

The Effect of Acute Popliteal Venous Interruption

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Popliteal vascular trauma continues to be associated with a relatively high morbidity rate when compared to other major vascular injuries in extremities. There is continuing controversy regarding the management of popliteal venous injuries. The advocates of ligation of injured veins have postulated that there is an increased incidence in thrombophlebitis and pulmonary embolism associated with attempted venous repair. There is a paucity of valid statistics supporting either side of this controversy. Clinical experience documented in the Vietnam Vascular Registry and experimental work at Walter Reed Army Institute of Research have supported our more aggressive approach for venous repair. This study evaluates the management of 110 injured popliteal veins without associated popliteal arterial trauma. Nearly an equal number were ligated and repaired. Thrombophlebitis and pulmonary embolism were not significant complications in this series. The only pulmonary embolus occurred after ligation of an injured popliteal vein. However, there was a significant increase in edema of the involved extremity following ligation, 50.9% compared to 13.2% after repair.

A REMAINING ENIGMA in vascular surgery involves the relatively high amputation rate following popliteal vascular trauma: approximately 30% compared to an overall amputation rate of about 13% following arterial trauma.²⁻⁴ Recent clinical and experimental data have supported the theory that deleterious effects result from acute popliteal venous interruption.^{1,5-8,10-12} Neverthe-

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less, some surgeons still advocate ligation suggesting that thrombophlebitis and pulmonary embolism may develop following attempted repair.^{8,9}

Approximately 7,500 patients are included in our Vietnam Vascular Registry² with more than 600 popliteal vascular injuries. A previous review emphasized that acute interruption of the popliteal vein with concomitant popliteal arterial trauma could contribute to acute venous insufficiency and subsequent amputation.⁷ In other patients chronic venous insufficiency with swelling and venous stasis changes, similar to the post-phlebotic syndrome, could develop.^{5,8,10}

This study evaluates 110 patients with popliteal venous trauma without concomitant adjacent arterial trauma. Realizing that concomitant injuries to adjacent bones, nerves, soft tissue, and lymphatics also contribute to morbidity of the lower extremity wound, an attempt was made to determine the extent of deleterious effects of acute popliteal venous interruption and to compare this with results following popliteal venous repair.

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Historical Note

Although venous repair was advocated in the 19th century, this is not generally accepted.⁹ On the contrary, within the past 10 to 15 years, numerous surgeons postulated a higher incidence of thrombophlebitis and pulmonary embolism following repair compared to ligation. A few major extremity venous injuries were repaired during the Korean conflict. It was recognized that acute venous interruption could lead to venous hypertension.⁹ Experience in Southeast Asia between 1965 and 1972 substantiated these beliefs and added additional clinical documentation.^{5-8,10-12}

TABLE 1. *Time of Injury*

Year	Number	Percent
1965	1	0.9%
1966	7	6.4%
1967	13	11.8%
1968	26	23.6%
1969	38	34.6%
1970	23	20.9%
1971	2	1.8%
Total	110	100.0%

Methods and Materials

The Vietnam Vascular Registry was established in 1966 at Walter Reed Army Medical Center to document vascular injuries in Vietnam, to analyze results of management of these injuries, and to provide long-term followup of associated morbidity or success rates of various types of repair.³ Complete records of 110 patients with isolated popliteal venous trauma were available for this report. In addition to review of old military clinical records, establishment of direct contact with all patients was attempted. Whenever possible, patients were seen in our Vascular Clinic and Laboratory. When impossible, additional information was obtained from local physicians, the Veterans Administration, and by questionnaire. Identification cards were sent to patients requesting information regarding any change in medical status or results of additional medical evaluation. Records of the Wound Data Munitions Effectiveness Team were also reviewed for additional details and photographic material of original wounds. Venograms were obtained in a sporadic fashion. Evaluation of the lower extremity venous system was carried out at Walter Reed Army Medical Center using the ultrasonic sounding device (Doppler).

Results

During fighting in Southeast Asia, at least 110 United States servicemen sustained popliteal venous trauma without accompanying popliteal arterial trauma from 1965 through 1971. The largest number of injuries, 38, occurred in 1969: 34.6% (Table 1). These wounds were treated in 25 different hospitals by a different surgeon in nearly

TABLE 2. *Pathology*

Injury	Number	Percent
Laceration	73	66.4%
Transection	37	33.6%
<u>Site</u>		
Right	58	52.7%
Left	52	47.3%

TABLE 3. *Adjacent Concomitant Injury: 110 Patients*

Type	Number	Percent
Nerve	65	59.1%
Bone	44	40.0%
Soft Tissue	14	12.7%
Artery	0	0.0%

every case. No more than 14 injuries were managed in any one hospital. The majority of popliteal venous injuries occurred on the right side: 58 or 52.7% and laceration was the most frequent type of injury: 73 or 66.4% (Table 2). Concomitant injuries occurred in many wounds. Damage to adjacent nerves was identified most frequently: 65 injuries or 59.1% of all injuries (Table 3). Fragments, from various exploding devices such as grenades and mortar rounds, caused the largest number of injuries: 73 or 66.4% (Table 4). Gunshot wounds were usually high velocity type military wounds. One stab wound occurred from an accidental bayonet stabbing.

Time from injury to treatment was established in 76 cases. In 85.5% of these "lag time" from wounding until the patient reached a definitive surgical center was less than 3 hours. Only three patients reached the hospital in more than 6 hours. Three frequently noted physical findings included bleeding of venous character, soft tissue wound of the popliteal fossa, or obvious fracture adjacent to the popliteal fossa. Multiple blood transfusions were frequently used but it was difficult to assess how much of the total loss was caused by bleeding from wounds in other body areas. One patient required 6 units of whole blood after transection of the popliteal vein with an associated comminuted fracture of the distal femur.

Ligation of the injured vein was accepted in the majority of these injuries: 57 or 51.8%. However, repair was used in nearly an equal number (Table 5). Venous hypertension was the most frequently recognized complication following injury. This was documented by presence of edema in 36 extremities representing 32.7% of the total. However, this complication was more frequently recognized following ligation, 29 of 57, or 50.9% of the ligations, than after repair, 7 of 53 injuries or 13.2%. Thrombophlebitis developed after 5 injuries or 4.5% of the total (Table 7). This complication occurred in 3 of the 57 injuries treated by ligation or 5.3%. The incidence

TABLE 4. *Wounding Agent*

Type	Number	Percent
Fragment	73	66.4%
Bullet	36	32.7%
Stab	1	0.9%
Totals	110	100.0%

TABLE 5. *Management*

Method	Number	Percent
Ligation	57	51.8%
Lateral Suture	32	29.1%
End-to-end Anastomosis	15	13.6%
Interposition Graft	6	5.5%
Total	110	100.0%

following repair was 2 of 53 injuries, or 3.8%. There was no statistically significant difference in this incidence. Pulmonary embolism occurred after one injury. There was one death; but, this was not attributed to injury of the popliteal vein. No amputations were required.

Twenty-eight, or 25.5% of the total, were evaluated at Walter Reed Army Medical Center during the long-term follow-up period. Nine of fourteen patients had significant chronic edema following popliteal venous ligation. Only three of fifteen patients who had popliteal venous repair (ten by lateral suture, three by interposition saphenous venous grafts, and two by end-to-end venous anastomosis) had edema and it was mild and transient in two. Fifteen venograms were performed with 11 of 12 patent venous repairs demonstrated: seven by lateral suture, two by end-to-end venous anastomosis and two by interposition autogenous venous grafts. Thrombosis occurred in one venous graft.

Discussion

This relatively large series of popliteal venous injuries provides additional important information in an area where controversy still exists. The only patient who developed a pulmonary embolus had ligation of the popliteal vein. Fear that many previously expressed of an increased incidence of pulmonary embolism following attempted venous repair was not substantiated by this study. Absence of this complication was also emphasized in our first major review of management of venous injuries.⁵ Also important is the low incidence of thrombophlebitis which was essentially the same following both ligation and repair. Previously, again without any valid statistical data, concern was expressed that there would be an increased incidence of thrombophlebitis following attempted venous repair. There are, obviously, major problems in identifying contributing factors to both thrombophlebitis and pulmonary embolism which can occur after many types of operations and additional confusion exists in patients sustaining multiple trauma. Despite these limitations and reservations, it is important to emphasize that neither thrombophlebitis nor pulmonary embolism occurred as significant complications whether the popliteal venous injury was treated by ligation or by repair.

TABLE 6. *Edema*

Management	Number	Percent
Ligation	29/57	50.9%
Repair	7/53	13.2%
Totals	36/110	32.7%

Acute venous hypertension is also extremely important when considering problems of acute popliteal venous interruption. That this occurred was profusely documented in medical records of three patients. The surgeon emphasized that popliteal venous repair was performed because of massive edema and venous engorgement of the lower extremity with rapid resolution of these findings within a few hours after repair of the popliteal vein. Although there were no amputations required in this series of 110 popliteal venous injuries, the three cases cited above emphasize that acute popliteal interruptions may cause severe venous hypertension and edema. While essentially one-half of those injuries treated by ligation had significant postoperative edema (29 out of 57 injuries) the incidence of edema was only 13.2% (7 of 53) following attempted repair. This difference is even more significant when additional details are recognized. The transient nature of the edema was more obvious following repair. Recanalization of the venous system can occur as was documented in one of our early cases where recanalization of a cephalic vein graft used to repair the popliteal vein was demonstrated by follow-up phlebography after a phlebogram performed in the early postoperative period in Vietnam had demonstrated thrombosis of the repair.⁶ Edema which had developed with the thrombosis disappeared completely following recanalization. Changes of venous stasis have been noted in those patients who had popliteal venous ligation and the incidence of additional problems secondary to chronic venous insufficiency is expected to increase in many of these patients. Although adequate statistics have not yet been obtained, we have been impressed with this clinical observation in our long-term followup of patients with lower extremity venous injuries. This clinical observation previously prompted our plea for a more aggressive approach to lower extremity venous repair.⁸ It is recognized that other factors such as concomitant fractures, massive soft tissue injuries, and interruption of lymphatics can also contribute to the edema. However, these concomitant injuries oc-

TABLE 7. *Morbidity and Mortality*

Type	Number	Percent
Thrombophlebitis	5	4.5%
Pulmonary Embolization	1	0.9%
Amputations	0	0.0%
Death	1	0.9%

curred with nearly equal frequency, whether the popliteal venous injury was managed by ligation or repair.

If laceration of the popliteal vein is encountered, it can be closed successfully by lateral suture and should be accomplished whenever possible. As reported in our initial review of management of popliteal venous trauma,⁵ this study also emphasizes the high success rate that can be expected. If there is any question of stenosis at the site of repair, autogenous venous tissue can be used as a patch graft in the lateral suture repair and potential stenosis eliminated. If the vein has been transected and adequate length remains, an end-to-end venous anastomosis can be successful and should be performed. Minimal data exist regarding management of a missing popliteal venous segment and it is obvious to all vascular surgeons that the "ideal conduit" is non-existent.^{8,10} Autogenous venous tissue is presently the conduit of choice and the greater saphenous vein near its junction with the superficial femoral vein should be used when possible. This graft should be taken from the contralateral side because important venous return must be preserved on the ipsilateral side. There can easily be a discrepancy in diameter between the donor and recipient vessels. Unresolved questions include the possible use of a composite venous graft to obtain additional diameter which might correspond more favorably with the diameter of the popliteal vein. Also, use of another vein such as the internal jugular vein has been considered. If the patient's general condition is satisfactory, the popliteal vein should be repaired whenever possible, even if an interposition autogenous venous graft must be used.

The following quote is an example of the continuing problem that can exist if acute popliteal venous interruption is used: "Since my discharge from the Army 7 years ago, my leg has given me a great deal of pain. It is necessary to elevate my leg several times a day to reduce the swelling." Additional research must be carried out. This has been a major area of interest for more than 6 years at Walter Reed Army Institute of Research. A symposium

in 1973 brought a number of experts together from many sectors of the United States in a two-day discussion of the problems associated with lower extremity venous trauma.¹² The number of unresolved questions in this area should provide a stimulus to future investigations. Adequate documentation of these repairs must be made and a continued exchange of information must be accomplished if the above and related questions are to be answered.

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