Open Access

Video-assisted harvesting of internal thoracic artery through median sternotomy incision in pectus excavatum

Burak Onan, Ersin Kadiroğulları, Serdar Başgöze, Adem Reyhancan

University of Health Sciences, Department of Cardiovascular Surgery, Istanbul Mehmet Akif Ersoy Thoracic and Cardiovascular Surgery Training and Research Hospital, Istanbul, Turkey

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ABSTRACT

Pectus excavatum is the most common deformity of the chest wall, in which the sternum and ribs show an abnormal growth. This pathology may complicate the operative exposure and manipulation during LITA harvesting through the median sternotomy incision in coronary artery bypass surgery. A 60-year-old female patient with three-vessel coronary disease and pectus excavatum was admitted. The patient underwent myocardial revascularization through median sternotomy, however, the exposure of the left internal thoracic artery was unsatisfactory due to the pectus deformity. Therefore, a 30-degree endoscope was successfully used for *in situ* harvesting of the left internal thoracic artery. In conclusion, the use of an endoscope is a safe and feasible solution for *in situ* internal thoracic artery harvesting in patients with pectus deformity who undergo coronary artery bypass grafting using sternotomy.

Keywords: Coronary artery bypass grafting; internal thoracic artery; pectus excavatum; video-assisted surgery.

The internal thoracic artery (ITA) is the preferred conduit of choice in coronary artery bypass grafting (CABG). Compared to other alternative conduits, the ITA provides the highest long-term patency and event-free survival.[1] Technically, the ITA is harvested under direct vision using a median sternotomy incision, although endoscopic techniques are frequently used in minimally invasive approaches, particularly through a left anterior small thoracotomy.[2] However, sternal depression in pectus excavatum may prevent optimal surgical exposure for ITA harvesting under direct vision. In such cases, endoscopic techniques may facilitate mobilization of the ITA graft from the chest wall through a sternotomy incision.

Herein, we report a case of three-vessel coronary disease and pectus excavatum in whom a 30-degree endoscope was successfully used for *in situ* harvesting of the ITA.

CASE REPORT

A 60-year-old female presented with progressive chest discomfort. Her past medical history included ischemic heart disease, hypertension, and diabetes mellitus. On admission, blood pressure and heart rate were 110/62 mmHg and 46 bpm, respectively. Physical examination revealed mild pectus excavatum and kyphoscoliosis. Cardiac auscultation revealed displaced heart sounds in the left hemithorax. Chest X-ray showed cardiomegaly. Transthoracic echocardiography demonstrated an ejection fraction of 45% and mild mitral regurgitation. Coronary angiography revealed significant stenosis of the left anterior descending, obtuse marginal, and right coronary arteries. The patient was scheduled for an elective CABG through sternotomy. As the patient had mild-degree pectus excavatum, sternotomy incision was considered feasible. A written informed consent was obtained from the patient.

Under general anesthesia, a median sternotomy incision was performed and the lower half of the sternum was found to be depressed symmetrically. A sternal retractor (Aygun Surgical Instruments Co. Inc., Samsun, Turkey) was placed; however, the exposure of the left ITA was unsatisfactory, despite

Corresponding author: Burak Onan, MD. SBÜ İstanbul Mehmet Akif Ersoy Göğüs Kalp ve Damar Cerrahisi Eğitim ve Araştırma Hastanesi, Kalp ve Damar Cerrahisi Kliniği, 34303 Küçükçekmece, İstanbul, Turkey.

Tel: +90 553 - 622 38 78 e-mail: burakonan@hotmail.com

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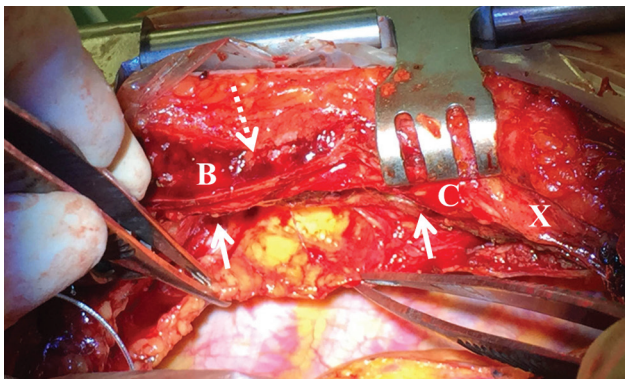

Figure 1. An intraoperative view showing that bone (B) of sternum and cartilage tissue (C) makes a depression (dotted-arrow) inferiorly. The left internal thoracic artery (between two white arrows) is behind left hemisternum (X= Xiphoid process).

maximal retraction and lifting the left side of the chest up. The direct vision of the ITA was unable to be achieved due to the depressed sternal bone in front of the graft (Figure 1). Coexistence of mild kyphoscoliosis might have also affected the surgical view. Rather than using a venous graft or other alternative conduits, we insisted on using an *in situ* left ITA graft for the left anterior descending artery. Therefore, a 30-degree endoscope (Evis Exera II Video System Cv-180, Olympus Medical Systems Corp., Tokyo, Japan) was used to expose the endothoracic wall and the ITA behind the depressed sternal bone. This instrument is a thoracoscope which can be used in the cardiothoracic surgery setting. The instrument was introduced into the chest cavity through the median sternotomy incision after placement of the chest retractor. The left pleura was, then, opened. An assistant surgeon directed and manipulated the endoscope helping the surgeon during the ITA harvesting. The endoscopic screen was placed on the left side of the patient and in front of the surgeon which allowed a good endoscopic view, and the pedicle of ITA was retracted inferiorly and its side-branches were gently cauterized (Figure 2). At the end of procedure, the ITA was transected distally and there was a pulsatile-free ITA flow of 60 mL/min. No graft injury or adventitial hematoma was evident macroscopically. Hemostasis of the thoracic wall was also performed endoscopically. Three-vessel coronary revascularization was performed uneventfully using cardiopulmonary bypass and cardiac arrest. The sternum was closed using the sternal steel wires after placing the chest tube. The postoperative course was uneventful and the patient was discharged on postoperative Day 6.

DISCUSSION

Pectus excavatum is the most common congenital chest wall malformation.[2,3] Depending on the severity of pathology, chest wall depression may complicate the operative exposure of the ITA following a sternotomy incision which makes harvesting of the ITA difficult under direct vision in CABG. In the literature, pectus deformity in patients undergoing open heart surgery has been described in several reports.[3] In such cases, the authors recommend the use of left thoracotomy approach for harvesting of the ITA under direct vision or using endoscopic techniques.[2] These approaches can be also used in hybrid revascularization strategy for multi-vessel disease and in high-risk patients for

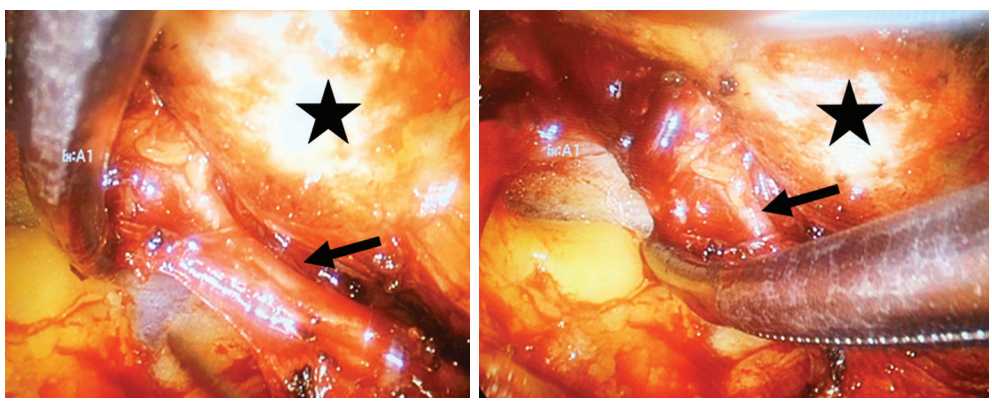

Figure 2. An endoscopic view showing internal thoracic artery (black arrow) harvesting using a 30-degree endoscope. The exposure of the artery and its side branches were improved with endoscopic vision which showed the artery behind the depressed sternum (black star). The artery was retracted inferiorly using an angled-clamp and side-branches were cauterized uneventfully.

a sternotomy incision in pectus excavatum. In this report, we described an alternative approach to obtain a good ITA exposure through a sternotomy incision in pectus excavatum using a 30-degree endoscope.

The technique of ITA harvesting may vary according to the revascularization approach applied. In patients with single vessel-disease and pectus excavatum, a left-sided mini-thoracotomy incision or endoscopic approaches can be used.[3,4] The effectiveness and safety of endoscopic approaches for ITA harvesting have been shown previously.[5] It has been also reported that the use of endoscopic approach does not jeopardize the quality of coronary anastomosis and late graft patency.[2] An additional benefit of the endoscopic approach is decreased postoperative pain, compared to the direct-vision approach.[6] However, the necessity of the right coronary artery or multi-vessel revascularization, repair of combined cardiac pathologies, and the need of using right ITA require a sternotomy incision. In such cases, our alternative endoscopic approach may be useful for harvesting of the ITA.

Technically, sternal depression in pectus deformity is a limitation for ITA harvesting under direct vision, despite maximal sternal retraction and positional maneuvers. In conventional CABG procedures, the use of classical sternal retractors may be unsatisfactory for the exposure of the ITA. Alternatively, the use of asymmetric sternal retractors, such as Rultract (Rultract Inc., Cleveland, OH, USA), may be feasible in pectus excavatum. These retractors directly elevate the left hemisternum away from the surgeon side to enhance the visibility of ITA. The anterior chest wall may also evert externally, which facilitates the exposure of ITA in mild pectus deformity. Nevertheless, harvesting of the ITA can be challenging in severe forms of pectus excavatum. Our approach with a 30-degree endoscope can be used concomitantly with these retractors, offering an uneventful ITA harvesting. Harvesting time is similar to conventional approach and, thus, does not impact the overall duration of the surgical procedure. The use of an endoscope seems to be a reasonable solution for ITA harvesting. However, some surgeons may have a concern about experience with the use of endoscopic screen during the ITA harvesting.

As an alternative approach, robotic harvesting of the left ITA can be considered in patients with pectus deformity. Asymmetrical chest wall, abnormal presentation of intercostal spaces, increased displacement of the heart toward the left hemithorax and associated pulmonary hypoplasia in certain patients are the major concerns for the feasibility of robotic ITA harvesting. In pectus patients, the lower ribs may present with abnormal growth of the cartilage which attaches the sternum to the ribs. This may cause an asymmetrical chest wall and narrowing of the left chest cavity. Intercostal spaces should be anatomically suitable for port placement, and the volume of the left hemithorax should be high enough for manipulations of the robotic instruments within the left chest cavity. In addition, the intercostal spaces may be small to place three ports (a camera and two arms) for docking procedures. As the heart moves to the left chest, port placement can be difficult and gas insufflation into the chest cavity may not be effective to expose the left ITA due to the malposition of the heart. Therefore, in robotic surgery, the major technical issue is the degree of the chest wall deformity. In mild-degree deformities, robotic approach can be considered. However, this can be a challenge in moderate or severe-degree deformities. In mild forms of pectus deformity, robotic ITA harvesting can be considered and coronary procedure can be performed using a mini-thoracotomy incision in single-vessel disease or using a sternotomy incision in multi-vessel coronary artery disease.

Pectus deformity in patients undergoing open heart surgery has been subject of several reports in the literature, usually combined with repair of pectus deformity itself.[3] A median sternotomy incision should be reserved for a mild or moderate form of sternal deformity, unless a decision is made to repair the pectus prior to closing sternum. In the presence of severe deformity, the use of sternotomy incision for cardiac surgery and simultaneous repair of chest deformity may be a reasonable approach to avoid severe sternal or cardiopulmonary complications postoperatively. Schmidt et al.[3] reported that simultaneous pectus excavatum correction and cardiac surgery was effective and reliable. A combined approach is advocated, if candidates for cardiac surgery present with significant pectus excavatum deformity. In the present case, such a pectus repair was obviously not necessary, and the use of endoscope enabled a takedown of the left ITA for coronary revascularization.

In conclusion, the use of an endoscope is a safe and feasible solution for *in situ* internal thoracic artery harvesting in patients with pectus deformity

undergoing coronary artery bypass grafting using a sternotomy incision. It may be also beneficial in pectus cases with a limited number of alternative conduits for coronary artery bypass grafting, as well as reoperations.

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Cardiovascular Surgery and Interventions

Case Report Open Access

An iatrogenic brachial arteriovenous fistula in an infant: A case report

Engin Karakuş[1], Soysal Turhan[2], Onur Işık[3]

[1]Department of Cardiovascular Surgery, Batman Regional State Hospital, Batman, Turkey
[2]Department of Cardiovascular Surgery, Tepecik Training and Research Hospital, İzmir, Turkey
[3]Department of Cardiovascular Surgery, Division of Pediatric Cardiology, Tepecik Training and Research Hospital, İzmir, Turkey

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ABSTRACT

Acquired arteriovenous fistulas, which are caused by arterial or venous puncture, are common in patients with a history of hospitalization in the intensive care unit for a long time. A four-month-old girl, who was born at 25 weeks and treated in the neonatal intensive care unit for one month due to respiratory distress, was admitted to our clinic with complaints of swelling and bruising on the right arm. Doppler ultrasound revealed an arteriovenous fistula located between the basilic vein and brachial artery, which was surgically treated. Unlike adults, fistulas during infancy may lead to a variety of morbidity, including heart failure, if left untreated. Herein, we report a rare pediatric case of an arteriovenous fistula and discuss our clinical approach.

Keywords: Arteriovenous fistula; premature; surgery.

Arteriovenous fistulas (AVFs) are characterized by an abnormal connection between the arterial and venous systems, which can be congenital or acquired. The main causes of AVFs during infancy include arterial or venous punctures. In the majority of patients, medical history reveals premature birth and prolonged intensive care unit stay due to additional lung problems.[1] Herein, we report a rare pediatric case of an arteriovenous fistula who was successfully treated with surgery.

CASE REPORT

The four-month-old girl was admitted to our clinic with complaints of swelling and bruising on the right arm. She was born 25 weeks old and was treated in intensive care unit for about one month due to respiratory distress. She underwent venous and arterial puncture frequently during this treatment period. The swelling started from the antecubital fossa and spread to the forearm. A strong thrill was obtained with palpation. The peripheral pulses of both upper extremities were palpable and equal. There was a difference in the diameter between the upper extremities, and the antecubital region measurements without difference in length. A hyperdynamic heart peak was present; however, the cardiac-to-thoracic ratio on the cardiac telemetry was within normal limits. Doppler ultrasound revealed a large-base fistula between the brachial artery and the basilic vein in the right antecubital fossa. In addition, brachial venous and arterial diameters increased about two times, compared to the contralateral measurements, and the arterial flow was within the brachial vein, increasing the brachial artery flow. Velocity measurement at the level of the fistula was recorded at 350 cm/sec and calculated blood flow at 250 mL/min.

The patient was scheduled for surgery, and a written informed consent was taken from her parents. Surgical dissection showed a broad base fistula between the median antecubital vein and the brachial artery. The median antecubital vein was seen to be aneurysmatic (Figure 1). Vein was ligated and the aneurysmatic area was excised. Brachial artery was primarily repaired with a 7/0 monofilament suture material. No complications developed after surgery. She was discharged in the second postoperative day following a rapid recovery period.

Corresponding author: Soysal Turhan, MD. SBÜ Tepecik Eğitim ve Araştırma Hastanesi, Kalp ve Damar Cerrahisi Kliniği, 35180 Konak, İzmir, Turkey.
Tel: +90 533 - 243 34 35 e-mail: sosyal.turhan@gmail.com

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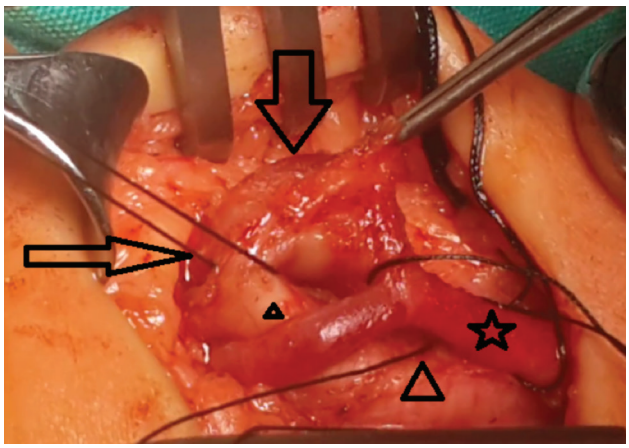

Figure 1. The appearance after the surgical preparation of the antecubital fossa.

Star: Basilic vein; Large and small triangle: Brachial artery; Small arrow: Vena mediana cubiti; Big arrow: Arteriovenous fistula.

DISCUSSION

Arteriovenous fistulas during childhood are rare pathologies.[2] These fistulas are typically caused by multiple punctures in the arterial and/or venous system.[3] Recognition can be difficult due to their rarity in childhood. However, the thrill on the lesion may be accompanied by hyperdynamic precordium, and cardiac murmur, and enlarged veins on the related extremity. The definite diagnosis can be usually made using Doppler ultrasound. In our case, the suspected AVF was supported with the presence of swelling which caused the diameter difference in the antecubital region, a strong thrill on palpation, and prolonged intensive care hospitalization. The diagnosis was confirmed through ultrasonographic examination.

Sonography is the first choice, as it is non-invasive, does not need sedation or ionizing radiation, is easily accessible, and can make definite diagnosis. Diagnostic criteria with sonographic examination include a low-resistance flow in the artery, high-velocity arterial flow within the vein, and turbulence in the fistula.[4]

Clinical management of childhood AVFs is based on adult studies, due to its infrequency and limited data. Therefore, treatment options include surgical excision, transcatheter embolization, ultrasound-guided compression or placement of a covered stent to exclude the lesion.[5] However, we consider that treatment with invasive techniques is not appropriate for infants. Even if the coated stents can be deployed successfully, complications may continue to grow, depending on the need for anticoagulation. Compression on ultrasound guidance may be an appropriate technique for narrow neck lesions; however, it may not be feasible in large and organized fistulas. On the other hand, we suggest that the complication rate of transcatheter embolization for distal vessels in infants would be high. Therefore, we believe that the most appropriate treatment is surgical repair of the artery and vein.

In conclusion, arteriovenous fistulas are infrequent in infants, and the main cause is multiple attempts in the arterial and/or venous system. These fistulas may cause morbidity in infants, leading to various conditions from aesthetic disorders on the limb to high-burdened heart failure. Thus, repair with surgical intervention is an appropriate approach.

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Cardiovascular Surgery and Interventions

Case Report Open Access

A right ventricular rhabdomyoma in a child presenting with right ventricular outflow tract obstruction

Mustafa Yılmaz, Ulaş Kumbasar, Baran Şimşek, İlhan Paşaoğlu

Department of Cardiovascular Surgery, Medical Faculty of Hacettepe University, Ankara, Turkey

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ABSTRACT

Primary tumors of the heart are extremely rare. Rhabdomyomas usually do not require any treatment, unless they cause outflow/inflow obstruction or conduction disturbances. Herein, we present an eight-year-old boy with a cardiac rhabdomyoma causing right ventricle outflow tract obstruction, which was successfully resected.

Keywords: Cardiac mass, rhabdomyoma, right ventricle.

Primary tumors of the heart are extremely rare with a prevalence rate of 0.01%.[1] Rhabdomyomas are the most common benign primary cardiac tumors in children which regress spontaneously and usually do not require any treatment, unless they cause outflow/inflow obstruction or conduction disturbances. Herein, we present an eight-year-old boy with a cardiac rhabdomyoma causing right ventricle outflow tract obstruction, which was successfully resected.

CASE REPORT

An eight-year-old patient was referred to our hospital with cardiac murmur. Physical examination findings were normal except a 3/6 systolic ejection murmur over his upper left sternal border. No abnormality was found on posteroanterior chest X-ray and electrocardiography. All routine blood tests were normal. Two-dimensional echocardiography revealed a 31×27 mm echo-dense mass in the right ventricle originating from the interventricular septum and protruding through the right ventricular outflow tract (RVOT) (Figure 1).

A severe outflow obstruction with peak systolic pressure gradient of 60 mmHg was found on Doppler examination. A median sternotomy incision was performed. Following initiation of cardiopulmonary bypass (CPB) under mild systemic hypothermia, the heart was arrested with cold blood cardioplegia. Right ventriculotomy was, then, performed. Surgical examination revealed a 35×35 mm round-shaped, pedunculated mass, originating from the interventricular septum and extending into the RVOT (Figure 2).

The mass was completely removed. Postoperative echocardiography was normal. The postoperative course of the patient was uneventful and he was discharged on postoperative Day 7. Histopathological examination of the specimen revealed a rhabdomyoma in which immunohistochemical stains showed the tumor cells to be positive for smooth muscle actin (SMA), desmin, and myoD1.

DISCUSSION

Among the rare congenital cardiac tumors, rhabdomyomas are the most common and are considered as benign myocardial hamartomas which are highly associated with tuberous sclerosis complex.[2] However, physical examination findings of our case did not reveal an evidence of tuberous sclerosis.

Histologically, cardiac rhabdomyomas are well-demarcated nodules of enlarged cardiac myocytes

Corresponding author: Baran Şimşek, MD. Hacettepe Üniversitesi Tıp Fakültesi Kalp ve Damar Cerrahisi Anabilim Dalı, 06100 Sıhhiye, Ankara, Turkey.
Tel: +90 505 - 697 21 39 e-mail: simsekbaran@yahoo.com

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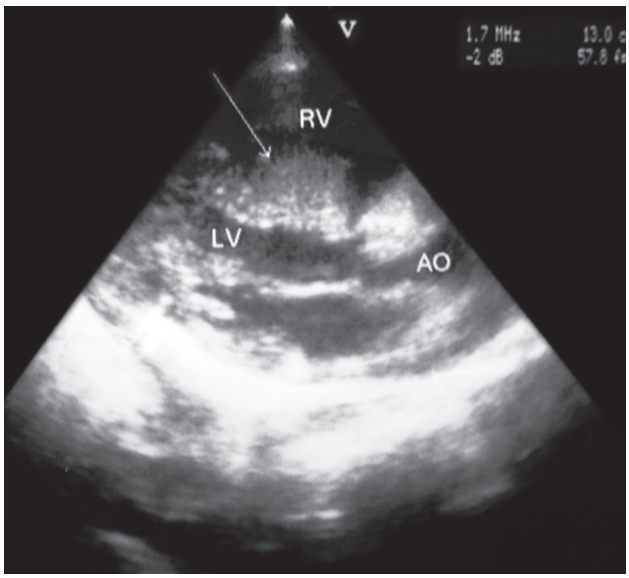

Figure 1. A preoperative echocardiographic view showing a 31×27 mm echodense in the right ventricle originating from the interventricular septum and protruding through the right ventricular outflow tract.

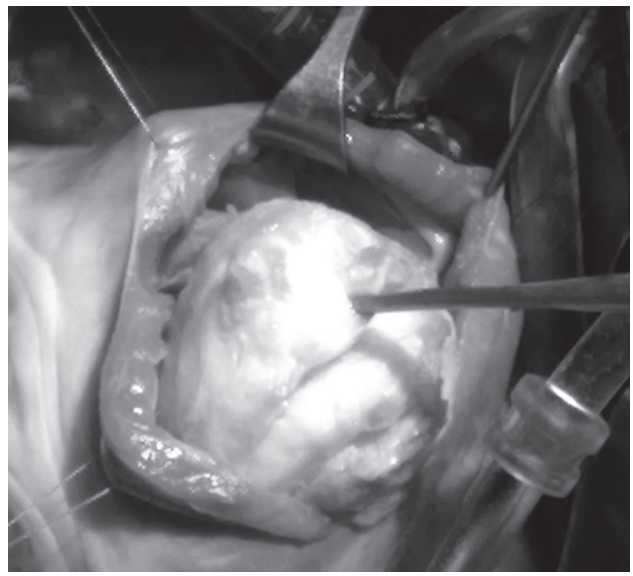

Figure 2. An intraoperative view showing a 35×35 mm round-shaped pedunculated mass, originating from the interventricular septum and extending into the right ventricular outflow tract.

which show ballooned out myofibers forming the typical "spider cells", which help to differentiate them from hamartomas of the mature cardiomyocytes.[2]

Rhabdomyomas may be totally asymptomatic, may present with an asymptomatic cardiac murmur as in our case, or may present with symptoms which include those related to valve obstruction or occlusion of chamber cavities, arrhythmias of various types and fetal hydrops.[3] The tumors may cause infant respiratory distress, congestive heart failure or low cardiac output. Any chamber of the heart may be affected. The left ventricle is the most frequently affected site. The right-sided tumors which cause obstruction may cause cyanosis or features mimicking tetralogy of Fallot or pulmonary stenosis, left-sided tumors may present as subaortic stenosis or hypoplastic left heart syndrome.[4]

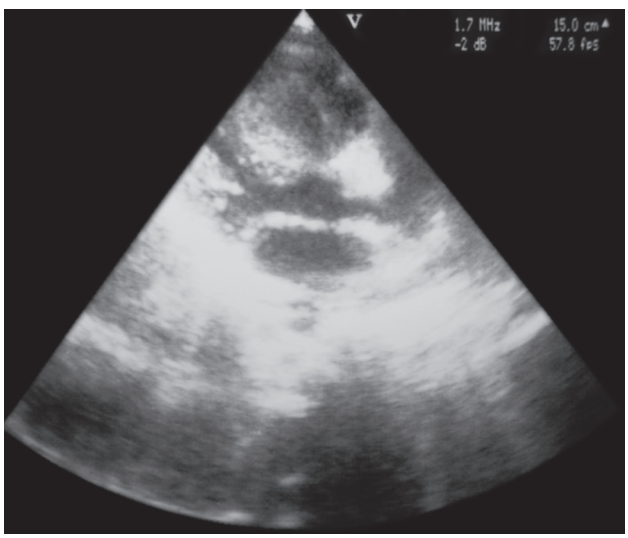

Figure 3. A postoperative echocardiographic view showing a mass-free right ventricle three days after surgery.

Echocardiography is a sensitive modality for the diagnosis of rhabdomyomas and shows relatively homogeneous well-circumscribed echo-bright masses. Cardiac magnetic resonance imaging or computed tomography are reserved for patients whom tumor type is questionable, for tumors that additional anatomical or functional information is required or for the evaluation of tuberous sclerosis.[5]

Furthermore, rhabdomyomas have a natural history of spontaneous regression and usually do not require any treatment. The indications for surgery include hemodynamic compromise due to obstruction of the cardiac chambers and intractable arrhythmias. Surgical removal of asymptomatic tumors is still controversial, as sudden death is also an important and ominous complication. The main goals of surgical

treatment are the relief of the obstruction and the treatment of intractable arrhythmias. Total tumor excision is sufficient.[6] While surgical resection of tumors causing RVOT obstruction is somewhat easier by the availability of a right ventriculotomy, left ventricular outflow tract obstruction remains surgically challenging as a retrograde approach through the aortic valve is limited by the size of the neonatal annulus.[7]

In conclusion, cardiac rhabdomyomas can be sporadic or associated with tuberous sclerosis or be seen with other cardiac malformations. They usually present early in life and indications for surgery are cardiac outflow obstruction, persistent arrhythmias, cardiac failure and cardiogenic embolism. Cardiac rhabdomyomas can be safely and completely resected. Surgical resection of right ventricular rhabdomyomas are technically easier than those originating from the left ventricle. Nonetheless, surgical resection is an adequate treatment in both cases.

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