improved symptoms, while fewer than 20 percent of the medically treated patients improved. Although severe pulmonary hypertension and cardiomegaly portended a poorer prognosis, there were no deaths in patients with peak pulmonary pressures less than 70 mm Hg. These encouraging results led these investigators, as well as others, to recommend closure of a patent ductus arteriosus at the time of diagnosis, unless a right-to-left shunt was present.

Our report reemphasizes that patent ductus arteriosus is compatible with survival to advanced age, even though the natural history of this anomaly usually portends significant morbidity and premature death. Surgical repair to improve symptoms, reduce morbidity, and prolong life expectancy should not be withheld (even in certain subsets of patients with moderate pulmonary hypertension) unless there is firm evidence that the ductus is closing. The surgical techniques currently employed have made interruption of the patent ductus arteriosus in the elderly patient safer, and, thus, age alone in the absence of a right-to-left shunt or severe pulmonary hypertension should not be viewed as a contraindication to surgery.

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Magnetic Resonance Evaluation of Patency of Stented Polytetrafluoroethylene Graft Connecting Right Atrium to Pulmonary Artery*

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Magnetic resonance imaging (MRI) was used to evaluate late postoperative patency of a stented polytetrafluoroethylene (PTFE) graft, which had been used to connect the right atrium to the pulmonary artery in a patient with tricuspid atresia. The MRI depicted patency, luminal size, course, and geometric morphology of the conduit. (Chest 1988; 94:1105-07)

As the operative criteria for the Fontan procedure have been expanded, prosthetic conduits are often used today to connect the right atrium to the pulmonary artery, though the exclusive utilization of the native tissues is recommended. One of the most important problems with the prosthetic materials is the long-term patency of the conduit used in the Fontan procedure. The patency of such grafts has been evaluated by invasive angiocardiography. Magnetic resonance imaging (MRI) may distinguish rapidly flowing blood within grafts and/or vessels from nonvascular structures without injecting contrast media, and the evaluation may be repeatedly performed with outpatients. We used MRI to assess the patency, luminal size, course, and geometrical morphology of the externally, spirally stented polytetrafluoroethylene (PTFE) graft (Impra-Flex graft) used in the Fontan procedure.

Case Report

A 14-year-old boy with tricuspid atresia underwent a modified Fontan procedure. The patient had received the superior vena cava right pulmonary artery anastomosis (modified Glenn's shunt) at the age of one year and three months. At operation, the diameter of the pulmonary trunk was 40 percent of the normal diameter; the pulmonary trunk was too small to directly anastomose to the right atrial appendage. Accordingly, an Impra-Flex graft (19 mm in diameter) was used to connect the right atrium to the pulmonary

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artery (Fig 1). The postoperative course was uneventful. Early postoperative angiography demonstrated patency of the conduit and no stenoses at the anatomic sites (Fig 2). The patient was begun on systemic anticoagulation with warfarin and discharged home.

The MRI of the PTFE graft was performed one year and eight months postoperatively, using a MRT 15A operating at 0.15 Tesla. Images were obtained on a 256 × 256 matrix with a pixel size of 0.6 mm × 0.6 mm. A multislice spin-echo pulse sequence was used; the pulse repetition rate was 320 ms; the echo delay time was 30 ms. Coronal, axial, and sagittal images of the mediastinum were obtained using 10 mm slice thickness in each plane. Neither electrocardiographic nor respiratory gating MRI were available.

Graft patency was clearly demonstrated by the signal void of relatively rapidly flowing blood. The conduit/intimal lining itself produced a medium intensity signal surrounding the signal void (Fig 3). Multiple slices in each plane were required to completely image the entire conduit and its anastomotic sites, since the graft coursed posteriorly from the right atrium, obliquely crossing in front of the aorta, to the pulmonary artery. Neither stenotic lesions nor external compression were observed on multiplanar images. Angiography of the PTFE graft was not performed at this time.

**Discussion**

We have used the PTFE graft in the Fontan procedure as well as in the venous system reconstructions with excellent results. However, a careful long-term follow-up is necessary, since the late result with this material has not been obtained. Evaluation of the graft patency has needed angiography.

**Figure 1.** Intraoperative photograph of the Fontan procedure using the Impra-Flex graft. The graft placed in front of the aorta bridges the right atrium to the main and left pulmonary arteries. RA, right atrium; R-RV, rudimental right ventricle; Ao, aorta.

**Figure 2.** Early postoperative angiograms (upper, anteroposterior projection; lower, lateral projection). SVC, superior vena cava; RA, right atrium; Rt-PA, right pulmonary artery; Lt-PA, left pulmonary artery; M-PA, main pulmonary artery.

This is an invasive technique which requires injections of contrast media via a catheter, and has potential risks of contamination and intimal injury. Contamination of a PTFE graft is a life threatening complication. Intimal injury by catheter and/or by a jet stream of contrast media may cause intimal separation from the inner surface of the PTFE graft, leading to a graft failure, since the intimal lining on this material is easily stripped. Less risky, noninvasive vascular imaging techniques such as echocardiography and computerized tomography with contrast media have not completely imaged PTFE grafts.

The MRI is a new noninvasive cardiovascular imaging technique, capable of producing images of a PTFE conduit in coronal, axial and sagittal planes. It has been successfully used to evaluate the patency of spiral vein graft bypass of the superior vena cava,7 and palliative systemic-pulmonary arterial shunts.8 In previously reported cases as in our case, multiplanar images were required to completely image the entire graft or shunt. Besides, in our case, neither cardiac nor respiratory gating MRI were available, and a routine slice thickness of 10 mm was used. Such thick slices and no gating might enable us to detect significant stenoses. Correct identification of stenoses from MRI has been reported difficult as in 67 percent of patent vessels, while that of patency in 100 percent.
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Focus of Bronchial Carcinoma in situ Eradicated by Endobronchial Biopsy*

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Bronchial carcinoma in situ is not frequently diagnosed in a clinical setting. A bronchoscopic biopsy of a small mucosal abnormality in a patient with hemoptysis yielded a diagnosis of carcinoma in situ. The involved lobe was resected. On thorough histologic examination of the surgical specimen, no residual carcinoma could be found. To our knowledge, this is unprecedented in the literature. This case emphasizes the importance of biopsying subtle abnormalities and raises questions about the optimal management of in situ bronchial carcinoma. (Chest 1988; 94:1107-09)

Carcinoma in situ is defined as the presence of atypical cells in all layers of an epithelium but confined therein by an intact basement membrane. Occult bronchial

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The medium signal intensity surrounding the signal void of blood flowing in the graft may be due to the intimal lining, which developed on the graft, or graft material itself. In vitro analysis of MR images of PTFE grafts is required to determine the source of the signal. There is another problem with conventional MRI, that is, intraluminal MR signals may be detected within vessels and/or conduits for a variety of reasons. These include blood stasis, slow blood flow, thrombosis and even-echo rephasing. It has been reported that signal intensity of intraluminal thrombus decreases from the first to the second-echo image, whereas slow flow within vessels increases in absolute signal intensity on the second-echo image.

Recent developments of new MRI techniques, as well as improvements of soft- and hardware of MRI units are remarkable; paraxial imaging, superimposition of traced contiguous images, partial flip angle imaging and cine MRI have been developed to overcome the aforementioned problems with conventional MRI.*

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FIGURE 3. Magnetic resonance images. Top left and right. Coronal MR images show the right atrial orifice to the graft as well as the graft lumen (arrows), and the transsectional graft lumen is clearly demonstrated (arrowheads). Center, left and right. Axial MR images show the longitudinal section of the graft (G) in front of the aorta, and proximal stump of the right pulmonary artery is also shown (arrow). The anastomosis of the conduit to the main pulmonary artery (PA) is shown (right). Bottom left and right. Sagittal MR images also show the transsectional shape of the graft (G) in front of the aorta (left), and the graft (G) course to the main and left pulmonary arteries is demonstrated (right). Neither obstructive nor stenotic lesions due to thrombus formation and/or intimal over-proliferation are observed on the MR images.