

Arteriovenous Fistulas After Cardiac Catheterization

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● In a review of five Dayton, Ohio, area hospitals during a six-year period, seven patients who were treated for an acquired arteriovenous (A-V) fistula after cardiac catheterization were identified. Four patients had undergone cardiac studies in area hospitals, while three were studied elsewhere. The four A-V fistulas after 23 291 cardiac catheterization procedures in Dayton hospitals represented an incidence of 0.017% for this complication. Congestive heart failure and limb ischemia were the most frequent presenting symptoms that developed from two to ten months after catheterization. Intentional puncture of both the artery and vein of the ipsilateral groin for right- and left-sided heart studies was the probable cause of fistula formation in two cases. Five patients sustained inadvertent injury to both an artery and adjacent vein during percutaneous vascular access. Six A-V fistulas that involved femoral vessels were managed by division of the fistula with lateral repair of the artery and vein. An unusual communication between the right thyrocervical trunk and the internal jugular vein was handled by ligation of the affected vessels. Prompt surgical correction of this unusual complication of percutaneous vascular access is recommended as spontaneous closure is unlikely.

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Arteriovenous (A-V) fistulas may be either congenital or acquired. The congenital type is characterized by a myriad of interconnecting arteries and veins. The acquired fistulas, on the other hand, usually have one or two such communications. The latter lesion is the consequence of a penetrating wound with simultaneous arterial and venous injury. In the military experience, A-V fistulas result from penetrating missiles, while in civilian trauma, they are usually caused by stab wounds. Less frequently, iatrogenic A-V fistulas have been described after a variety of surgical operations, as well as invasive diagnostic procedures. In this report, we summarize our experience with A-V fistulas noted after procedures that were performed in the cardiac catheterization laboratory.

MATERIALS AND METHODS

We screened the records of all discharges from five medical school-affiliated hospitals, from Jan 1, 1981, through Dec 31, 1986, to identify all patients with a diagnosis of acquired A-V fistula. Patients whose A-V fistulas were constructed because of chronic renal failure were excluded from this review. To restrict the series to those patients whose fistulas followed diagnostic and therapeutic procedures, A-V communications that occurred after penetrating trauma were also eliminated. The remaining charts were carefully reviewed to determine the type of procedure that caused the fistula, the location of the fistula, and the duration from procedure to onset of symptoms, as well as the nature of the presenting symptoms and associated physical findings. Methods of diagnosis and management of these lesions were also evaluated. In addition to enumerating the various types of diagnostic and therapeutic interventions that preceded the development of A-V fistulas, the number of those procedures done at the participating institutions during the period studied was ascertained.

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RESULTS

Our review identified seven patients who were treated for an acquired A-V fistula after diagnostic or therapeutic procedures. These cases are summarized in the Table. All occurred after procedures that were performed in the cardiac catheterization laboratory. No A-V fistulas were noted after arteriographic studies or surgical operations. Four of the seven patients had undergone cardiac catheterization at a Dayton, Ohio, area hospital. Three others were referred to one of the area hospitals after cardiac catheterization studies that were performed elsewhere.

During the study period, there were 23 291 procedures that were done in the catheterization laboratories of the participating institutions. The four A-V fistulas noted after catheterization procedures performed in Dayton area hospitals represented an incidence of 0.017% for this complication. The number of catheterization studies in the hospitals responsible for the other three patients in this series was not determined.

Six of the seven patients described in this report had heart studies performed via the femoral artery. Five were diagnostic studies only, while one individual underwent transluminal angioplasty after coronary arteriography. Not surprisingly, the A-V fistulas that developed after femoral punctures involved communications between either the common femoral or superficial femoral arteries and the femoral vein. A very unusual A-V fistula was demonstrated in case 3 between the right thyrocervical trunk and the internal jugular vein (Fig 1). This followed percutaneous puncture of the right internal jugular vein to perform a right-sided heart catheterization and endocardial biopsy on a patient with severe cardiomyopathy. Of interest, the summary of this procedure included a description of the arterial bleeding encountered during the attempted venipuncture. On careful review of all the other catheterization procedure summaries, venous bleeding was noted during attempted femoral arterial puncture in two cases. In still two other cases, A-V fistulas developed after right- and left-sided heart catheterizations via arterial and venous punctures in the same groin.

The mean duration from cardiac investigational studies to onset of symptoms was 4.1 months (range, two to ten months). Congestive heart failure was the most prominent symptom, noted in five patients in this series. Patient 3 did have congestive heart failure before undergoing catheterization although this problem became much more severe after the procedure. Angina was the indication for catheterization in the other six cases. None of these individuals had symptoms of congestive heart failure before their heart studies. Lower-extremity ischemia distal to the fistula was also a frequent complaint. Four patients reported the recent onset of claudication, while one progressed to pain at rest. Venous problems were seen less frequently. Two of the patients included in this series had troublesome leg swelling. One patient developed extensive superficial varicosities that were complicated by repeated episodes of bleeding from these dilated veins.

A clinical diagnosis of A-V fistula was suggested in all patients by the presence of a machinery murmur and a

A-V Fistulas After Cardiac Catheterization*

Patient/ Age, y	Catheterization Procedure	Location of Fistula	Onset of Symptoms, mo	Symptoms
1/64	L-sided heart catheterization,† coronary angiograms	Common femoral artery to femoral vein	3	CHF, leg swelling, claudication
2/33	L-sided heart catheterization,† coronary angiograms	Superficial femoral artery to femoral vein	10	Claudication
3/53	R-sided heart catheterization,‡ endocardial biopsy	Thyrocervical trunk to jugular vein	2	CHF
4/73	L-sided heart catheterization, coronary angiograms, abdominal aortogram	Common femoral artery to femoral vein	7	CHF, claudication
5/66	L-sided heart catheterization, coronary angiograms, transluminal angioplasty	Common femoral artery to femoral vein	3	CHF
6/48	L-sided heart catheterization,§ R-sided heart catheterization	Superficial femoral artery to femoral vein	2	CHF, leg swelling, varicose veins with bleeding
7/58	L-sided heart catheterization,§ R-sided heart catheterization	Superficial femoral artery to femoral vein	2	Claudication, rest pain

*A-V indicates arteriovenous; CHF, congestive heart failure.

†Venous bleeding noted during attempted arterial puncture.

‡Arterial bleeding noted during attempted venipuncture.

§Arterial and venous puncture in same groin.

palpable thrill at the site of the lesion. Arteriography proved to be uniformly helpful in confirming the A-V fistulous communication and in localizing it (Fig 2). Surgical correction was undertaken in all cases. Division of the fistula with lateral repair of the involved arteries and veins was readily accomplished in the six patients with A-V fistulas in the groin. The jugular vein-to-thyrocervical trunk communication proved to be more challenging because of its location at the base of the neck. In this case, the vein was divided proximal and distal to the fistula. This afforded satisfactory access to the involved branch of the thyrocervical trunk that was also ligated. After surgical repair, there was marked improvement of both congestive heart failure and lower-extremity symptoms. Improvement was temporary for patient 3 who died three months postoperatively due to advanced cardiomyopathy. All other patients were alive and well at the time of preparation of this report.

COMMENT

Injuries that are sustained during diagnostic and therapeutic procedures account for approximately 10% of civilian arterial trauma.¹ Although many different procedures have been implicated, cardiac catheterization and arteriography are the most frequently cited causes of iatrogenic vascular complications.^{2,3} These studies are usually performed by percutaneous retrograde catheterization of the femoral artery as originally described by Seldinger.⁴ Modifications of this technique for cardioangiography were introduced by Judkins.⁵ After these diagnostic studies, local puncture site complications may be noted. Hematoma, false aneurysm, and thrombosis are the puncture site problems that are reported most frequently. Arteriovenous fistulas similar to those included in the current report have also been described after cardiac catheterization or arteriographic studies.^{6,7} This lesion is quite uncommon. Bourassa and Noble⁸ found only one A-V fistula after 5250 coronary arteriograms that were performed by percutaneous femoral puncture, an incidence of only 0.019%. In an extensive review of 118591 angiographic procedures, Hessel et al⁹ noted the incidence of this complication as 0.01% after transfemoral studies and 0.02% after transaxillary procedures. The incidence of A-V communications after percutaneous femoral puncture for cardiac investigation in Day-

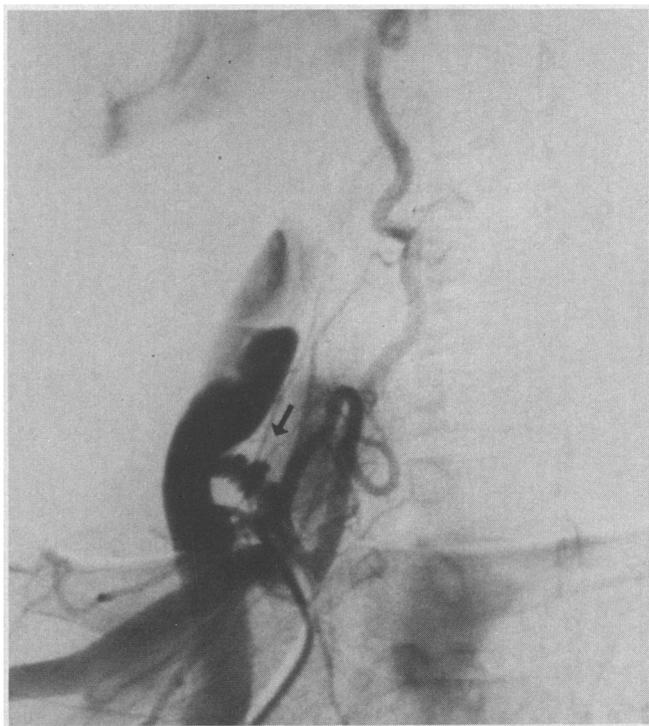


Fig 1.—Selective arteriographic study of thyrocervical trunk of right subclavian artery demonstrating fistulous communication to internal jugular vein.

ton area hospitals was 0.017%, which is quite similar to that reported in previously published studies. Although it is a low-frequency event, A-V fistulas will be seen in most communities due to the large number of cardiac and vascular studies conducted.

Simultaneous arterial and venous injury permits the flow of blood from the traumatized artery into an adjacent vein. As already stated, missile-induced injuries cause most A-V fistulas in the military setting, while stab wounds are responsible for those noted after civilian injuries. Arteriovenous connections have been described after surgical procedures on the thyroid gland, kidney, thorax, and female

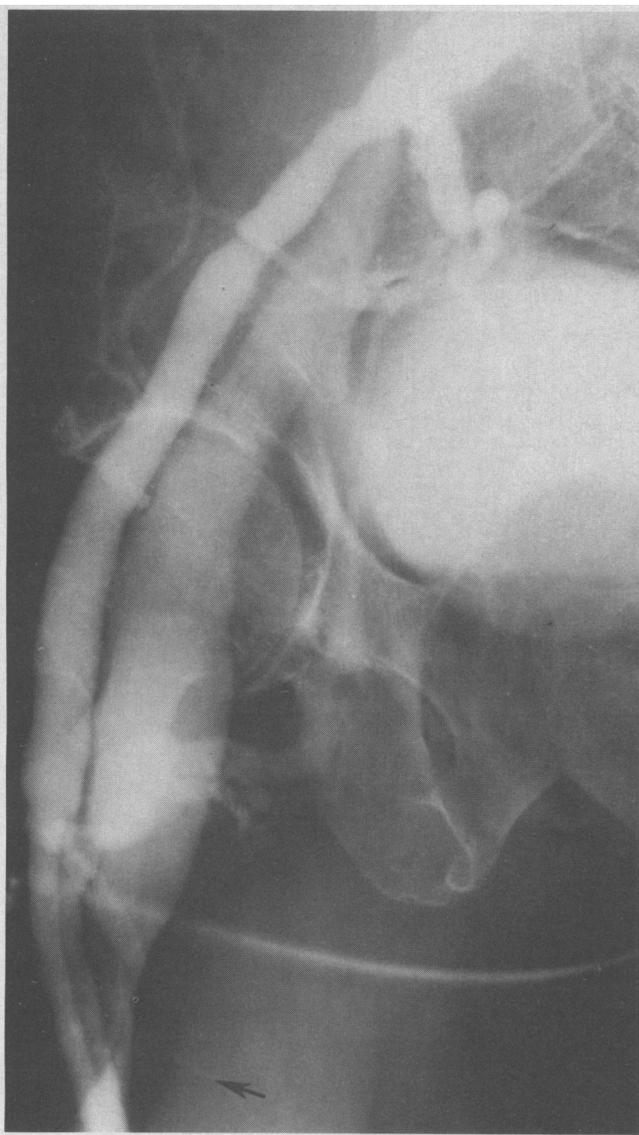


Fig 2.—Arteriogram demonstrating arteriovenous fistula between femoral artery and vein.

reproductive organs.¹⁰ Mass ligation of a vascular pedicle that includes both artery and vein is cited as the cause of A-V fistulas after such a diverse group of operations. Percutaneous vascular access, such as that routinely employed in the cardiac catheterization laboratory, provides still another opportunity for simultaneous arterial and venous injury. Other investigators have cautioned against the intentional puncture of the vessels of the ipsilateral groin when performing both right- and left-sided heart studies because this increases the risk of fistula forma-

tion.¹¹ The fact that two patients in the current series underwent right- and left-sided heart catheterization by puncture of the femoral artery and vein on the same side supports the use of anatomically separate sites. Inadvertent injury of both the artery and vein may also occur during percutaneous puncture. Documentation of this cause of fistula formation was found in the procedure summaries of five patients in our series. We urge close follow-up of those individuals who are known to have sustained either deliberate or accidental puncture of adjacent arteries and veins during diagnostic studies.

Symptoms of high-output congestive heart failure were the predominant presenting complaints in our patients. The shunting of arterial blood through a fistula into the venous circulation produces a decrease in peripheral vascular resistance, a fall in diastolic blood pressure, and an increase in heart rate. The decreased resistance of the fistula causes the development of a collateral circulation with dilatation of the involved vessels that further increases flow through the fistula. Progressive dilatation results in congestive heart failure from the markedly increased cardiac output. Because the secondary circuit of the A-V fistula offers the lower resistance of the venous system, flow through the involved artery distal to the communication is reduced. Ischemia of the affected extremity was noted frequently among our patients. The venous hypertension associated with this lesion can produce leg swelling and prominent superficial venous collaterals. The latter, which may ulcerate and bleed, might be mistaken for varicose veins.

The hemodynamic consequences of an A-V fistula are often reversible. The improvement noted among our patients after closure of the fistula was quite gratifying in almost all cases. Unfortunately, some structural changes, such as dilatation of the proximal artery as well as cardiac enlargement, may not resolve with surgical correction.¹⁰ Spontaneous cure of an A-V fistula has been described. This is due to obliteration by thrombus that occurs in fewer than 2% of cases.¹² As most cases are characterized by relentless enlargement with progression of symptoms, early surgical correction is advocated. At an earlier time, surgical intervention was delayed until there was sufficient collateral circulation to assure the viability of the affected limb after ligation of the involved arteries and veins. Division of the fistula with arterial and venous repair is now the recommended approach. Although the diagnosis is readily established by physical examination, angiographic demonstration of the lesion aids in planning the operative strategy. Exposure of the artery and vein proximal and distal to the fistula should be achieved before division is attempted. Lateral suture of the vessels is usually possible. Occasionally, a roof patch or interposition graft is required to complete the arterial reconstruction. When the affected artery supplies a nonvital vascular bed, transcatheter embolic occlusion represents an alternative method of management.¹³

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