

**INFECTIONS AFTER ELECTIVE  
BYPASS SURGERY FOR LOWER  
LIMB ISCHEMIA: THE INFLUENCE  
OF PREOPERATIVE  
TRANSCUTANEOUS  
ARTERIOGRAPHY**

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# Infections after elective bypass surgery for lower limb ischemia: The influence of preoperative transcutaneous arteriography

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*The relationship between the site of arteriography and groin infection has been examined in 1,173 cases. Of 39 wound complications, 81% occurred on the side that arteriography was performed on and only 15% on the opposite side. One (3%) occurred after transaxillary arteriography. It is suggested that the global trauma of transfemoral arteriography predisposes to postoperative groin infection.*

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INFECTION represents one of the most serious complications that can occur after arterial surgery, and groin incisions have been found to be especially prone to infection. A number of explanations for groin infections have been advanced. However, we fortuitously observed that the majority of graft infections after aortobifemoral bypass surgery seemed to develop in the right side of the groin. Furthermore, it was found that arteriographic procedures usually were performed via the right femoral approach, apparently because this approach is more accessible for a right-handed person carrying out angiography. Thus a relationship between preoperative arteriography and postsurgical wound infection was suspected. It is common to see poorly healing skin punctures with considerable hematoma in the underlying tissues after arteriography.

To examine the relationship between preoperative arteriography and postoperative wound complications and infections, a retrospective analysis of 1,173 patients who had undergone surgery for lower limb ischemia at our university and Veterans Administration Hospitals was undertaken.

## CLINICAL MATERIAL

A total of 1,173 patients who underwent elective bypass or other prosthetic surgery for lower limb

ischemia between 1972 and 1981 was analyzed. Only those patients with a femoral incision were included. All patients had undergone transcutaneous arteriography within 30 days prior to surgery. The distribution of case material between the two hospitals and the surgical procedures are shown in Table I.

## RESULTS

Thirty-nine groin wound complications occurred for an overall incidence of 3.3%. A bacterial contaminant was identified in 31 of the 39 wound complications; thus the majority of the complications were infective. Nevertheless, the term "complication" will be retained to cover the entire group of 39 cases. A wound complication was defined as an event that resulted in an open groin wound with discharge of serum or hematoma or pus in the postoperative period. Only group II and III wound infections, as classified by Szilagyi et al.,<sup>7</sup> were considered. Very superficial dermal infections were not included. All wound complications that occurred are further categorized in Table II. The incidence of graft sepsis was 0.8%. All therapeutic incision and drainage procedures were included as wound complications.

Among the 1,173 patients, arteriography was performed by the transaxillary route in 158 (13.5%). In all others arteriography was performed through the inguinal approach, predominately through the right side (Fig. 1, A). There was a significant increase in the incidence of postoperative groin wound complications when arteriography was performed through the transfemoral rather than the transaxillary approach (3.7% vs 0.6% [ $P < 0.05$ ]). The distribu-

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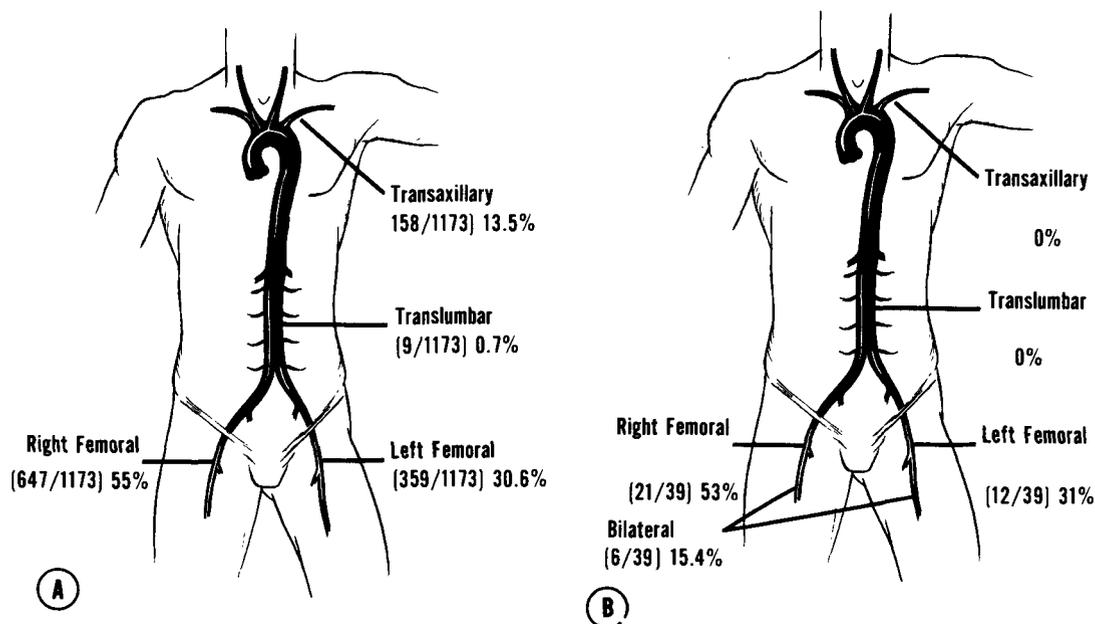


Fig. 1. The striking similarity between the distribution of skin puncture sites for arteriography (A) and the sites of subsequent postoperative wound infections (B) is demonstrated.

Table I. Types of vascular procedures performed in 1,173 patients\*

Procedure	No.	Hospital	No.
Aortofemoral	857	University of Mississippi Medical Center	746
Iliofemoral	21	Veterans Administration Hospital	427
Femoropopliteal	191		
Axillofemoral	76	1,173 Total	
Femorofemoral	83		
Profundoplasty	59		
Other	9		

\*Multiple procedures are included separately.

tion of femoral wound complications between the right and left sides (Fig. 1, B) has a striking similarity to the distribution of arteriographic skin puncture sites. Among 39 wound complications, 15% (6 of 39) were bilateral. Of the remaining 33 cases, 81% (27 cases) occurred on the same side as the presurgical arteriographic skin puncture site. A wound complication occurred in the opposite groin site in only five instances (15%). One wound complication (3%) occurred after a transaxillary arteriogram was taken. The incidence of wound complications was lower (1.8%) if surgery was carried out within 24 hours after arteriography or if there was a delay of 7 or more days between arteriography and surgery. There was an incidence of 3.8% wound complications when surgery was carried out between 2 and 6 days after

Table II. Types of wound complications encountered

Complications	No.
Hematoma	26
Seroma	4
Abscess	7
Aneurysm	2
Total	39

arteriography (Table III). These differences, however, were not statistically significant. Eight percent of the case population (93 cases) under study was subjected to a second or multiple surgical procedures for graft thrombosis, embolectomy of the distal

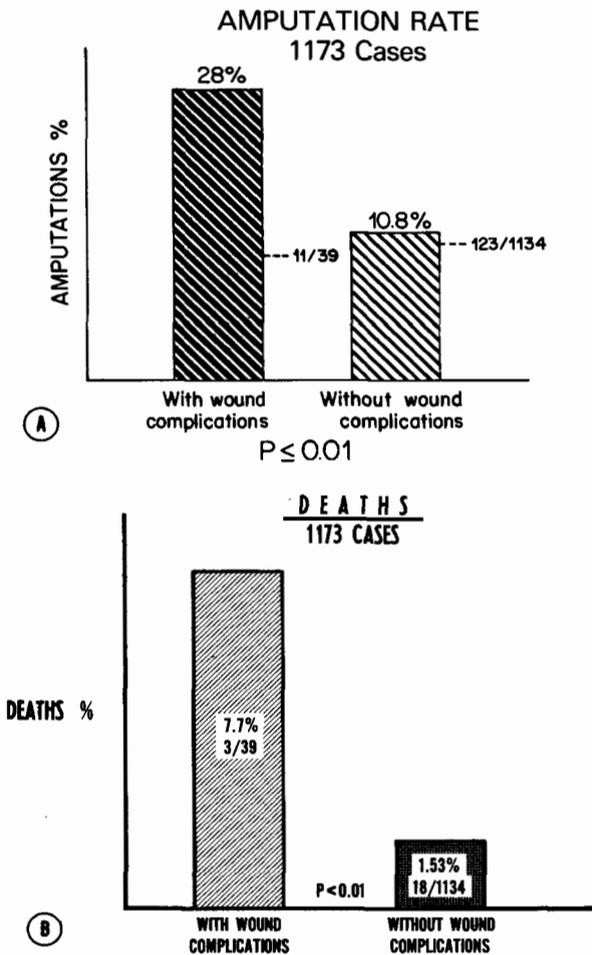


Fig. 2. The significant increase in the amputation rate (A) and the mortality rate (B) after wound complication is shown.

arteriography or other reasons. In this small group of patients, the peak incidence of wound complications appeared to occur with a 4-day interval between arteriography and surgery. The list of bacterial flora isolated from 31 wound infections is shown in Table IV. Single organism infections were rare, most being mixed gram-positive and gram-negative infections. Graft infections generally resulted in higher amputation and mortality rates (Fig. 2). Among the 1,173 patients studied, nearly 18% (211 cases) had preexisting gangrene or limb infections before graft insertion. The incidence of culture-positive wound infections in this subset of patients was significantly increased (5.6%) compared to the overall group (2.9% [ $P < 0.05$ ]). There was no significant association between diabetes and the incidence of postoperative wound infection. Other factors analyzed for

Table IIIA. Single surgical procedure (1,080 cases)

Time interval between arteriography and surgery	Infections/Cases	Incidence %
0 hr: Day 1	3/167	1.8
Day 2: Day 7	30/782	3.8
Day 8: Day 14	2/105	1.9
14 Days	0/26	0

NOTE: Peak incidence day 4.

Table IIIB. Multiple surgical procedures (93 cases)

Time interval between arteriography and surgery	Infections/Cases	Incidence %
0 Hr: Day 1	0/9	0
Day 2: Day 7	3/67	4.5
Day 8: Day 14	1/13	7.6
14 Days	0/4	0

possible correlation with postoperative wound infection included age, sex, race, length of surgery, and obesity. No significant association was found. Several clinical parameters, such as fever and elevated white cell count, were analyzed for their predictive value of wound infection. Consistent association was not present in about 50% of the cases.

## DISCUSSION

The relatively low incidence of wound complication and graft sepsis in this group of 1,173 patients is not unlike that reported by other major centers.<sup>4-7</sup> However, once a wound complication sets in—although this rarely occurs—there is a dramatic increase in morbidity and mortality rates; this is well noted in this series and others.<sup>1-4-7</sup> The continuing effort to reduce the incidence of wound complications even below the current low levels is therefore highly desirable. It is generally agreed that a great majority of wound complications after bypass surgery occur in the inguinal incision. Several explanations have been offered for the predisposition of the inguinal incision to wound complications and sepsis: (1) There is chronic colonization of staphylococcus and other pathogens in the inguinal skin, especially in obese patients prone to intertrigo in skin folds.<sup>7</sup> (2) A longitudinal inguinal incision cuts across Langer's lines, leaving a gaping incision that readily permits bacterial contamination.<sup>1, 5</sup> (3) Hematoma formation around the femoral anastomosis after graft

insertion is frequent.<sup>5</sup> This hematoma may be a frequent source of infection. (4) The femoral region has an abundance of lymph nodes and lymphatics that are invariably incised during exposure of the femoral vessels. Postoperative seepage of lymph in the area leads to fluid collection underneath the wound, predisposing to sepsis. In those instances where there is preexisting gangrene or infection in the distal limb at the time of surgery, the lymph seeping out into the wound may be contaminated with bacteria carried from the infected area, providing a source of wound sepsis.<sup>1-4</sup> (5) Because of the lack of extensive soft tissue cover, especially in thin patients, prosthetic grafts are superficially situated underneath the skin incision in the inguinal area.<sup>4-5</sup> This allows the prosthesis to become involved in even relatively superficial infections of the subcutaneous tissue. This tendency may be further aggravated by a delay in the formation of a fibrous sheath around the prosthesis because the mobility of the hip joint results in considerable motion of the graft itself.<sup>5</sup>

It should be noted, however, that several of these explanations, although plausible, do not have supportive documentation in the literature.<sup>1</sup> The present study offers yet another explanation for the predisposition of groin incisions to wound complications. It is suggested that tissue trauma, hematoma formation, and possible bacterial contamination introduced at the time of percutaneous transfemoral arteriography predispose to later wound complication and sepsis in this area. It has been shown in this study that the incidence of postoperative inguinal wound complications is much higher when transfemoral rather than transaxillary percutaneous angiography was carried out in the preoperative period. Furthermore, there was a preponderance of right-sided groin wound complications corresponding to the preponderance of right femoral skin punctures for arteriography. Ipsilateral wound complication occurred five times as frequently as contralateral wound complications after transfemoral arteriography.

Although a relationship between preoperative percutaneous arteriography and subsequent wound complication in the area is suggested by this study, the mechanism remains obscure. It is not uncommon to witness a considerable hematoma after arteriography that suffuses the tissues several inches away from the skin puncture site. Fat necrosis and tissue trauma are often present around the catheter tract, especially when the arteriography procedure is prolonged and difficult. Bacterial contamination

**Table IV.** Organisms in wound infection (31 cases)

Gram positive		Gram negative	
<i>Staphylococcus aureus</i>		<i>Escherichia coli</i>	9
Nonpenicillinase	15	<i>Klebsiella</i>	6
Penicillinase	3	<i>Pseudomonas</i>	2
		<i>Bacteroides</i>	2
<i>Streptococcus pyogenes</i>	1	<i>Enterobacter</i>	3
<i>Enterococcus</i>	9	<i>Proteus mirabilis</i>	2
		<i>Serratia</i>	2
Total	28	Total	26
%	52	%	48

NOTE: Eighty-seven percent were mixed infections.

through the skin puncture site could conceivably occur during arteriography if strict standards of sterility and technique are not maintained in the angiography room. The degree of bacterial contamination required to cause a wound infection in healthy tissues is very high,<sup>2</sup> but a relatively low level of contamination may suffice in the presence of tissue trauma and hematoma.<sup>2</sup>

It is also possible that subclinical dermal infection secondary to the shaving of the skin in preparation for arteriography may be a source of postoperative wound infection.

As a preventive measure it may be suggested that all patients undergoing arteriography should be covered with antibiotics according to the schedule described by Burke.<sup>2</sup> However, the value of prophylactic antibiotics is not universally accepted.<sup>1,4,7</sup> Several major vascular centers<sup>1,7</sup> do not use antibiotics in this fashion and have nonetheless experienced a low incidence of septic complications.

Graft anastomosis to the iliac artery segment rather than to the femoral artery has been shown to reduce the incidence of postoperative wound infection.<sup>1</sup> Although such an approach might be considered when there is extensive hematoma formation after arteriography, this may not be practical in patients with extensive disease of the femoral segment necessitating graft insertion close to the origin of profunda femoral artery. In some instances particular effort must be directed to covering the graft with viable soft tissue, such as the sartorius muscle.<sup>4</sup> Since patients with preexisting limb gangrene and tissue necrosis are shown to be particularly prone to wound complications in this study, consideration should be given to transaxillary rather than the transfemoral approach for arteriography in such patients. Our data reveal a peak incidence of wound

complications when the interval between arteriography and surgery is about 4 days. Although the figures are not statistically significant, there does appear to be a trend toward a lower incidence of wound complications when arteriography precedes surgery by only a few hours or when there is a delay of at least 2 weeks.

A variety of factors traditionally associated with increased wound complications such as obesity, old age, and diabetes was shown to have no such correlation in this study. However, as already stated, preexisting limb gangrene or infection was found to be associated with a significantly higher incidence of postoperative wound complication. As previously reported from this institution,<sup>3</sup> the bacterial flora retrieved from wounds after graft insertion appear to be undergoing a shift from gram-positive to gram-negative organisms. *Staphylococcus aureus*, however, was the single most commonly identified organism.

## SUMMARY AND CONCLUSIONS

In an analysis of 1,173 cases, percutaneous transfemoral arteriography appears to predispose to an increased incidence of postoperative wound complications in the inguinal incision. The possible mechanisms involved and preventative measures were discussed.

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## DISCUSSION

**Dr. William J. Fry** (Dallas, Tex.). I compliment Drs. Landreneau and Raju on a fine presentation and analysis. In most radiology suites arteriography obviously is performed under less-than-sterile conditions because of the amount of time required. Contamination can occur from the area of the groin, from the catheter, and from the

multiple personnel required to perform the procedure.

Often at operation a large area of hematoma is found and if there is concomitant open ischemic ulceration, it is obviously going to be seeded with bacteria. In such instances we prefer not to utilize the groin for arteriography but to use an alternative route such as the transaxillary-or translumbar-type procedure.

Also, as the authors pointed out, meticulous hemostasis must be accomplished at operation, and cleaning of any clot or other hematoma will be helpful in the event of the hematoma being present from the arteriogram. In the case of the individual with a hematoma and a potential source of contamination, we recommend covering the graft with viable muscle, such as the sartorius muscle. This helps preclude the chance of open infection. I think careful cultures and antibiotic coverage of the patient prior to the time of arteriography and the continual use of those cultures for determination of sensitivity during operation is paramount in eliminating or at least reducing the incidence of infection to its lowest level.

**Dr. Wesley S. Moore** (Los Angeles, Calif.). The overall incidence of actual graft sepsis of 0.8% is quite low, nonetheless any factor that contributes to an increase in wound complication has the potential for resulting in graft sepsis. It was interesting that the incidence of wound complication was low if the operation was performed within 24 hours of angiography in contrast to a rapid increase in the incidence of complication if the operation was performed after a 24-hour interval. This is similar to what happens to wound infection rates when the time interval between shaving a surgical field and subsequent operation is examined.

Are your patients routinely shaved prior to angiography, and, if so, will you consider asking your angiographers not to do this, since I doubt if shaving improves the field for angiography?

Are you routinely using the antibiotic prophylaxis at time of operation, and, if not, would you consider doing that on the basis of your current data?

**Dr. John O. Roehm** (Houston, Tex.). As a vascular radiologist, I—along with my surgical colleagues—was concerned about the implications of this article.

At the Methodist Hospital in Houston, the surgeons of the Baylor College of Medicine prefer to perform surgery as soon as possible after arteriography to minimize anatomy change in the occlusive disease and to minimize the degree of inflammatory response in the groin soft tissues that occur after percutaneous catheterization and is characteristically well developed 1 week after the catheterization. Surgery is usually performed the first or second day after arteriography. The patients are shaved and are not covered with an antibiotic before arteriography.

A review of our surgical records for occlusive disease over a 12-month period from July 1, 1979, to June 30, 1980, revealed 203 cases of aortobifemoral bypass grafts and 143 cases of femoral-popliteal or femoral-tibial bypass graft, for a total of 346 cases of groin dissection for

occlusive disease after transfemoral arteriography in this 1-year interval. There were no infections. Extrapolation of this over the past 9 years produced a figure of between 2,000 and 3,000 such cases without any recognized relationship between percutaneous transfemoral arteriography and graft infections.

Further, at our institution, an examination utilized without undue concern is the immediate postoperative percutaneous arteriogram in patients who have undergone difficult operative procedures, often for complicated extensive total abdominal or thoracoabdominal aortic aneurysms. Immediate postoperative arteriograms are accepted as routine in these patients if there is any concern about patency of reattached or endarterectomized visceral vessels, intraoperative visceral artery embolization, or even perioperative bleeding. Immediately after skin closure, these patients are moved to the angiography suite while still under general anesthesia. They are then taken to the adjacent intensive care unit or returned to the operating room. Percutaneous aortography and selective arteriography of the reattached visceral arteries in these patients

with fresh grafts has not resulted in a single instance of graft infection or bleeding.

In light of our excellent experience, we think that the authors should initiate examination of technical factors, both arteriographic and surgical, and leave the procedure of preoperative percutaneous arteriography without indictment.

**Dr. Seshadri Raju** (closing). Dr. Fry, we agree that antibiotics should be used in patients at high risk for groin wound infections. Patients with an already present source of infection such as a gangrenous or necrotic toe at the time of arteriography will fall in this category.

Coverage of the prosthesis by the sartorius muscle in the femoral incision is indeed a useful technique, especially in patients with sparse subcutaneous tissue.

Dr. Moore, our patients are shaved for arteriography but are not routinely covered with antibiotics. As a result of this study, we intend to change these practices appropriately.

Dr. Roehm, thank you for bringing to our attention your extensive experience with no infections.