

**Practice Management Guidelines for  
Penetrating Trauma to the Lower Extremity**

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# **PRACTICE MANAGEMENT GUIDELINE FOR EVALUATION AND MANAGEMENT OF LOWER EXTREMITY VENOUS INJURIES FROM PENETRATING TRAUMA**

## **I. Statement of the Problem**

Venous injuries occur frequently with penetrating trauma to the lower extremity. Neither the natural history nor the optimal treatment of isolated venous injuries is known. Most frequently, venous injuries are diagnosed in association with a concomitant arterial injury or during exploration for a presumed arterial injury. In this scenario, controversy still exists regarding the proper management of these injuries.

## **II. Process**

A Medline computer search was conducted on all articles in the English literature during the years 1980-1997 pertaining to venous injuries of the lower extremity. The subject words used included "Avascular injury," "Avenous injury," "Aextremity trauma," "Apenetrating trauma," "Avascular trauma," and "Avenous trauma." The references of these articles were also used to locate articles not found in the Medline search. Personal files were also used. All letters to the editor, case reports, book chapters, review articles, series involving less than 20 cases, series involving predominantly blunt trauma, and series in which the percentage and outcome of the penetrating injuries were not clearly specified were excluded. Also articles whose focus was the management of arterial injuries but also included the results of their venous injuries were excluded. This left 14 articles of relevance to this practice parameter.

## **III. Recommendations**

### **A. Level 1**

There is no class I evidence to support a standard of care for this parameter.

### **B. Level 2**

There is no class 2 evidence to support a standard of care for this parameter.

### **C. Level 3**

1. There is insufficient data to recommend treatment for isolated venous injuries. Isolated venous injuries accompanied with active hemorrhage require exploration and cessation of bleeding.
2. Venous injuries found during exploration for associated arterial injury should be repaired if the patient is hemodynamically stable and the repair itself will not significantly delay treatment of associated injuries or destabilize the patient's condition.
3. Lateral venorrhaphy that does not significantly narrow the lumen or paneled grafts appear to be the best options for repair. Interposition vein grafts consistently have poor results, and synthetic grafts are the least desirable option for repair.
4. There is insufficient data to recommend adjunctive measures to improve vein repair patency.

5. Venous ligation in conjunction with leg elevation, compression stockings, and liberal use of fasciotomies offers similar results to repair.
6. Fasciotomy should be considered when there is a combined arterial and venous injury.

#### **IV. Scientific Foundation**

Most available studies on venous injuries secondary to penetrating trauma to the lower extremity are retrospective in nature. There is virtually no data available on isolated venous injuries. Except for Borman et al., virtually no one has attempted to diagnose venous injuries preoperatively.<sup>12</sup> Even in this paper, in which 30% of patients had a preoperative venogram, 90% of the patients underwent exploration for the indication of suspected arterial injury. Since most patients with penetrating trauma to the lower extremity get evaluated for the possibility of arterial injury, there is probably an unknown population of patients with normal arterial evaluations and undiagnosed isolated venous injuries. There are no data to show adverse sequelae of missed isolated venous injuries. Thus neither the natural history nor the optimum management of isolated venous injuries is known. It is reasonable to assume that only the isolated injuries that present themselves because of active bleeding need to be pursued. Otherwise, management recommendation cannot be given.

Most of the literature on venous trauma deals with venous injuries that are diagnosed during exploration for suspected arterial injuries. In this scenario, there has been an ongoing debate regarding the optimal management strategy. Again, except for one prospective study, most of the literature is retrospective.<sup>6</sup> Nonetheless, these studies provide enough evidence to support a number of recommended and suggested management options, as well as directions for future investigation.

The majority of papers on this subject deal with whether to ligate or repair. Venous injuries found during exploration for associated arterial injury should be repaired if the patient is hemodynamically stable and the repair itself will not significantly delay treatment of associated injuries or destabilize the patient's condition.<sup>7,9,12,14</sup> With respect to the type of repair performed, the highest patency rates are achieved with lateral venorrhaphies that do not significantly narrow the lumen of the repaired vein or vein patching.<sup>5,6,8,11,12</sup> For complex repairs, end-to-end and paneled repairs are probably the best options. Synthetic or interposition vein grafts have the worst reported patency rates.<sup>6,8,11</sup> Nevertheless, irrespective of the type of repair chosen, the thrombosis rate and lower extremity edema rate are significant. Even the patent or recanalized repairs have significant physiologic impairment when assessed with photoplethysmography.<sup>10</sup> When ligation is performed, the clinically significant edema rate does not appear to be significantly different if leg elevation, compression stockings, and liberal use of fasciotomies are utilized.<sup>7,8,9,11,12,14</sup> Fasciotomy rates are not affected by the type of management of the venous injury.<sup>1,7,9,12</sup> Rather, it is the presence of a combined arterial and venous injury that significantly increases the rate of fasciotomy. Adjunctive measures that improve venous repair patency rates have not been clearly elucidated in the literature. There is some evidence that creation of an arteriovenous fistula may improve patency rates.<sup>3</sup> There is no rigid scientific data to support use of anticoagulants.

## **V. Summary**

Very little data exists on the diagnosis and management of isolated venous injuries. The literature suggests that venous injuries encountered during exploration for an arterial injury should be repaired if the patient is stable. Lateral venorrhaphies result in the best patency rates, synthetic and interposition vein grafts have much lower patencies. Complications of thrombosis and distal edema are common regardless of the type of repair chosen.

## **VI. Future Investigation**

While all areas concerning the management of venous injuries require more rigorous scientific evaluation, there are some issues that have not been studied in great detail which lend themselves to prospective study:

The natural history of isolated venous injuries

The proper management of isolated venous injuries

Role for post operative venography or venous duplex

Role of anticoagulation after repair or ligation

## VII. References

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<b>First Author</b>	<b>Reference</b>	<b>Class</b>	<b>Findings</b>
Meyer J, et al	The early fate of venous repair after civilian vascular trauma. Ann Surg 206(4):458-464, 1987	II	28 LE v.v. injuries. All dx=d in OR. 94% assoc. a.a. injuries. Mostly penetrating trauma. Mostly complex repairs- 17% lat. Venorrhaphy. All pts had US & impedance plethysmography on POD 7 followed by venography. 39% thrombosis by venography. Interposition grafts had significantly higher thrombosis. No difference between sights of repair. 4 pts w/ edema(1 patent repair). Edema resolved in two @ 3 months. Venography was more accurate than PE which was more accurate than non-invasive tests in assessing patency. Limb salvage equal in the patent vs. thrombosed groups.
Mullins RJ, et al	The natural history following venous ligation for civilian injuries. J Trauma 20: 737- 743, 1980	III	129 pts w/ major v.v. injuries identified. 6 died before TX & were excluded. 68 had primary repair most by lat. Venorrhaphy. The results of these patients were not included. 55 pts. had v.v. ligation. 9 of these excluded for various reasons. 32 of the remaining were of the LE. 11 of these underwent fasciotomies. Main reasons for ligation were hemorrhagic shock, extensive injury to v., multiple associated injuries. Most injuries were from penetrating mechanism. Pt. Were kept at bed rest w/ involved leg elevated until edema free. Ambulation trials followed by bed rest & leg elevation cont=d until edema would not recur- this occurred in most pts by second trial. Median LOS 29 d. 40/46 were free of edema on ambulation. Of the 33 pts w/ long-term f/u, 30 remained edema free on long-term f/u. None had severe edema or evidence of venous stasis. 28/46 w/ assoc. a.a. injuries had successful a.a. repairs.
Agarwal N, et al	Experience with 115 Civilian Venous Injuries. J Trauma 22:827-832,1982	III	Retrospective. 115 pt.=s w/ venous injuries. Intraabdominal v.v. included. 92% penetrating. 28 LE venous injuries. 75% assoc. a.a. injuries . 8 ligate ; 20 repaired. Incidence of edema significantly greater in ligation group. Compartment syndrome significantly > in combined injury group. No one who had fasciotomy at time of initial repair developed foot drop. Patency of venous repairs was not established
Hardin WD, et al	Management of traumatic peripheral vein injuries. Am J Surg 144: 235-238, 1982	III	86 v.v. injuries- 69 in the LE=s. 97% penetrating. 66% had repair- 21% by lat suture; 14% had interposition grafts. 2 had primary amputation. Results classified as good ( no sequelae), fair ( short term sequelae), & poor (long term sequelae). 88% had long-term full recovery. 36% had short-term sequelae (fair), 10% had long-term sequelae (poor). 1 PE and 1 post-op amputation both pts had had repair w/ interposition v. grafts. Vein interposition was associated w/ the highest rate of long-term morbidity. Primary repair & V. ligation had long-term morbidity of 9.3 & 3.5 % respectively.

Hobson RW, et al	Femoral venous trauma: techniques for surgical management and early results. Am J Surg 146: 220-224, 1983	III	24 femoral v.v. injured over 4 yr pd. 22 from a penetrating mechanism. 10 repaired by lat. Venorrhaphy, 5 by venous patch, 4 by end-to-end, 3 by interposition graft & 2 ligated- 1 of them later underwent in situ bypass w/ saphenous v. 3 Illustrative case reports reported. The pt. W/ ligation had no complications. Of the repairs 74% deemed patent on f/u venography and or non-invasive evaluation. No clinically evident PE=s. 3 pts w/ narrowed repairs had clinically significant edema. 5/6 occluded repairs had significant edema. Claim to be first to report in-situ saphenous v. bypass and spiral grafts for repair of femoral v.v. injuries.
Phifer TJ, et al	Long-term patency of Venous Repairs Demonstrated by Venography. J Trauma 25:342-346, 1985	III	Retrospective. Attempt made to locate 31 patients w/ femoral v. injury over 20 yr. Pd. 24 of these repaired. 5 patients w/ 6 reconstruction=s located. 5 gsw, 1 shotgun. All were 5-20 yr. post-injury. 5/6 were patent. The occluded repair had used Teflon interposition graft. This patient had edema and incompetent deep valvular system. All others had nl valvular fxn and no edema.
Richardson JB, et al	A Temporary AV Shunt in the Management of Traumatic Venous Injuries of the Lower Extremity. J Trauma 26:503-509, 1986	III	8 patients over two year period with venous reconstruction who had distal AV shunts (Scribner type) created. All gsw=s. 7 had combined a.a & v.v injuries. All pts w/ shunts that worked greater than 3 days had patent venous repair on post-op venograms @ 1-2 weeks.
Timberlake GA, et al	Venous injury: To repair or ligate, the dilemma. J Vasc Surg 4:553-558, 1986	III	Gp I 31 LE isolated v.v. injuries all dx=d during operations for suspected a.a. injuries. All penetrating. Gp II 38 pts. w/ LE v.v. injuries also had assoc. a.a. injuries. Venous injuries were either ligated or repaired by end-to-end or lat. Venorrhaphy. No permanent sequelae of ligation identified. No limb loss in this series. 31/43 w/ isolated injuries were ligated. Transient post-op edema was not significantly different between ligation & repair. Fasciotomies were higher in popliteal v. group again no difference w/ respect to Tx. Repaired popliteal v.v thrombosed. Results in the combined injury gp-similar.

Borman KR, et al	A Decade of Lower Extremity Venous Trauma: patency and outcome. Am J Surg 154: 608-612, 1987	III	Retrospectively identified pts w/ v.v. injuries who had been explored. 71 v.v. injuries. 87% penetrating. 46% were in shock on admission. 25 (30%) had preoperative venograms- 22 of these were abnl. 90% of patients were operated on for suspicion of a.a. injury. 76% had concomitant a.a. injuries. 46% had lat. venorrhaphies the rest were complex repairs of which 44% were interposition grafts. 1 v. was repaired w/ synthetic material. 8% of v. were ligated. V.v. repairs usually preceded a.a. repairs. 40% of repairs and 43% of ligations had fasciotomies. 11% pts w/ repair had major post-op morbidity (sepsis), 46% had early LE complications mostly edema but 24% these had gangrene and 8% had PE=s. These complications were more often following repair 49% vs. 14% in ligation group. 67% repaired limbs were intact w/o sx=s on long-term f/u and 40% of ligations. 9 repairs and two ligations had edema. In the long-term venography group 41(56%)- 4 initially patent occluded, 1 initially thrombosed was partially recanalized. 63% in repair grp remained patent. Simple repairs were more likely patent vs. Complex repairs. 19% of patent repairs had DVT=s at distant site and 33% of occluded repairs. 4% of patent repairs and 13% of occluded repairs had PE=s. 74% of patent repairs had intact limbs vs. 38% of occluded repairs. Edema was higher in the failed repairs.
Aitken RJ, et al	Lower limb vein trauma: a long-term clinical and physiologic assessment. Br J Surg 76: 558-588, 1989	III	f/u study. Pts w/ v.v. injuries were identified & asked to come back for assessment. Venography used to assess patency & photoplethysmography used to assess fxn. 26/48 pts contacted. Median elapsed time from injury was 19.5 months. Mostly penetrating trauma. 6 ligation. 11 repairs were either lat. or patch venorrhaphy, the remaining were complex repairs of which 5 were interposition v.v. grafts. 11/12 pts w/ fasciotomies had assoc a.a. injuries. 5/6 pts w/ ligation had clinical dependent pedal edema. 9/20 repairs had edema. 12 pt. W/o edema had abnl v.v. fxn. 4/6 ligations were assessed as poor outcome; 7/20 of repairs were poor, 6/20 fair & 7/20 were good. 58% of the repairs thrombosed. The patent repaired v.v. had serious physiologic impairment when assessed w/ photoplethysmography.
Nypaver TJ, et al	Long-term results of venous	III	Follow-up study. Retrospectively were able to locate 32 pt.=s w/ previous venous

	reconstruction after vascular trauma in civilian practice. J Vasc Surg 16:762-768, 1992		reconstruction. 94% penetrating. 26 LE injuries. 84% assoc. a.a. injuries. Most v.v. injuries discovered during exploration for a.a. repair-3 seen on preop a-gram. 56% lat. venorrhaphy, 13% patch, 9% end- to- end, 22% interposition grafts. 41% had fasciotomies. 17/32 pt.=s had early venography-53% thrombosed. 4/32 had edema @ dc. 1 PE. 2 thrombosed repairs required rehospitalization for IV anti-coagulation. 7 had venous stasis @ long term f/u. Long-term duplex studies revealed 90% venous repairs patent. 94% of lat venorrhaphies and 86% of complex repairs were patent- not significant. Of the 17 pts who had had venography all patent repairs remained patent and 8/9 repairs, which were occluded, were now patent.
Sharma PV, et al	Meticulously restored lumina of injured veins remain patent. Surgery 112:928-932, 1992	III	38 v.v. injuries mostly penetrating; 81% assoc. a.a. injuries. Retrospectively divided into two groups. Those that underwent intra-op venogram and those who did not. 2/17 in group 1 had repair revised secondary to venogram. Group 1 had significantly better patency rates and lower post repair fasciotomy rates
Yelon JA, et al	Venous injuries of the lower extremities and pelvis: Repair versus ligation. J Trauma 33:532-538, 1992	III	55 LE v.v. injuries. Almost all penetrating. 24/55 repaired. Most of the repaired v.v. (74%) had an associated a.a. injury. 48 pts. 60% of total group (pelvic and LE v.v. injuries) had associated a.a. injuries. Popliteal v.v. were more frequently repaired than ligated. 57% presented in shock/71% of these had venous ligation which represents 60% of the venous ligation group.39/45 w/ grade III/IV v.v. injuries had ligation. 15 had lat. venorrhaphies & 15 had complex repairs. 2 had interposition grafts. No difference in fasciotomy rates. All pts. W/ fasciotomies had concomitant a.a. injuries. No difference in clinically significant post-op edema rates. No difference in LOS.
Khaneja SC, et al	Outcome in the management of penetrating venous injury. Vasc Surg 28:39-43, 1994	III	19 LE v.v. injuries due to penetrating trauma. 13/17 femoral v.v. were repaired for by lat. venorrhaphy the rest by complex repair. Both popliteal v.v repaired/thrombosed. 6/8 interposition v. grafts thrombosed. The only isolated v. injury (femoral) was Tx=d w/ PTFE and distal AV fistula & was patent on f/u after ligation of fistula. None of the pts. w/ ligation had post-op sequelae. 4/6 thrombosed repairs had post-op sequelae.