trauma as the cause for the postoperative recurrence of the chylothorax. The successful management of this chylothorax and its apparent complete disappearance after six months of therapy reemphasizes the value of the dietary therapy with medium-chain triglycerides that was first proposed by Hashim and colleagues in 1964 and more recently by Kosloske and colleagues. The conservative management of chylothorax, whatever the cause, relies on such dietary management with medium-chain triglycerides and employs closed-tube thoracostomy or serial thoracocenteses to remove the fluid only if it causes symptoms. Repeat surgical intervention is now necessary only in the exceptional case for specific mechanical reasons.

The fat blend of the commercially available diet (Portagen) contains 87 percent medium-chain triglycerides. When compared to the fat of conventional food, medium-chain triglycerides and medium-chain fatty acids are (1) more rapidly hydrolyzed, (2) not dependent on bile salts for emulsification, (3) carried by the portal circulation, and (4) not dependent on formation of chylomicrons or on lymphatic transport.

References

Deep Venous Thrombosis of the Upper Extremity Associated with Use of the Swan-Ganz Catheter*


Two patients who developed unilateral neck vein distention following insertion of a Swan-Ganz catheter are described. One patient developed unilateral swelling of the arm used for catheter insertion. Following removal of the Swan-Ganz catheter in this patient, venograms of both upper extremities revealed internal jugular vein thrombosis and subclavian vein thrombosis of the involved extremity. The other patient had thrombosis of the internal jugular veins and subclavian veins bilaterally, as well as superior vena cava thrombosis.

In recent years, the use of a flow-directed balloon-tipped catheter as introduced by Swan and Ganz et al has become a useful adjunct in many clinical situations. Clinical use of these catheters has been associated with minimal complications. However, occasional serious complications may occur. In this report, we describe thrombosis of the jugular and subclavian vein in one patient and thrombosis of the superior vena cava in another patient following insertion of Swan-Ganz catheters.

Case Reports

Case 1

A 51-year-old man was admitted to the coronary care unit for treatment of acute anterior myocardial infarction. On initial physical examination, his blood pressure was 130/80 mm Hg in both arms, his pulse rate 100 beats/min and regular, and respirations 16/min. Examination of the chest revealed a few bibasilar rales which persisted after coughing. An S2 gallop and an intermittent S4 gallop were present, but there was no murmur. The remainder of the physical examination was unremarkable. The electrocardiogram exhibited ST segment elevation in leads V1-V4 with loss of R wave in these leads. The chest x-ray film showed slight cardiomegaly and pulmonary venous hypertension.

A No. 7 thermococulation Swan-Ganz catheter was inserted from an incision near the antecubital fossa and its tip was positioned easily in the right pulmonary artery. The initial pulmonary artery pressure was 50/40 mm Hg with a

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The larynx was unremarkable. By the third day, his pulmonary artery end-diastolic pressure was less than 12 mm Hg.

The Swan-Ganz catheter was removed without difficulty on the fourth hospital day. On the next day, the patient noted a "knot" in the right side of his neck. He denied respiratory symptoms. Concurrently there was slight erythema of the incision but no purulence or cellulitis. He remained afebrile. Generalized edema of the right arm and hand developed with unilateral jugular venous distention on the right (Fig 1). A clinical diagnosis of right subclavian vein thrombosis was made and therapy with intravenous heparin was begun. A venogram of the right arm exhibited thrombosis of the right subclavian and jugular venous systems. Venogram of the left arm displayed a normal left subclavian, left jugular venous system, and superior vena cava. Gradual improvement in edema of the arm was associated with the development of extensive collateral venous drainage seen on the anterior chest wall. Therapy with warfarin (Coumadin) was begun after seven days of therapy with intravenous heparin. At the time of discharge, the patient had no complaints, but continued to demonstrate unilateral jugular venous distention on the right side and slight edema of the right arm.

**Case 2**

A 45-year-old woman was admitted to the coronary care unit for treatment of an acute anterosetal myocardial infarction. Her blood pressure was 80/60 mm Hg; pulse rate was 76 beats/min and regular; respiratory rate was 16/min and regular. Auscultation of the chest revealed bilateral rhonchi. The cardiac examination was unremarkable; there was no gallop rhythm or murmur. Extremities were cool with good distal pulses and no edema. The remainder of the examination was unremarkable. The electrocardiogram demonstrated acute anterosetal myocardial infarction.

A No. 7 Swan-Ganz thermodilution catheter was inserted easily via a right antecubital cutdown. The initial pulmonary artery pressures were 36/28 mm Hg and a pulmonary capillary wedge pressure was 24 mm Hg. The initial cardiac index was 3.3 liters/min/m². Hemodynamic monitoring was continued for four days during which the patient remained asymptomatic. When the catheter was removed, there was no evidence of thrombosis or inflammation. On the fifth day following removal of the Swan-Ganz catheter, the patient complained of a sore throat and an area of tenderness at the right side of her neck. Examination revealed fullness in the right supraclavicular fossa. Over the next three days the fullness and tenderness increased. There was dilatation of the right external jugular vein without any other venous distention. A low grade fever developed. Roentgenograms of the soft tissue of the neck demonstrated generalized enlargement of the soft tissues of the right side of the neck without a discrete mass.

Eight days following the appearance of the right supraclavicular fullness, and 13 days after the removal of the Swan-Ganz catheter, bilateral upper extremity venograms were performed. These demonstrated complete thrombosis of both subclavian veins, and bilateral internal and external jugular vein thrombosis. The superior vena cava was not visualized (Fig 2). A ventilation/perfusion lung scan demonstrated multiple large perfusion defects consistent with multiple pulmonary emboli. The patient was treated with intravenous heparin and later changed with Coumadin; there have been no sequelae.

**Discussion**

Following admission for treatment of acute myocardial infarction these patients underwent hemodynamic monitoring utilizing a Swan-Ganz catheter. The catheters remained in position four days. In our experience use of these catheters has not been associated with increased morbidity or mortality. At removal of the catheter there was no evidence of inflammation, cellulitis, or thrombosis. One day and five days (respectively) following removal of the catheter the patients noted a "knot" in the right side of the neck. The "knot" was a distended external jugular venous system and there was associated generalized edema of the right arm in Case 1. Subsequent venograms of both upper extremities revealed extensive deep venous thrombosis in both patients. Patient 2 sustained multiple small pulmonary emboli as well.

Thrombosis of a deep venous system following insertion of a catheter is not an unlikely complication and...
may be more common than generally appreciated. Thrombosis around the catheter tip has been well described, as well as venous thrombosis developing around the entire length of the catheter. This latter situation may have been responsible in patient 2, but in patient 1 the normal superior vena cava by venography seemed to eliminate that consideration. The hallmark of the subclavian venous thrombosis in these patients was the unilateral jugular venous distention in both patients and unilateral upper extremity edema in one.

In the presence of this occurrence following venous catheterization, it behooves the physician to consider occult mediastinal tumor which might cause superior vena caval obstruction. In the present patients, an extensive search for an occult neoplasm was undertaken and none was found. These patients also had normal hematologic and coagulation parameters. Therefore, the major factors most likely responsible for the thrombosis in these patients are left ventricular dysfunction, low cardiac index, and the light thrombogenic stimulus of the catheter itself. The development of unilateral upper extremity edema or unilateral neck vein distention in a patient with an indwelling Swan-Ganz catheter should suggest deep venous thrombosis of the upper extremity and possibly superior vena cava, and the appropriate diagnostic and therapeutic interventions should be undertaken.

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Echocardiography and Perfusion Scintigraphy in the Diagnosis of Pulmonary Arteriovenous Fistula

Alan B. Lewis, M.D.; Gary F. Gates, M.D.; and Philip Stanley, M.D.

The echocardiographic and perfusion scintigraphic evaluation of an adolescent boy with a pulmonary arteriovenous fistula is reported. Contrast echocardiography following the rapid intravenous injection of indocyanine green dye was utilized to document extracardiac right-to-left shunting. Perfusion lung scintigraphy demonstrated the presence of a single large pulmonary arteriovenous fistula. Contrast echocardiography and perfusion scintigraphy are minimally invasive, safe and easily performed techniques for the rapid diagnosis of pulmonary arteriovenous fistula.

The first description of a pulmonary arteriovenous fistula was in 1897, but it was not until 1939 that Smith and Horton reported the first antemortem diagnosis. Since then, many cases have been described particularly following the advent of successful surgical excision and the introduction of pulmonary angiography. This report details the use of two minimally invasive, complimentary techniques, contrast echocardiography and radionuclide perfusion lung scintigraphy, for the diagnosis of pulmonary arteriovenous fistula.

CASE REPORT

This 18-year-old boy was asymptomatic until one year prior to his admission to Children's Hospital of Los Angeles when he first noted diminished exercise tolerance. Progressive cyanosis developed and his hemoglobin rose to 22 gm/dl. On admission to Children's Hospital, he exhibited moderate cyanosis and digital clubbing. The lungs were clear and breath sounds were normal. Cardiac examination was normal except for a grade 1/6 continuous murmur heard over the anterior left upper lung field. No other bruits were heard and the remainder of the examination was normal.

A chest radiogram on admission showed a prominent area of hypervascularity in the left upper lobe (Fig 1). His echocardiogram and pulmonary function studies were normal. Arterial blood gas and pH determinations were as follows: while breathing room air, pH 7.42; Pco2, 26 mm Hg; Po2, 50 mm Hg; while breathing 100 percent O2, pH 7.45; Pco2, 25 mm Hg; Po2, 53 mm Hg.

An echocardiogram using a Unirad ultrasonoscope with a 2.25 MHz Aerotech transducer focused at 10 cm and a Tektronix strip chart recorder, showed the cardiac valves and ventricular chambers to be normal. Contrast echocardiography (Fig 2) was performed by injecting 2 ml of indocyanine green dye into the right antecubital vein while recording the

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