collections of bile in the liver and fistulas between the bile ducts and the kidney, the pleura or the skin. They can be diagnosed by biliary scintigraphy or endoscopic cholangiography. The treatment of bile collections is by percutaneous drainage of the collection using CT or ultrasound for guidance. After drainage, biliary fistulas usually close spontaneously. However, when there is massive biliary leakage, biliary drainage via ERCP or by poercutaneous drainage of the biliary tree under fluoroscopy should be attempted. This can be very difficult because the biliary tree will not be very dilated. Remember that because there is leakage, bile duct may not be obstructed and the bile duct will be small. Rarely stenting of transected biliary ducts can be helpful. Occasionally persistent drainage from small transected ducts can be controlled by sclerosing the bile duct with ethanol. This should only be done when there is no flow into the main biliary ducts. We do not want to sclerose the main bile ducts.

Another complication which is not uncommon is a post-traumatic infection. Intraparenchymal hepatic hematomas or bile collections may become infected Areas of the liver may become devascularized by the trauma and this can also lead to hepatic abscess formation. Hematomas in the peritoneal cavity can also be contaminated by bile and become peritoneal abscesses. Drainage of post-traumatic abscesses is usually easily accomplished percutaneously using CT or ultrasound for guidance. The catheter should be kept in until the abscess has cleared and the infected space has become scarred. Periodic contrast injections through the drainage catheter is rcommended before removal of the drain so that we can diagnose biliary fistulas. These biliary infections may take a longer time to heal. In summary, hepatic trauma is common and potentially life-threatening. However, most patients with liver injury can be managed by nonoperative treatment. If bleeding persists, one should consider angiography as a method of diagnosing hepatic bleeding from arterial sources. Once diagnosed, advancing the catheter near the site of hemorrhage to embolize the bleeding site should be considered. It is a highly effective method of treating many of the these patients. Complications of hepatic trauma such as biliary leakage, delayed gastrointestinal hemorrhage and intraabdominal and intrahepatic abscesses can usually be managed by the radiologist.

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Transcatheter arterial embolization for difficult post-traumatic arterlovenous fistulas

Salvatore J. A. Sclafani, M. D. Professor of Radiology, Surgery and Emergency Medicine State University of New York Health Science Center at Brooklyn and Dieter Apitzsch, M. D. Chafarzt, Paracelsus Klink der Stadt Marl Marl, Germany

Post traumatic arteriovenous fistulae are abnormal potentially life-threatening communications between adjacent arterial and venous structures. They comprise approximately 10% of all vascular injuries and are usually caused by penetrating trauma. The majority occur in the peripheral vascular tree but may be occur in the neck and scalp, in the abdomen between systemic arteries and veins or between systemic arteries and portal tributaries or in the chest between the pulmonary arteries and veins. They may result in congestive heart failure, varicose veins and stasis ul-

Address correspondence to:
dSalvatore J. A. dSclafani. M. D.
Ddepartment of Radiology
Kings County Hospital Center
451 Clarkson Addvednus
Brooklyn, New York 11203
Tdelephone: 718 245 4447
Fax: 718 773 6445
E-mail: SJASMD@AOL.COM

cers, arterial insufficiency, portal hypertension and accelerated atherosclerosis.

The pathological and hemondynamic changes which occur in post traumatic AVF are considerably different from those of the congenital arteriovenous malformation. Traumatic fistulas are formed by a number of mechanisms which result in lesions of larger vessels. The arteriolar and capillary communications seen in malformations are not present in traumatic AVF. Penetrations may partially lacerate adjacent arterial and venous walls. Vessels may be completely transected and communicate through an intervening pseudo-aneurysm. Potential communications created by the penetration and closed by hematoma may reestablish when the surrounding hematoma liquefies or becomes infected. Tissue necrosis or infection may create a common chamber into which severed vessels may erode.

Flow is initially directed through the fistula into the vein and back to the heart. Retrograde venous flow is inhibited by competent venous valves., Peripheral distal blood flow is maintained if the vessel is not completely interrupted. Proximal arterial collaterals become larger and more numerous as the fistula become chronic. Proximal arterial flow increases with time. This results in venous dilatation and valvular incompetence. Flow through the distal arterial segment eventually reverses. The collateral arterial circuits also reverse and these vessels become dilated and tortuous. In the extremities, the distal limb becomes edematous and ischemic. The proximal artery undergoes dilatation and elongation within six to twelve months after the injury. These structural changes progress more proximarlly and eventually cardiomegaly and arteriomegaly occur. This dilatation may be reversible if the lesion is closed within two years but they become more marked if the fistula persists. The elastic and muscular fibers in the media become fragmented and the vessel become atheromatous and calcified. These changes may not be reversible. Arteriomegaly may progress to true aneurysm even if the fistula is subsequently closed.

The surgical treatment of chronic arteriovenous fistulas can be extremely difficult. Sutures placed for vascular anastomoses do not hold in the friable and degenerative vascular wall. The diffuse and tangled varicosities, distended veins and tortuous arterial collaterals limit surgical dissection which can be associated with significant blood loss.

Transcatheter arterial embolization offers an attractive alternative to the surgical technique. The fistula is approached intravascularly and incisions into tissue with a vascular plethora is avoided. Blood loss during angiography is minimal. Revascularization when indicated can be performed using an extra-anatomic approach and avoid the problems of the fistula. There are, however, considerable technical difficulties in the management of AVF by interventional radiologists.

Successful transcatheter treatment of chronic arteriovenous fistulas requires attention to detail during diagnostic angiography. An arteriogram adequate for therapeutic planning requires identification of all arterial inflow into the fistula both from the injured vessel and from all arterial collateral sources. Large volumes of contrast media and rapid sequence filming are essential. Multiple views are ofter necessary to unfold the large and tortuous arterial branches and varicosities. This is necessary to determine the exact site of the communication between arteries and veins.

The embolic materials used should occlude large conduit vessels. These include colis and detachable balloons. Particulate emboli are substandard as they will flow directly through the AVF into the venous circulation, resulting in pulmonary embolism. Coils must be of sufficient size to prevent distal embolization into the veins. Because of the high flow within AVF, coil occlusion may be delayed. The use of an occulusion balloon to slow arterial inflow may facilitate thrombosis at the site of coil deposition.

Isolation of the fistula from all its arterial supply is the key to successful tretment of these lesions. This means that, when both the proximal and distal segments of the injured arteries flow into the fistula, they must both be occluded. There should be no branches between the coil and the fistula because these branches will continue to provide an inflow into the fistula and the fistula will not close. Failure to exclude all arterial flow into the fistula may result in recurrence or persistence of the arteriovenous shunt by retrograde flow. Proximal occlusion alone may make the limb more ischemic by decreasing the pressure in the fistulous chamber, thereby increase the " steal" from the distal circulation.

Embolization of the distal arterial segment poses the most difficult technical consideration. A variety of solutions are avaliable when this task must be performed. Distal occlusion can be accomplished by passing a catheter through the proximal vessel under two circumstance: 1、when the artery is only partially transected and part of its wall is intact and 2、when both ends of a totally transected vessel flow into a false aneurysm which connects both ends of the artery with a vein. The catheter can be advanced through the pseudoaneurysm or partial laceration across the fistulous site into the distal vessel. A gently curved catheter and a straight guidewire have been useful in this traversal. The vessels at the fistula may be thinned and atheromatous. The angiography must use great caution not to perforate during these manipulation. Once the guidewire has traversed the lesion, the catheter is advanced into the distal artery. Coil occlusion of the distal vessel is done first. Then the catheter is withdrawn back into the proximal artery which is then occluded by coils.

Transarterial catheterization of the distal vessel may be impossible if the proximal vessel has become very tortuous or enters the fistula chamber at a such an angle or location that the origin of the distal vessel cannot be cannulated through it. Another approach to the distal segment must be performed. This can be through the venous side of the fistula back into the fistulous chamber and then into the distal artery. Another approach is to directly puncture the aneurysm chamber and cannulate either the proximal artery and or the distal arterial segment. The distal artery can also be approached through a proximal collateral branch that connects to the distal artery. Finally a more distal artery can be punctured percutaneously or exposed surgically and a catheter can be directed in a retrograde fashion to the site of fistula.

In summary, treatment of an arteriovenous fistula requires occlusion of all connections between the arterial system and the fistula. Exquisite diagnostic arteriography to identify all these connections is mandatory. A number of different approaches to the distal side of the arteriovenous fistulas are available to complete the embolization.

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Interventional radiology in the management of pelvic retroperitoneal hemorrhage

Salvatore J. A. Sclafani, M. D.
Professor of Radiology, Surgery and Emergency Medicine State University of New York Health Science Center at Brooklyn

Introduction

Pelvic fractures are common, potentially life-threatening injuries which are caused by high energy impact trauma. Pelvic fractures account for about 3% of all skeletal injuries and are the third most common injury described in patients who have sustained motor vehicle accidents. The management of patients with these pelvic injuries is controversial, difficult and fraught with danger. The treatment options available are often contradictory and the associated injuries of-

Address correspondence to:
Salvatore J. A. Sclafani, M. D.
Director of Radiology
Kings County Hospital Center
451 Clarkson Avenue
Brooklyn, New York 11203
Phone: 718 245 4447
E-mail: SJASMD@AOL.COM