

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

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# **PRACTICE PARAMETER FOR DIAGNOSIS AND MANAGEMENT OF LOWER EXTREMITY ISOLATED ARTERIAL INJURIES FROM PENETRATING TRAUMA**

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

Evaluation and management of arterial injuries to the lower extremity due to penetrating trauma continues to challenge trauma surgeons. Questions remain concerning the method of evaluation and management of the arterial injury. The vast majority of the literature on this subject is retrospective in nature. There is sufficient data to support the recommendations made.

## **II. Process**

A Medline computer search was conducted on all articles in the English Literature during the years 1980-1997 pertaining to arterial injuries of the lower extremity. The subject words used included Avascular injury@, Aartery injury@, Aextremity trauma@, Apenetrating trauma@, Avascular trauma@, and Aartery 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, and series in which the percentage and outcome of the penetrating injuries were not clearly specified were excluded. This left 36 articles of relevance to this practice parameter. In addition there were 2 abstracts that were relevant 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**

Patients with hard signs of arterial injury (pulse deficit, pulsatile bleeding, bruit, thrill, expanding hematoma) should be surgically explored. There is no need for arteriogram in this setting unless the patient has an associated skeletal injury or a shotgun injury. Restoration of perfusion to an extremity with an arterial injury should be performed in less than six hours in order to maximize limb salvage.

### **C. Level 3**

1. There is no defined role for the use of noninvasive Doppler pressure monitoring or duplex ultrasonography to confirm or exclude arterial injury. There may be a role for these studies in patients with soft signs of vascular injury or with proximity injuries.
2. Absence of hard or soft signs of vascular injury reliably excludes surgically significant arterial injury and does not require arteriography.

3. Nonoperative observation of asymptomatic nonocclusive arterial injuries is acceptable.
4. Repair of occult and asymptomatic nonocclusive arterial injuries managed nonoperatively that subsequently require repair can be done without significant increase in morbidity.
5. Simple arterial repairs fare better than grafts. If complex repair is required, vein grafts appear to be the best choice. PTFE, however, is also an acceptable conduit.
6. PTFE may be used in a contaminated field. Effort should be made to obtain soft tissue coverage.
7. Tibial vessels may be ligated if there is documented flow distally.
8. Early four-compartment lower leg fasciotomy should be applied liberally when there is an associated injury or there has been prolonged ischemia. If not performed, compartment pressures should be closely monitored.
9. Arteriography for proximity is indicated only in patients with shotgun injuries.
10. Completion arteriogram should be performed after arterial repair.

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

The limb salvage rate following uncomplicated penetrating arterial injury is over 95%. Faster transport times, improved resuscitation, early operative intervention, and advances in critical care have all contributed to these impressive results. The approach to these injuries continues to evolve. Based on the physical exam, patients with hard signs of arterial injury (pulse deficit, arterial bleeding, bruit, thrill, expanding hematoma) without associated skeletal injury can proceed to operative exploration without an arteriogram(1,8,9,15,21,24,25,27,30,35). There may be some exceptions to this statement. Patients with shotgun wounds or with preexisting peripheral vascular disease may still benefit from a preoperative arteriogram. Soft signs of arterial injury (nerve deficit, nonexpanding hematoma, associated fracture, significant soft tissue injury, history of bleeding or hypotension ), while being a widely recommended indication for arteriography, do not appear to be clinically useful predictors of arterial injuries with the exception of shotgun wounds (8,15,20,24,35). In those patients without hard or soft signs of arterial injury there is no role for proximity angiogram (9,15,20,21,23,24,35,36). Patients with clinically occult arterial injuries may be treated nonoperatively in most instances (8,19,26,27,28,29). There still remains questions on selection criteria for nonoperative management of patients with pseudoaneurysms or arteriovenous fistulae. Patients with clinically occult arterial injuries which later manifest themselves as needing repair can be repaired without additional morbidity (19,21,25,26,27). Patients with hard signs that are surgically explored are best managed with simple repair, either by end-to-end anastomosis or arteriorrhaphy (1,7,8,9,11,12,16). If complex repair is required, vein grafts appear to have the highest patency rates. PTFE however seems to be an acceptable alternative even in contaminated fields ( 2,3,5,9,11,12,14,15,38). Ligation of tibial vessels is

acceptable when there is evidence of good perfusion distally (7,8,13,14,24).

The role of noninvasive evaluation of the lower extremity has not been elucidated. There is data to suggest that duplex studies are accurate in diagnosing arterial injuries (17,18,23,31,32,33,34). However, it is unclear when to initiate these studies. Should they be performed for proximity or in the presence of soft signs of arterial injury? If there is no role for proximity arteriography, why then do noninvasive testing for proximity? Should they be used to follow up patients with normal vascular exams? These questions require further investigation.

## **V. Summary**

Most patients with hard signs of arterial injury should be operated upon without a preoperative arteriogram. A preoperative arteriogram may be helpful in patients with shotgun wounds or preexisting peripheral vascular disease. There appears to be no role for proximity angiography in patients with soft signs of arterial injury, as most patients with occult injury may be treated nonoperatively.

Patients who have an arterial injury that requires exploration (ie. those with hard signs) are best repaired with simple repair or vein grafts. PTFE grafts are an acceptable alternative even in a contaminated field.

## **VI. Future Investigation**

Several issues in diagnosis and management of arterial extremity injuries remain unresolved. Future studies should focus on prospective evaluation of the following:

Role of noninvasive tests to diagnose vascular injury in extremity penetrating trauma

1. Use of PTFE versus autogenous vein in the repair of arterial injuries
2. Role of intraoperative completion arteriogram
3. Nonoperative observation of asymptomatic nonocclusive arterial injuries
4. Proper follow up of patients treated nonoperatively for asymptomatic nonocclusive arterial injuries
5. Role of heparin/thrombolytics in the repair of arterial injuries
6. Evaluation of patients with soft signs of vascular injury
7. Role of antioxidants in prevention of reperfusion injury and need for fasciotomy

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<b>First Author</b>	<b>Reference</b>	<b>Class</b>	<b>Findings</b>
Feliciano DV, et al.	Five-year Experience with PTFE Grafts in Vascular wounds. J Trauma 25: 71-82, 1985	II	Prospective study. 206 pt(85% penetrating) all w/ resex/PTFE. 46% lower extremity. Completion arteriogram performed routinely in the LE=s. Fasciotomies performed on clinical criteria alone. 5% early occlusion due to technical error, delay in Tx, or low flow-1/2 successfully revised. Only exposed grafts became infected. Concluded PTFE an acceptable conduit unless no soft tissue coverage.
Frykberg ER, et al	The Natural History of Clinically Occult Arterial Injuries: A Prospective Evaluation. J Trauma 29: 577-583, 1989	II	20 arterial injuries managed nonoperatively (65% pen). 9 LE injuries. Proximity was the indication for a-gram. Intimal flap the most common finding(13),segmental narrowing in 6 cases, 1 pseudoaneurysm. Of those who had follow-up a-gram (15 lesions) 10 had resolution of the lesion, 3 showed improvement. The 4 who refused f/u angio remained asymptomatic. The false aneurysm of brachial a. required surgery due to enlargement-w/o morbidity.
Frykberg ER, et al	A Reassessment of the Role of Arteriography in Penetrating Proximity Trauma: A Prospective Study. J Trauma 29: 1041-1052, 1989	II	Pts w/o hard or soft signs of vascular inj. were a-gramed. 135 pts w/ 107 LE wounds. 27 abnormalities detected on a-gram. 11 were on noncritical vessels-all did well w/o surgery. 16 abnormalities in LE in major a.a. included 7 narrowing, 6 intimal flaps, 2 sm. pseudoaneurysms, 1 AVF. The AVF was repaired immediately. The other 15 were observed. 1 of these enlarged at 10 wks & even though the pt remained asymptomatic he underwent repair w/o morbidity. 3 pts refused f/u a-gram but remained clinically asymptomatic. 9 showed complete resolution, 2 showed improvement. Both pts that required surgery were from SGW. 50% of pts w/ soft signs had injury.
Bynoe RP, et al	Noninvasive Diagnosis of Vascular Trauma by Duplex Ultrasonography. J Vasc Surg 14: 346- 352, 1991	II	pts w/ proximity injuries were studied. After pts were studied further evaluation & TX depended on Trauma surgeon not protocol. 319 studies performed-23 had a.a. inj. dx=d by duplex-13 lacs, 4 intimal flaps,3 pseudoaneurysms 2 AVF, 1 shotgun inj. All confirmed either by a-gram or operation. 13 vasospasms & 6 ext. compression=s also identified giving 42 true positive studies. 13 operations based on Duplex alone. 6 venous injuries also identified. 2 FN duplex studies. 153 TN studies based on continued nl. Vasc. Exam. Only 20 of these had a-grams as well. 1 study called false pos.
Frykberg ER, et al	The Reliability of Physical	II	pts w/ proximity inj. were observed for 24 hrs. All SGW had a-grams performed.

	Examination in the Evaluation of Penetrating Extremity Trauma for Vascular Injury: Results at One Year. J Trauma 31: 502-511, 1991		260 wounds of the LE. 2 pts w/ missed inj. 1 SGW & 1 gsw. Both pt were operated on w/o morbidity. The rest of pt w/ vascular injury had hard signs. Therefore 92% of injuries that required surgery were detectable by physical exam.
Johansen K, et al	Non-invasive Vascular Tests Reliably Exclude Occult Arterial Trauma in Injured Extremities. J Trauma 31: 515-522, 1991	II	All pts w/ hard signs were explored. The rest underwent Doppler arterial pressure measurement. Pts w/ API < 0.9 underwent a-gram. 100 limbs studied(84 pen) - 17 w/ API < 0.9. 16 of these (94%) had pos. a-gram. 7 of these underwent surgery. Of the 79 limbs w/ API > 0.9 f/u duplex studies revealed 5 minor a.a. lesions- 1 required operation.
Trooskin SZ, et al	The Management of Vascular Injuries of the Extremity Associated with Civilian Firearms. Surg Gynecol & Obstet 176: 350-4, 1993	II	Prospective. 50 UE/LE pen (only GSW=s) A. inj. 42 LE injuries. 32 req=d repair. 22 w/ hard signs went to OR w/o a-gram. 19/41 a-grams on pts w/ soft signs were pos.- 2 intimal flaps(observed),3 nonessential a.a. embolized. Only 9/41 taken to OR. Of the repairs-62% vein graft, 22% PTFE, 12% ligation. No rec=s given on type of repair. 153 a-grams performed for proximity- 7 injured a.a. noted(3 intimal flaps (observed),1 AV fistula,1 thrombosis and 2 pseudoaneurysms)- 2 of these injuries required operation. Despite this authors still recommended a-gram for proximity.
Reichle FA, et al.	Diagnosis and Management of Penetrating Arterial and Venous Injuries in the Extremities. Am J Surg 140: 365-367, 1980	III	Descriptive review of 44 pts w/ penetrating injuries to UE/LE. 32 to LE. 21 SW, 18 gsw, 3 shotgun,2 blunt. Avg interval bet injury & repair- 2 hr 50min.Explored if had pulse deficit, active bleeding, expanding hematoma, shock, bruit, thrill, proximity, ischemic signs, nerve deficit. A-gram obtained for shotgun injuries felt to be helpful. Arteriorrhaphy in 24,end-to-end in 10, patch repair in 4, interposition v. graft in 6. Limb salvage of all penetrating injuries achieved. Tension free anastomosis felt to be important.Fasciotomy of ischemic legs recommended.
Menzoian JO, et al	Evaluation and Management of Vascular Injuries of the Extremities. Arch Surg 118: 93-95, 1983	III	records of 306 pts w/ 315 extremity injuries were reviewed. The majority of pts w/ hard signs who were explored had a.a. inj. repaired. 42 pts w/ a-grams performed for proximity -5 (12%) w/ pos. results.
Sirinek KR, et al	Exclusion Angiography for Patients with Possible Vascular Injuries of the Extremities a Better Use for	III	63/124 pts explored for proximity had neg. explorations. 9 of these pts developed complications. 1 arterial injury was missed @ exploration. 50/124 pts who had a-gram underwent surgery. This gp included 11 pseudoaneurysms, 7 AVF, 2

	Trauma Center Resources. Surgery 94: 598-603, 1983			intimal tears.. There were 2 false pos. a-grams, 1 false neg.
Shah DM, et al.	Polytetrafluoroethylene Grafts in the Rapid Reconstruction of Acute Contaminated Peripheral Vascular Injuries. Am J Surg 148: 229-233, 1984	III		Review of 20 patients tx w/ PTFE. Mostly blunt trauma. 20% penetrating. Arterial repair before skeletal. Acceptable choice in contaminated wounds where rapid repair is necessary.
Menzoian JO, et al	A Comprehensive Approach to Extremity Vascular Trauma. Arch Surg 120: 801-805, 1985	III		Rev. 368 pt w/ UE/LE A/V inj. (89% pen). 70 pts w/ LE injuries. Recommend : repair artery before bone. Simple repair when feasible over grafting. Completion arteriography recommended. PTFE only if no vein available.
Meyer JP, et al	Peripheral Vascular Trauma From Close Range Shotgun injuries. Arch Surg 120: 1126-1131, 1985	III		Review of 49 pt w/ UE/LE/neck injuries due to SGW. LE 56%. Assoc. injuries present > 80%. All stable pts had A-gram. Ortho fixation & fasciotomy performed before arterial repair. All fx=s of LE stabilized w/ ext. fixation. 88% resex/vein graft(16% extra-anat), 10% repair or patch, 2% PTFE(extra-anat.). Most had systemic heparin. Conclusion: If stable preop angio helpful, most require vein graft, soft tissue coverage is important
Gomez GA, et al	Suspected vascular trauma of the extremities: the role of arteriography in proximity injuries. J Trauma 26: 1005-1008, 1986	III		72 pts had a-gram for proximity. 55/72 (76%) were nl. 17 had angio abnormalities but exploration was not warranted. 1 pt was explored & found to have spasm of a. & repair not needed.
Feliciano DV, et al	Delayed Diagnosis of Arterial Injuries. Am J Surg 154: 579-584,1987	III		Pt w/ hard signs were explored. Pt w/ soft signs including diminished pulse or proximity inj. were a-gramed. All clinically detected inj. were repaired. Pts w/ delayed dx of a.a. injury(28) were studied. 27 from pen mech. Delay ranged from 12 hr. to 26 yr. 64% delayed dx involved LE- tibioperoneals being the most common. These injuries were either repaired or embolized. Perioperative morbidity was considered significant.
Richardson JD, et al	Penetrating Arterial Trauma: Analysis of Missed Vascular Injuries. Arch Surg 122: 678-683, 1987	III		137 a.a. identified on surgical exploration. Some of these pt were explored for proximity, for hard signs, some had a-grams before exploration. 65% of the explored LE had a.a. injuries. The majority of inj. Were repaired w/ interposition v. graft followed by primary repair. 8 grafts thrombosed. There were 17 initially unrecognized injuries found on f/u. 8 missed by a-gram, 6 by exploration, 3 by

Rose SC and Moore EE	Angiography in patients with arterial trauma: correlation between angiographic abnormalities, operative findings, and clinical outcome. AJR Am J Roentgenol 149:613-619, 1987	III	sm gp of pts who had proximity a-grams & nl vasc. Exams w/ angiographic abnormalities who were TX=d nonoperatively. Concluded that nonoperative Tx of these lesions can be successful as long as there is no clinical evidence of vascular insufficiency.
Whitman GR, et al	Traumatic Popliteal and Trifurcation Vascular Injuries: Determinants of Functional Limb Salvage. Am J Surg 154: 681-684, 1987	III	Review of 47 pts(38% pen) w/ pop/trif a. injury. The majority repaired w/ v. graft. All had assoc. injuries. 79% had fasciotomy. The greater the number of associated injuries the worse the outcome.
Armstrong K, et al	Popliteal Vascular Injuries and War: Are Beirut and New Orleans similar? J Trauma 28: 836-839, 1988	III	Review of 76 pt w/ popliteal a. injury. Vein graft had 36% amputation rate vs. 11% for repair & 8% for end-to-end anastomosis. Vein graft group had more assoc. injuries.
Ashworth EM, et al	Lower Extremity Vascular Trauma: A Comprehensive, Aggressive Approach. J Trauma 28: 329-336, 1988	III	Review 25 pt w/ LE A/V injuries(84% pen). Anast or repair in 88%, 12% ligated-all tibial vessels. 96% limb salvage & 88% patency. Rec: completion angio, arterial repair before ortho, liberal fasciotomy.
Feliciano DV, et al	Management of Vascular Injuries in the Lower Extremities. J Trauma 28: 319-328, 1988	III	Review of 220 pt w/ LE A/V inj (82% pen). 39% resex/graft, 28% anast., 17% ligated, 7% repaired. PTFE had higher occlusion rates but was more commonly used. No amputations in the delayed Tx group. Rec. contralateral vein graft if graft required.
Feliciano DV, et al	Extraanatomic Bypass for Peripheral Arterial Injuries. Am J Surg 158: 506-9; 1989	III	Reviewed 12 pt w/ a and soft tissue injuries(67% pen). Extra-anat. RSV used. 92% w/ pulses at D/C. 1 pt w/ anastomotic blowout. Presented as another option for repair.
Stain SC, et al	Selective Management of NonOcclusive Arterial Injuries. Arch Surg 124: 1136-1141, 1989	III	All pts a-gramed for proximity & even w/ hard signs. All nonocclusive a.a. injuries detected were Tx=d nonoperatively if they were not hemorrhaging or had evidence of distal ischemia. Repeat a-grams obtained 1-3 wks after inj. 61 nonocclusive a.a. inj. were managed in this fashion. 44 of these were of major

			<p>a.a.- 20 in the LE. 17 minor. 5 pseudoaneurysms &amp; 5 AVF were embolized on f/u a-gram. 21 a.a. inj. were observed w/o f/u a-gram-all w/ nl vascular exams . 30 inj=d a.a had serial a-grams-all pt were clinically asymptomatic. Of the 6 minor a.a. inj. in this group 2 resolved,1 improved,1 stabilized, 2 progressed. 24 major a.a. were serially studied. 10 intimal defects-7 of which resolved or markedly improved on f/u study, 1 progressed but pt. Refused Tx., there were 4 intimal flaps-3 resolved,1 stabilized. 7 pseudoaneurysms-4 resolved,1 stabilized. Only one pt w/ major a. injury required operation.</p>
<p>Anderson RJ, et al</p>	<p>Reduced Dependency on Arteriography for Penetrating Extremity Trauma: Influence of Wound Location and Noninvasive Vascular Studies. J Trauma 30: 1059-1065, 1990</p>	<p>III</p>	<p>All pts w/ hard signs explored. Performed a-grams on 22 pts w/ SW for proximity all were neg. Performed a-gram on 412 gsw for proximity 368 (89.3%) were neg. Of the 44 pos. results 30 were explored. However of the surgical group there were 7 intimal flaps, 1 pseudo aneurysm &amp; 4 thrombosed nonessential a.a. that could have potentially been Tx nonoperatively w/ observation and embolization.</p>
<p>Peck JJ, et al</p>	<p>Popliteal Vascular Trauma: A Community Experience. Arch Surg 125: 1339-1344, 1990</p>	<p>III</p>	<p>Reviewed 108 pt w/ pop a inj. 63% had end-to-end anast., 37% had vein graft/patch. 6% amputation rate(both SGW). All SW?GSW w/ good results. Recommend operative exploration w/ hard signs. Vascular repair before skeletal repair.</p>
<p>Francis H, et al</p>	<p>Vascular Proximity: Is it a Valid Indication for Arteriography in Asymptomatic Patients? J Trauma 31: 512-514, 1991</p>	<p>III</p>	<p>160 a-grams performed on 146 pts w/ proximity injury (98% pen). 89% true neg. a-grams. 10.6% (17 pts)suggestive of inj. 6 were found to be false pos. on exploration, 4 pts w/ pos. study were not operated on. Of the 7 true pos. 6 were intimal injuries. 3.8% a-gram complications (hematomas). SGW were more likely to have asymptomatic injuries.</p>
<p>Meissner M, et al</p>	<p>Duplex Scanning for Arterial Trauma. Am J Surg 161: 552-555, 1991</p>	<p>III</p>	<p>69 LE studied out of 93 total study group. 65% done for proximity. API also measured. Duplex studies done for a variety of reasons. There were 25 abnl duplex. In the proximity group 4/60 scans were abnl.- mostly tibial vessels. &amp; a lg hematoma. Pts w/ signs of vascular injury 13/19 were pos.- 4 pseudoaneurysms, 4 occlusions, 1 laceration, 1 intimal flap, 1 AVF, 1 combined AVF/pseudoaneurysm. Some pts received post-op scans. 7/23 pts underwent surgery on basis of duplex alone. 4 pts had abnl a-gram &amp; nl duplex.</p>
<p>Bergstein JM, et al</p>	<p>Pitfalls in the Use of Color- Flow</p>	<p>III</p>	<p>Pt w/ hard signs were explored &amp; not included in study. Pts w/ soft signs or</p>

	Duplex Ultrasound for Screening of Suspected Arterial Injuries in Penetrated Extremities. J Trauma 33: 395-402, 1992		proximity were studied .CFD =s done first if not those performing/interpreting CFD were blinded to a-gram results. 72 neg. & 3 pos. CFD. A-gram revealed 4 pos. results. CFD 50% sensitivity, 99% specificity.
Cargile JS III, et al	Acute Trauma of the Femoral Artery and Vein. J Trauma 32: 364, 1992	III	Review 233 pt w/ femoral A/V inj (88% pen). 18% repair, 43% anast, 37% vein graft, 1% PTFE, 1% ligation. Rec: simple repairs, vein graft when graft necessary.
Padberg FT, et al	Infrapopliteal arterial injury: Prompt revascularization affords optimal limb salvage. J Vasc Surg 16: 877-885, 1992	III	Review 68 pt w/ infrapop a. inj. 50% pen. 21% of single a. injuries were ischemic & required repair. Others treated w/ ligation or observation. Rec: preop angio, most single vessel inj do not req. repair.
Fry WR, et al	The Success of Duplex Ultrasonographic Scanning in Diagnosis of Extremity Vascular Proximity Trauma. Arch Surg 128: 1368-1372, 1993	II	175 extremities were evaluated for proximity. Duplex detected 18 injuries, 17 confirmed by a-gram & 1 by surgical exploration. 1 false positive-a CFA spasm seen on a-gram. 7 unsuspected venous injuries detected. ABI only demonstrated 4 injuries.
Knudson MM, et al	The Role of Duplex Ultrasound Arterial Imaging in Patients with Penetrating Extremity Trauma. Arch Surg 128: 1033-1038, 1993	II	77 patients w/ proximity injury were studied. All pts had nl vascular exams including ABI. 4 pts w/ abnl color imaging underwent a-gram which confirmed injury. 3 of these patients did not require surgery. The remaining 73 pts w/ nl studies none developed signs or sx of vascular injury on f/u exams.
Schwartz M, et al	The Utility of Color Flow Doppler Examination in Penetrating Extremity Arterial Trauma. Am Surg 59: 375-378, 1993	III	12 pts w/ angiographically documented nonocclusive a.a. inj. from penetrating trauma that were managed nonoperatively had color flow Doppler exams to see if the injuries could be detected. 7/12 injuries detected.
Martin LC, et al	Management of Lower Extremity Arterial Trauma. J Trauma 37: 591-599, 1994	III	Pts w/ hard signs were explored w/o a-gram. Pts. W/ soft signs had a-gram. Pts w/ proximity injuries were observed. Arterial flow for the most part was restored prior to skeletal repair. Local heparin infusion was used. Systemic heparinization was used sparsely. Simple repairs ( lateral or end-to-end) were attempted as much as possible. PTFE or vein interposition grafts were used when necessary depending on the location, size of injured vessel and hemodynamic status of pt.

			<p>PTFE was used more than vein. No sig. Diff. in patency bet vein &amp; PTFE grafts. Vein grafts were used more frequently for popliteal repairs. None of the primary repairs of popliteal a. failed but 6/24 pts w/ interposition grafts failed at this site (2 vein &amp; 4 PTFE). All of these were from blunt trauma. 31/45 tibial a. injuries were not repaired. Int iliac, profunda, and single tibial a.a. injuries were uniformly ligated. Completion a-gram performed for popliteal &amp; distal a.a. but not for a.a. proximal to popliteal. Fasciotomy performed if clinically indicated, for prolonged ischemia time &amp; for combined A/V injuries.</p>
<p>DeGiannis E, et al</p>	<p>Arterial Gunshot Injuries of the Extremities: A South African Experience. J Trauma 39: 570-575, 1995</p>	<p>III</p>	<p>Reviewed 173 pt w/ UE/LE pen a. inj. 76% req=d graft ( vein&gt;PTFE). PTFE used when vein not available, vein diameter &lt; 6 mm, or when speed was of essence. Pt w/ hard signs taken to OR w/o angio, all w/ pos. exploration. 13 pt w/ soft signs had angio- 9 were pos. Completion angio only performed when distal pulse nonpalpable. Early revascularization is important. W/ femoral a. no difference in patency rates vs. PTFE</p>
<p>Melton SM, et al</p>	<p>Popliteal Artery Trauma: Systemic Anticoagulation and Intraoperative Thrombolysis Improves Limb Salvage. Ann Surg 225: 518-527, 1997</p>	<p>III</p>	<p>Reviewed 102 pt (61% pen) w/ pop a. inj. 56% primarily repaired. 2 pt w/ PTFE failed &amp; req=d amputation. 52% had systemic heparin. Recommend use of heparin and simple repairs when possible</p>