

Management of Venous Injuries

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ENCOURAGED by successful results during the past 15 years, surgeons have adopted the practice of repairing arterial injuries. With venous injuries, however, ligation rather than repair of the veins continues.

Reports from surgeons in Vietnam have confirmed the knowledge that amputation may be necessary, particularly in the lower extremity, after disruption of major venous return when the associated artery remains patent.

What is the significance of acute venous insufficiency in the injured patient? What role does venous stasis play? These and related questions, plus the fact that we believe more effort should be expended in attempting to repair venous injuries, prompt this preliminary report.

Of the 4,500 patients registered in the Vietnam Vascular Registry, over 1,000 had venous injuries. We arbitrarily selected representative cases for this initial review.

Method and Material

Preliminary reports from the Vietnam Vascular Registry evaluated 500 patients with vascular injuries including 194 venous injuries of which 28 were injuries to isolated major veins.⁵ Sixty-four, or 32.9% of the injured veins were repaired and ligation of the traumatized veins was performed in the remaining 130 (Table 1).

The interim report from the Registry analyzed 1,000 major arterial injuries in-

cluding most of those in the preliminary report.⁴ There were 124 repairs of veins in 377 concomitant venous injuries (Table 2). The per cent of vein repairs remained at 32.9%.

At Walter Reed General Hospital it has been the policy for the past 18 years to repair injured major veins, usually by lateral suture, although autogenous vein grafts have been utilized. Approximately 50 venograms have been performed in the past 3 years to evaluate injured veins repaired at both Walter Reed and Vietnam.

Because the significance of concomitant popliteal arterial and venous injuries is uncertain, an effort is being made in these injuries. The amputation rate for popliteal arterial injuries is highest of peripheral arterial vessels, but concomitant venous injuries occur in 58.7% of all popliteal arterial injuries.³ Sullivan *et al.*⁶ reported an analysis management of more than 25 popliteal venous injuries at the 12th Evacuation Hospital in Vietnam in 1969. This effort has been coordinated with the Registry and clinical evaluations including venograms performed at Walter Reed.

Records in the Registry are increasing in volume and number and are not yet reviewed but selected cases are reported here as experiences in management of venous injuries.

Case 1. A 20-year-old man sustained fragment wounds from an enemy mortar in November 1967

Presented at the Annual Meeting of the Southern Surgical Association, December 8-10, 1969, Hot Springs, Virginia.

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TABLE 1. *Vietnam Vascular Registry*
Venous Injuries

Registry	Injuries	Repairs	%
Initial report	194	64	32.9
Interim report	377	124	32.9

TABLE 2. Location of Vascular Injuries

		Arteries	Concomitant Veins	Ligation	Repair
Neck	Carotid	50	14	10	4
Chest	Innominate	3	1	0	1
	Subclavian	8	4	1	3
Upper extremity	Axillary	59	20	18	2
	Brachial	283	54	42	12
Abdomen and pelvis	Abdominal aorta	3	1	0	1
	Common iliac	9	6	6	0
	External iliac	17	5	3	2
Lower extremity	Common femoral	46	17	8	9
	Superficial femoral	305	139	83	56
	Popliteal	217	116	82	34
Totals		1,000	377	253	124

and first noticed a thrill in his right thigh approximately 2 weeks later. The diagnosis of arteriovenous fistula of the superficial femoral vessels was made at Walter Reed. Approximately 3 months after injury, repair of the right superficial femoral A-V fistula was carried out. The vein was repaired by continuous lateral suture with synthetic vascular sutures. A femoral venogram one month after repair showed patency of the superficial femoral vein (Fig. 1).

Comment: Repair of veins in the management of arteriovenous fistulas was advocated after experience in the Korean Conflict.² We continue to attempt repair of larger veins in arteriovenous fistulas.

Case 2. A 24-year-old soldier received multiple fragment wounds to his body from an explosive



FIG. 1. Patency of the superficial femoral vein is seen approximately 1 month after lateral repair of the vein in a 20-year-old man with superficial femoral arteriovenous fistula from multiple fragment wounds (Case 1).

device in July 1968 in Vietnam. The only significant vascular injury was to the left femoral vein which was repaired by lateral suture. He had no edema in the involved extremity and no venous insufficiency when examined at Walter Reed. An ultrasonic sound recording (Doppler) was interpreted as showing normal flow through the left femoral vein (Fig. 2). Femoral venogram 4 months after repair showed the left femoral vein patent (Fig. 3).

Comment: Except that this patient did not have a concomitant arterial injury, this case is representative of the experience in

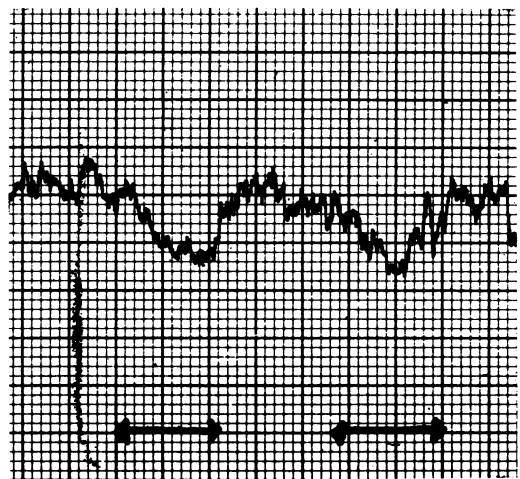


FIG. 2. This recording from the ultrasonic sounding device (Doppler) demonstrates normal flow through the left femoral vein during deep respirations in a patient after lateral repair of a vein laceration (Case 2).



FIG. 3. To substantiate Figure 2 this venogram shows the left femoral vein to be patent (Case 2).

Vietnam in management of venous injuries. Our impression is that a high percentage of veins repaired thus have remained patent. There has been little difficulty with thrombophlebitis after repair.

Case 3. A 20-year-old man was hit by multiple missile fragments in October 1969. In addition to a through and through laceration of the right common femoral artery he also received a through and through laceration of the common femoral vein. Both lacerations were repaired with running 00000 Dacron sutures. One month later at Walter Reed he was ambulatory and had no edema. The Doppler ultrasound recording and physical examination indicated adequate flow through the right common femoral vein. Venogram 6 weeks after injury showed narrowing of the right common femoral vein at the site of repair with adequate flow (Fig. 4).

Comment: Repair of a large vein by both anterior and posterior suturing may be possible but care must be taken not to constrict the vein to the extent that thrombosis may occur. Even though the venogram shows constriction at the repair site, there are no collaterals which often result from obstruction of a major vein.

Case 4. A 20-year-old soldier received a gun shot wound of the left lower extremity in Vietnam in August 1967. The superficial femoral artery was repaired with a saphenous vein graft. The femoral vein laceration was also repaired with saphenous vein patch graft. At Walter Reed 2 months later, auscultation with the Doppler and venogram showed the femoral vein patent (Fig. 5). There was no edema.

Comment: In repairing a large laceration of a vein it is possible to prevent constriction by utilizing an autogenous vein patch graft.

Case 5. The right popliteal artery and vein were both lacerated when a 22-year-old man was shot in the right knee with a low velocity bullet in November 1968. After debridement it was possible to perform an end-to-end anastomosis of both the popliteal artery and the popliteal vein with synthetic vascular sutures. Two months later at Walter Reed there was pitting edema of the right calf and ankle despite the use of an elastic stocking. The greater saphenous venous system was also dilated below the knee. Venogram showed thrombosis at the repaired site with numerous collateral veins (Fig. 6).

Comment: This is an example of collateral veins. At follow-up examination most of the edema disappeared. Either collateral veins became more effective or there was recanalization of the popliteal vein.

Case 6. A 20-year-old man received a gun shot wound of the left thigh in Vietnam in July 1969.



FIG. 4. Adequate flow through the right common femoral vein is seen although there is constriction at the repair site. Note the absence of any venous collaterals. Suture of an anterior and posterior laceration caused by a small low velocity fragment was successful in this patient (Case 3).

A contralateral saphenous vein graft was used to repair a defect in the left superficial femoral vein, the only vascular injury. When seen at Walter Reed there was minimal pedal edema in the left lower extremity which subsided in one month. Flow in the left femoral vein was recorded by ultrasound, but there was less flow on the left as compared to the normal right side. Venogram showed that the vein graft had occluded, but that venous collaterals had developed (Fig. 7).

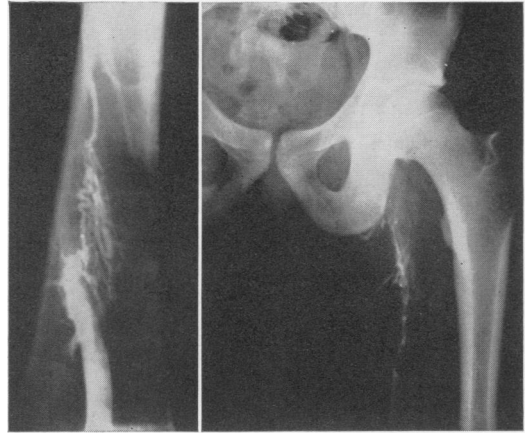


FIG. 7 (left). The autogenous saphenous vein graft to the superficial femoral vein was occluded 3½ months after repair. Deep collateral veins as well as a patent superficial venous system were adequate and the patient had no significant edema (Case 6).

FIG. 8 (right). After a fragment wound of the left common femoral vein, ligation of the shattered vein was believed mandatory. In addition to occlusion of the left common femoral vein, an absence of significant collateral veins and also a recanalization of thrombus is seen in a thrombosed segment of the femoral venous system (Case 7).

Comment: Thrombosis of the saphenous vein graft to the superficial femoral vein was shown by venography three and one half months after repair. Collateral circulation had not developed as it had in Case 5; nevertheless, venous return was adequate.

Case 7. Amongst multiple fragment wounds in this 21-year-old man the femoral vein was shattered and was ligated with 00 silk. At Walter Reed one month later the patient complained of swelling of the left ankle after prolonged walking or standing. He had moderate swelling of the left calf and ankle. Flow sound was diminished on the left as compared to the right, believed to be evi-



FIG. 5 (left). The distal superficial femoral vein in this patient was repaired with an autogenous saphenous vein patch graft. This venogram shows successful repair and patency of the vein (Case 4).

FIG. 6 (right). Thrombosis of an end-to-end vein repair of the popliteal vein is demonstrated in this venogram. Although there appears to be adequate venous collateral flow, this patient initially had significant pedal edema (Case 5).

dence of flow in collateral veins only. Left femoral venogram showed in addition to occlusion of the left common femoral vein recanalization of the thrombus in other segments of the femoral venous system.

Case 8. A 34-year-old man was injured by a high velocity rifle bullet in January 1967. An end-to-end repair of the severed right superficial femoral artery was possible. Because a segment of the superficial femoral was avulsed next to the saphenofemoral junction, the surgeon anastomosed the greater saphenous vein to the superficial femoral vein end-to-end. This patient spent many months in bed because of a right femoral fracture complicated by osteomyelitis. When he began ambulation, however, there was only minimal edema of the right ankle. The edema soon disappeared. One year later at Walter Reed venogram showed occlusion of the anastomosis and numerous collateral veins (Fig. 9).

Comment: There was time for collateral circulation to develop in this patient, and he now has no edema. Anastomosis of one end of the greater saphenous vein to a transected superficial femoral vein has been carried out on at least three patients.

Case 9. A 21-year-old man received a grenade fragment wound of the right popliteal fossa in

Vietnam in January 1969 and an autogenous saphenous vein graft was used to restore flow in the right popliteal artery. The transected popliteal vein was ligated. At Walter Reed initially he had moderate right ankle and calf edema. Six months later despite a support elastic stocking he continued to have swelling of the right ankle. Venogram showed only minimal venous collateral (Fig. 10).

Comment: This patient demonstrates moderate venous insufficiency because of poor venous collaterals. Further complications are anticipated.

Case 10. A 33-year-old man sustained a high velocity gun shot wound of the left thigh in December 1966. An ipsilateral greater saphenous vein graft was utilized to repair the superficial femoral artery. All disrupted veins were ligated at the level of the distal thigh. Ultrasound examinations showed diminished return flow in the left common femoral vein, with absent flow sound and minimal flow change when the patient performed the Valsalva maneuver (Fig. 11). Venogram (Fig. 12A and B) confirmed that all normal venous channels were occluded and that some collateral veins had developed. He has persistent edema of the left calf and ankle despite elastic support stocking and stasis dermatitis, superficial varicosities, and superficial ulcerations on three occasions.

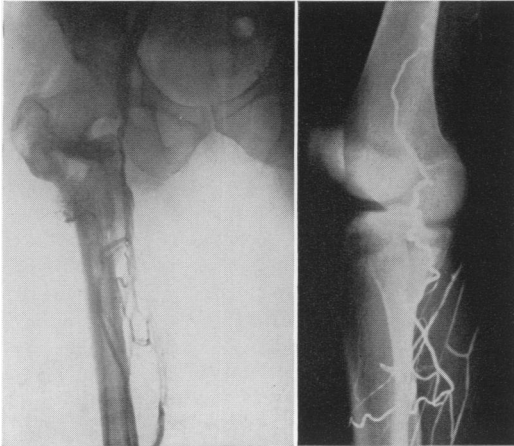


FIG. 9 (left). By use of the subtraction technic good venous collateral circulation is seen one year after attempt was made to restore venous return by end-to-end anastomosis of the greater saphenous vein to the superficial femoral vein (Case 8).

FIG. 10 (right). After ligation of the right popliteal vein this venogram demonstrates poor venous collateral return. The patient had persistent pedal edema and will have additional difficulties in future years from venous insufficiency (Case 9).

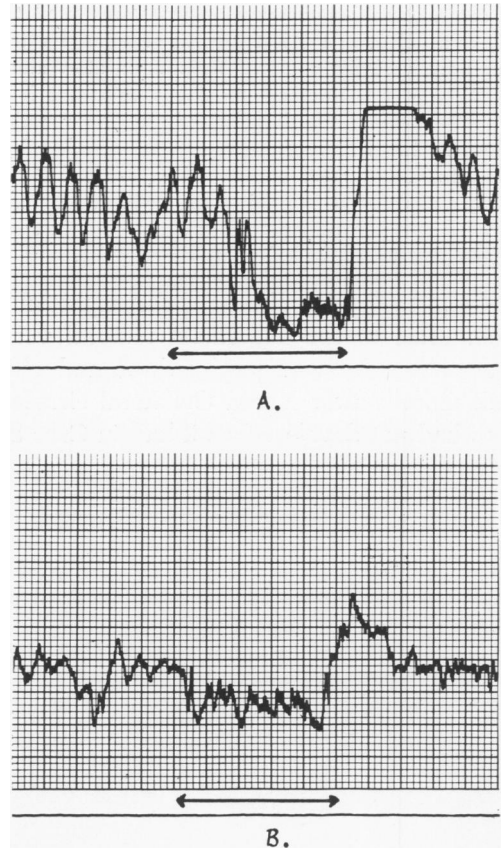


FIG. 11. The ultrasonic sounding device (Doppler) records normal depression with rapid elevation (A) of the right common femoral vein after the Valsalva maneuver. In contrast this characteristic flow pattern was absent (B) when the Doppler was placed over the left common femoral vein (Case 10).

Comment: In spite of venous collaterals, this patient has venous insufficiency of major venous occlusion.

Case 11. A 7-year-old boy was first seen at Walter Reed in 1963 because of increased length and girth of the right lower extremity when compared to the left. He had an exchange transfusion via the right femoral vessels during his first few days of life for erythroblastosis fetalis. Before one year of age the right lower extremity was larger than the left, and there were varicosities in the right lower extremity and across the anterior abdominal wall. Venogram showed obstruction of the right common femoral vein. In August 1963 reconstruction of the right common femoral vein was carried out by an autogenous internal jugular vein interpositioned graft. Venogram 5 months later showed patency of this graft. Six years later the patient is active and well.

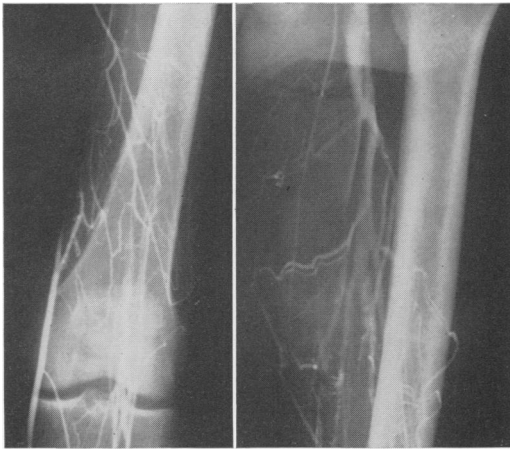


FIG. 12A (left). Occlusion of the greater saphenous vein and the femoral vein is shown. Some small venous channels have appeared (Case 10).

FIG. 12B (right). Venous collaterals carry venous flow from the left lower extremity and re-establish filling of the left common femoral and iliac veins (Case 10).

Discussion

Inadvertent laceration of a major vein is probably more common in the internal jugular vein during neck dissection, the axillary vein during radical mastectomy and the common femoral during operations on the saphenous vein. These lacerations can be repaired. Definitive repair of arteriovenous fistulas showed the feasibility of repair of major veins.

In the acutely injured patient who is hypovolemic and in shock, and with possible increased clotting tendencies questions arise. Arterial injuries were repaired in large numbers in Korea, although vein repairs were limited. Approximately 50% of such repairs became obliterated by thrombosis.

During the past 10 years there have been numerous investigative studies of venous repair. Dale and Scott reported their experiments and reviewed the literature.¹ Vein repairs have been accomplished in approximately one third of the venous injuries in Vietnam (Table 1). The incidence of concomitant venous injuries with 1,000 major arterial injuries is 37.7%.⁴ Of 124 vein repairs reported 106 were by con-

tinuous or interrupted suture of a laceration of the vein (Table 3). There has been a trend toward autogenous vein grafts to repair venous injuries in the lower extremities.

Concern over the possibility of thrombophlebitis and pulmonary embolization associated with thrombosis of vein repairs has not materialized. These occurrences have usually followed ligation of veins.

Need for a more aggressive approach to repair of venous injuries has been recognized particularly in the lower extremities where the highest percentage of non-fatal combat injuries occur. There are a multiplicity of factors involved when considering the cause of a vascular repair failure resulting in amputation. Included are massive soft tissue and osseous destruction, technical problems, and improper patient selection. Nevertheless, many combat surgeons are aware that amputation is frequently required soon after a popliteal artery repair when there is no effective remaining venous return. At the time of the amputation in these patients massive distal venous congestion has been present and the arterial repair has been functional. The frequency of concomitant popliteal venous and arterial injuries contributes to the high amputation rate for the popliteal wounds.³

If venous repairs remain patent for 24 to 72 hours this may allow for relaxation of spasm and establishment of venous collaterals, as illustrated in Figures 5 and 6. Veins that have thrombosed can recanalize (Fig. 8), as can a thrombosed autogenous vein graft. Temporary arteriovenous shunt in small vessels to increase pressure in autogenous vein grafts to increase patency

TABLE 3. *Repair of Venous Injuries*
Interim Report
Vietnam Vascular Registry

Lateral suture	106
End to end anastomosis	10
Vein interposition graft	5
Vein patch graft	3
Total	124

has been suggested. This has the disadvantage of an additional operation and eventually repair of both the vein and the artery.

Ultrasonic sounding (Doppler) is useful for evaluating patency of veins, particularly femoral veins. Graphic representation (Figs. 3 and 11) is a permanent reference. Depression and rapid elevation with the Valsalva maneuver is an indication of adequate venous flow (Fig. 11). In 50 venograms there was one complication.

Follow-up of Registry patients with venous injuries will establish the significance of venous insufficiency and value of venous repair. Early impressions are that venous insufficiency in the upper extremities is unusual. Venous insufficiency in the lower extremities manifested by stasis dermatitis, edema, ulcerations, and varicose veins is more frequent (Case 11). The incidence and severity of the complications will probably increase with longer follow-up.

Summary

Although the management of acute arterial injuries has been established, there is less enthusiasm for repairing acute venous injuries. A preliminary review of the Vietnam Vascular Registry reveals that there

have been more than 1,000 venous injuries among 4,500 patients registered.

Initial follow up indicates a low incidence of complications associated with venous repairs and emphasizes the benefit, particularly in lower extremities. The initial impression is that the majority of lateral vein repairs remain patent. Autogenous vein grafts in the venous system provide time for collateral circulation even if the graft thromboses early. Recanalization of this thrombosis is possible.

An effort to repair major venous injuries should be made. Long-term follow-up will be necessary to determine the significance of resultant chronic venous insufficiency.

References

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DISCUSSION

COLONEL NORMAN M. RICH (Closing): (Slide) I would like to mention the ultrasonic sounding device that we have been utilizing for the last 2 years. We use a Doppler, but there are other models that you can utilize.

In this instance, on the right side there was flow through the normal vein accentuated with the Valsalva maneuver. We obtained a good tracing as you can see here.

On the opposite side—really no flow. This was after ligation of both the left superficial femoral vein and also the left greater saphenous vein on that side.

There is no panacea with this type of instrument, as with so many other instruments that are devised, but it does provide a graphic recording with which to study these patients in the registry.

(Slide) Several members of this organization—Drs. Foster, Dale, Scott and DeWeese—have shown that there can be recanalization of autoge-

nous vein grafts put into the venous system. We do not have all of the slides yet, because we are working with a group of surgeons in Vietnam at the present time, but I was assured very recently that this young man had a thrombosis of a 3 cm. saphenous vein graft placed into the popliteal vein in Vietnam about 3 months ago. When I first saw him in Walter Reed he had edema which subsided after a month's convalescent leave.

We obtained a second venogram, which, as you can see here, does show recanalization of this small segment of the vein graft. We have three other patients that we feel clinically demonstrate the same situation.

Initially, when we started the Vietnam Vascular Registry we felt that the greatest interest would come from management of the arterial injuries. We more or less pushed the venous injuries to the background. But in the last year we have become more interested in the repair of venous injuries, and feel that this area needs to be pursued with greater vigor.