Embolectomy

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Embolectomy was performed by Dr. Powell in 1911. The lack of initial enthusiasm for embolectomy can be traced to the extensive dissection required to extend the clot and remove the embolus and its propagated thrombus, as well as the frequent lack of clinical success. The technique of balloon catheter embolectomy was greatly improved and expanded in 1963 by the introduction of arterial tree until it impacts a site of luminal narrowing, usually at an arterial bifurcation. It is the location of the embolic occlusion and the events subsequent to its impaction that determine the eventual viability of the dependent structure.

When acute embolic occlusion occurs in a major artery, a soft coagulum of blood forms in the adjacent proximal and distal arterial segments secondary to stagnant flow. The occlusive process is thus extended as the clot propagates along the arterial tree, progressively embarrassing the important collateral pathways (Fig. 1). It has long been recognized that the extent of distal thrombotic propagation is the primary determinant of outcome after embolic arterial occlusion; failure to recognize and remove the distal thrombus results in incomplete restoration of circulation and possible loss of limb. In approximately one third of instances, distal circulatory stasis results in the development of discontinuous distal thrombosis. Backbleeding is an unreliable indicator of distal patency. Its presence may be secondary to remaining unobstructed collateral vessels. Full-length passage of the embolectomy catheter is the only means of ensuring complete clot removal (Fig. 2).

Although most clinically significant emboli originate within the heart, the vessels of the lower limbs are the site of impaction in approximately 90% of the surgically treatable emboli (Fig. 3). The bifurcations of the aorta and femoral and popliteal arteries are the principal sites of impaction. Multiple emboli are more common than is generally accepted, and, in approximately 10% of instances, they involve more than one limb. Many smaller emboli undoubtedly lodge in well-vascularized “silent” arterial beds and are never recognized.

The tissues distal to the impacted embolus and associated thrombus are deprived of adequate oxygenation. Because of the sensitivity of peripheral nerve tissue
to ischemia, pain and paresthesias are quickly noted in the affected limb. Continued cellular ischemia leads to anaerobic metabolism with local lactic acidosis and cell death, accompanied by nerve and muscle necrosis. Although local factors determine the rate of ischemic damage, diagnosis and therapy must be prompt because tissue necrosis may occur within 6 hours, and is a frequent occurrence after 12 hours of profound ischemia.

**DIAGNOSIS**

The sudden onset of symptoms of profound limb ischemia should immediately suggest the diagnosis of arterial embolus, particularly in a patient with atrial fibrillation, recent myocardial infarction, or abdominal aortic aneurysm. In more than 85% of instances, the clinical presentation and associated disease allow differentiation between embolic occlusion and arterial thrombosis. This differentiation is useful in planning the surgical approach because additional vascular reconstructive techniques are often required with arterial thrombosis but are rarely needed with embolization. The characteristic clinical presentation of acute embolic occlusion is an abrupt onset without warning; it consists of the embolic syndrome of pain, paresthesia, pallor, paresis, and paralysis.

The initial examination should focus on the presence and amplitude of all arterial pulsations in the limb. The color and temperature of the limb, the presence or absence of sensation and proprioception, the level of motor movement are related to the time of onset of pain. In addition, arterial blood flow should be evaluated and recorded by Dopple technique. In most instances, the diagnosis can be confirmed and the site of impact localized by history and physical examination alone. It is an almost universal finding that the site of embolic occlusion is usually a major arterial bifurcation above the absent arterial pulsation.

Patients with suspected renal embolism should undergo a selective arteriogram. Arteriograms also be helpful in delineating the morphology, if noninvasive studies suggest extensive atherosclerotic involvement. Time-consuming studies that may compromise the ischemic limb should be avoided.

Because virtually all patients with arterial embolism have associated cardiac disease, a careful evaluation of cardiovascular function is necessary before surgery.
preoperative management

Instrumentation

Although the Fogarty embolectomy catheter has undergone minor modification to improve its effectiveness and safety since its introduction in 1961, the general concept remains unchanged. The embolectomy catheter consists of a hollow, pliable catheter body with a soft, distensible balloon placed at its tip. It is available in graduated sizes from No. 2 to 7 French. A syringe fitting at the proximal end allows controlled inflation and deflation of the balloon. A soft, rounded extension of the balloon material covers the tip of the stiffer catheter body. The smaller catheters are constructed with a flexible spring tip to further reduce the chance of intimal damage or arterial perforation. Each size of catheter has been calibrated for an optimal level of balloon distention, and that recommended volume should not be exceeded. Overinflation does not produce a considerable increase in balloon diameter, but results in decreased fluid displacement within the balloon and increased pressure on, and possible damage to, the vessel wall.

Saline solution is the routine balloon inflation medium; however, air is more appropriately used with the No. 2 and 3 French catheters. Because air is considerably more compressible than saline solution, the balloon exerts less force on, and is less likely to cause damage to, the smaller vessels. In addition, the operator has considerably more control over balloon size because the delay between syringe manipulation and balloon response is minimized.

The general aspects of embolectomy catheter manipulation are as follows. The instrument is threaded into the artery and passed either through the thrombus or between the thrombus and the vessel wall. It is virtually impossible to "push" an embolus and its associated thrombus with a deflated catheter. Although the pliability of the catheter tip is designed to facilitate safe proximal or distal passage, forceful probing at sites of nonembolic obstruction can lead to vessel wall injury and resultant arterial occlusion. Embolic material and associated thrombus do not, in themselves, offer significant resistance to catheter advancement.

Even in the absence of large amounts of atherosclerotic plaque, passage of the instrument may be hindered by angulation at bifurcations or by vessel tortuosity. Maneuvers often helpful in these circumstances include preforming the tip of the catheter at an angle, a step that is followed by the rotation of the catheter at the site of obstruction, the simultaneous introduction of more than one catheter, and the progressive flexion of a nearby joint to alter the advancement angle of the catheter tip. An additional technique particularly useful in passing an eccentric plaque involves gentle balloon inflation at the site of the difficult catheter passage, followed by gentle advancement of the catheter during deflation. This maneuver brings
Fig. 4. The technique of Fogarty catheter embolectomy with catheter insertion in the distal vessel.

When the appropriately sized catheter has been gently advanced as far as possible, the balloon is progressively inflated while the catheter is being slowly withdrawn (Fig. 4). The surgeon who withdraws the catheter should also control balloon size because the "feel" that the surgeon gains in this manner is an important factor in ensuring complete clot retrieval and preventing vessel damage. When "traction" on the catheter appears excessive, it is imperative to allow sufficient balloon deflation to permit smooth passage across segments of atherosclerotic luminal narrowing. As catheter withdrawal continues, additional fluid should be added as needed to maintain gentle wall contact. The catheter is so constructed that inflation takes place initially only in a 1-cm area in the center of the balloon jacket. The increased resistance engendered by mild atherosclerotic plaque causes displacement of fluid to the uninflated portion of the balloon, allowing the catheter to "glide" across areas of mild constriction without causing undue trauma to the wall (Fig. 5).

**SURGICAL TECHNIQUE**

**Extraction of Aortic and Iliac Emboli**

In the surgical management of an aortic embolus, bilateral vertical groin incisions are made and the common, superficial, and deep femoral (profunda femoris) arteries are isolated and looped with Silastic (polymeric silicone) tapes. In the presence of atherosclerotic involvement of the femoral artery, it is suggested that Fogarty-Hydragrip vascular clamps be used to allow atraumatic vessel occlusion, particularly with the catheter in place. This clamp, with a pressible fluid-filled jaw, allows approximation of surfaces without causing undue trauma (Fig. 6).

After placement of the clamp just proximal to its bifurcation, strumuization of the superficial femoral orifices under direct vision should be carefully performed. The location of plaque should be determined, though it is preferable to perform arteriotomy, and then the lower end of the vessel may be dissected from the plaque. The location of plaque may dictate an oblique or even vertical incision. In the event of luminal narrowing during closure, it is useful to perform a "tongue-in-groove" repair, if luminal narrowing persists. If luminal narrowing persists, a vein patch angioplasty is the preferred approach.

We prefer to carry out the operation initially (Fig. 7). Depending on the size of the vessel, a No. 5 or 6 catheter is gently introduced into the superficial femoral artery or the iliac arteries.
Technique of Fogarty catheter arterial embolec- cyte of the iliofemoral system.

and inflated until the arterial wall mild resistance. The catheter is drawn with the balloon in the intro- and then withdrawn to extract the vessel increases.

resistance during the introduc- the catheter, gentle probing usually instrument to pass. The catheter distally without extreme force; attempts to force the catheter to complications. During the ex- of the catheter, only mild traction is to remove embolic material or a bus. The deep femoral artery is a similar manner, but the No. 3 catheter in this vessel rarely beyond a distance of 25 cm. Care taken so that the catheter is intro- the deep femoral artery and not the large circumflex branches, an early origin from this vessel. If a flex branch is explored, it should that the catheter can be intro- for a short distance, and the No. French catheter should be used for successful exploration of the distal 30 mL of heparinized solution of heparin in 250 mL of in- via the Thru-Lumen embolec- (Baxter Vascular Division, and the vessels are occluded early clamps. A No. 6 French amy catheter is placed in the common femoral artery and threaded into the aorta. The balloon is inflated with the appropriate amount of fluid and extracted in the inflated position. During the process of extraction, the balloon can be deflated to accommodate the narrowed vessel. The procedure should be repeated if a forceful, pulsatile flow is not obtained on the first passage. Significant bleeding, even somewhat pulsatile, may occur from the proximal common femoral artery in the presence of partial continued obstruction, and repeated passes should be made until one is confident that all obstructing thrombi have been removed. To reduce blood loss, the embolectomy catheter can be passed through the jaws of the Fogarty clamp without causing undue trauma or blood loss. It is best accomplished by plac- ing Hydragrips on both blades of the clamp. Immediately before the balloon portion of the catheter is removed from the artery, the clamp is released, the catheter is removed from the arterial inci- and the clamp is reapplied. After ade- quate extraction of the clot from one side, a similar procedure is performed on the opposite limb. Both arteriotomies are closed after ensuring bilateral simultaneous pulsatile flow.

It should be mentioned again that the presence of backbleeding is no assurance that distal patency has been established be- cause collateral circulation may result in vigorous backbleeding, even in the presence of distal arterial thrombus. If the status of the distal arterial tree is uncertain, oper- ative angiography should be performed.

In the removal of an iliac embolus, the incision is made only on the affected side. Both limbs are prepared for surgical inci- sion because of the small but real possibility of dislodging a high iliac embolus, with subsequent occlusion of the previously un- affected contralateral vessel.

Extraction of Femoral and Popliteal Emboli

In early experience with emboli below the inguinal ligament, incisions were made over what was thought to be the site of embolic occlusion. It has been found, however, that a more satisfactory approach to removal of emboli at the level of the adductor magnus tendon and the popliteal areas is through an incision in the distal common femoral artery. This proximal approach to accessing emboli lo- cated at a lower level has several advan- tages. It allows exploration of the deep femoral system, which can be occluded with additional thrombotic material. If the embolus is in the common femoral artery, digital pressure proximal to the em- bolus may squeeze the embolus out and reestablish forceful, pulsatile flow. Even in this circumstance, however, an embolec- tomy catheter should be passed prox- mally, inflated, and then withdrawn to ex- tract any residual thrombotic material that may be loosely adherent to the intima. Because of the presence of discontinuous distal thrombosis in more than one third of the instances of acute proximal embolic occlusion, catheters are threaded distally, regardless of the presence or absence of backbleeding from the superficial femoral artery.

Thrombotic material can be extracted from two or more branches of the popliteal artery by inserting multiple catheters in the superficial femoral artery. The No. 2 and 3 French catheters should be used for this purpose. The first catheter most commonly passes into the peroneal or posterior tibial artery. After initial placement of one catheter, the leg is placed in a slightly flexed position and a second catheter is inserted. In this manner, the second catheter is de- flected from the obstructed orifice of the previously cannulated vessel and may find its way into an unobstructed channel. Exam- ination of the thrombus can provide valuable information about the comple-teness of clot removal. The presence of a sharp cutoff usually indicates that additional thrombotic material remains, whereas a smooth taper indicates adequate clot removal.

When thrombus remains in the tibial vessels and efforts to remove it from above prove unsuccessful, a direct approach to the distal popliteal artery is required through a second incision made medially at the knee. The distal popliteal artery is exposed and the proximal portions of the anterior and posterior tibial arteries are looped with Silastic tapes (Fig. 8). Through a small inci- sion in the distal popliteal artery, the No. 2 and 3 French embolec- tomy catheters should be directly introduced into the anterior and posterior tibial arteries, respect- ively. If these vessels were previously patent and uninvolved in an arterioscle- rotic process, the No. 2 French catheter should be passed beyond the ankle joint. The course of the catheter can be felt by placing the fingers over the distribution of the anterior and posterior tibial arteries. If the catheter is hindered at the ankle joint, it can frequently be passed farther by plantar flexion of the foot.

Inability to pass the No. 2 French catheter beyond the ankle joint in the presence of angiographic evidence of
Adherent Clot Catheter

The ACC consists of a No. 4 or 6 flexible catheter body with an adjusting pitch, corkscrew-shaped distal tip (Fig. 9). The corkscrew balloon consists of a balloon membrane covering an outer, flexible, polyethylene tubing that is loosely spiraled around an inner wire running the length of the catheter. A control handle at the proximal end of the control handle allows the surgeon to adjust just the pitch and diameter of the corkscrew from completely spiral fully spiraled. Unlike the conventional Fogarty balloon catheter, the ACC does not inflate. Instead, the diameter of the corkscrew-shaped working end of the catheter is varied by mechanical retraction of the inner wire via a knob on the control handle. In this manner, the device can be continuously adjusted from profile No. 6 French size to a larger profile of up to 10 mm.

The ACC is used like the conventional Fogarty balloon catheter. After initial exploration with the standard balloon catheter, the ACC tip is collapsed to its low-profile position and passed into the vessel and beyond the thrombus. The tip is then advanced until the spiral is enlarged to the desired diameter, thereby engaging the thrombotic material within the spaces of the spiral. Subsequently, the catheter is withdrawn slowly back along the vessel and the material is retracted through the arteriotomy. As in the conventional balloon catheter technique, the diameter of the spiral can be adjusted according to "feel" in response to resistance within the vessel.

The ACC's mechanism of entrapping the clot is thus quite different that of the conventional balloon catheter. The traditional Fogarty balloon is distal to the material and essential to the thrombus along the vessel toward the arteriotomy. In contrast, the catheter entraps thrombotic material within the spaces of the spiral, providing a larger of contact to grip and remove extraction from a brachial arteriotomy. It should always be borne in mind, however, that if the embolus appears to reside in proximity to the origin of the cranial vessels, fragmentation of the embolus may occur during manipulation, resulting in central nervous system emboli and ischemia.

Removal of Mature Adherent Thrombotic Material

As the patient population becomes increasingly elderly and more prone to atherosclerosis, mature adherent thrombotic lesions are becoming more prevalent. The standard fluid-filled Fogarty balloon catheter may be quite effective for removing large amounts of soft, fresh thrombus, but it is limited in its ability to remove more adherent material, such as old clot of thrombotic origin. To meet this need, two new tools have been designed: an adherent clot catheter (ACC) and a graft thrombectomy catheter (GTC).

Extraction of Upper-Limb Emboli

The technique for management of emboli to the upper limb is identical to that described for the lower limb. Proximal subclavian artery emboli can be routinely removed under local anesthesia by retrograde extraction from a brachial arteriotomy. It should always be borne in mind, however, that if the embolus appears to reside in proximity to the origin of the cranial vessels, fragmentation of the embolus may occur during manipulation, resulting in central nervous system emboli and ischemia.

FIG. 8. Technique of popliteotibial exploration.

FIG. 9. The adherent clot catheter, in its extended position (top) during catheter introduction and contracted position (bottom) during retrieval of adherent material in native vessel.
the latex-covered edges of the fully corkscrew provide more of a sharp edge than an inflated balloon, allowing this catheter more capable of removing material adhered to the inside vessel wall.

The ACC is designed for use in both vessels and synthetic grafts in situations that require a slightly more aggressive approach to retrieve a particularly fresh clot, embolus, or flap that has not been removed by a conventional balloon catheter. The catheter system is appropriate for vessels whose diameters range from 4 to 10 mm. One particular indication of this catheter is the thrombectomy of arteriovenous fistula grafts, in which a more thorough removal of thrombotic material is often a viable alternative to graft revision or replacement.

Thrombectomy Catheter

The development of the Thru-Lumen embolectomy catheter has provided additional options for embolectomy and thrombectomy. The catheter is similar to a conventional Fogarty embolectomy catheter, except that an additional lumen runs through its center. A Y-connector at the proximal end has two extensions that allow access to the two lumens. One lumen is used for balloon inflation and the other is used for infusion of fluids or guidewire access (Fig. 12).

Whereas the standard Fogarty balloon catheter was designed in an era in which there was limited angiographic capability in the operating room, the Thru-Lumen embolectomy catheter has been designed to take advantage of the wide availability of fluoroscopy in today's operating rooms. The Thru-Lumen catheter can be passed over a guidewire, which can be monitored fluoroscopically. In situations of difficult access, when a standard Fogarty balloon catheter cannot be passed through the obstruction, a tapered Van Andel catheter can be substituted. A guidewire can then be placed through the Van Andel catheter. Subsequently, the Van Andel catheter can be removed and replaced with a Thru-Lumen embolectomy catheter. The Thru-Lumen catheter can then be inflated and used for embolectomy in its normal manner.

Fig. 11. The graft thrombectomy catheter is shown with residual clot, which could not be removed adequately with a balloon catheter, that has been extracted from a synthetic graft.
The Thru-Lumen embolectomy catheter also can be used to deliver contrast material to monitor fluoroscopically the clot removal process without exchanging the embolectomy catheter for an angiographic catheter. The inflated balloon can also act as an occlusion device to facilitate distal localized injection of fluids, such as contrast media, heparin, or lytic agents.

**Management of Advanced Ischemia**

Patients who have relatively far-advanced peripheral ischemia represent more difficult problems. The recognition and treatment of complications that occur as a result of advanced tissue ischemia lessen mortality and morbidity. The finding of acute venous thrombosis in the presence of acute arterial occlusion was first recognized in 1964. It was found that 27% of patients who had sustained an acute arterial occlusion also had simultaneous venous occlusion, and venous thrombectomy was required in 8% of these patients. To identify venous thrombosis, a clamp is placed before arterial exploration to occlude venous return from the extremity. After arterial embolectomy and establishment of the arterial circulation, a second venous clamp is placed proximal to the first venous clamp and a venotomy is made between the pair of clamps. The foot is flexed and extended a number of times to raise the resting venous pressure in the leg. On release of the distal venous clamp, any retained thrombus is ejected from the circulation. If necessary, additional venous thrombus is removed with a venous thrombectomy catheter.

Swelling of a previously ischemic limb in which arterial continuity has been reestablished demands attention and is frequently observed in patients with obvious pregangrenous changes before the operation. Capillary damage that results in fluid exudation into ischemic tissue is a factor in this swelling, which is often aggravated by venous outflow obstruction. Fasciotomy for control of massive edema has been required in 10% of the patients. If manometric measurement of interstitial pressure is used, any pressure exceeding 30 mm Hg is regarded as an indication for fasciotomy. Failure to decompress the limb may result in compression of the arterial inflow and reocclusion. Initial fascial decompresion should be continued until extraneous pressure is lessened and propagation of thrombus is seen in the small vessels not directly cleared by the embolectomy catheter. Heparin administration is continued until the patient is ambulatory. Oral warfarin administration is also initiated 5 to 7 days after intravenous heparin administration has been stopped.

Myoglobinuria may be recognized by the absence of red blood cells in the urine or with a positive urinary guaiac test. If myoglobinuria is suspected, the patient should be treated with intravenous hydration sufficient to establish a diuresis of 100 ml per hour, as measured by indwelling bladder catheter output.

**POSTOPERATIVE MANAGEMENT**

In almost all instances, anticoagulation with intravenous heparin should be instituted 6 to 12 hours after embolectomy. Although this results in wound hematomas in a few patients, the likelihood of recurrent embolization is lessened and propagation of thrombus is retarded. Small vessels not directly cleared by the embolectomy catheter. Heparin administration is continued until the patient is ambulatory. Oral warfarin administration is also initiated 5 to 7 days after intravenous heparin administration has been stopped. The warfarin is continued indefinitely unless the primary embolic source has been definitively corrected.

Early ambulation is encouraged and prolonged sitting is prohibited. During the early postoperative period, considerable effort should be expended in an attempt to uncover a potentially correct primary source of the embolus. This investigation may include electrocardiography, roentgenography, real-time cardiac scanning, cardiac radionuclide echocardiography, abdominal echography, and angiographic evaluation of the aorta and thoracic and abdominal aortas.

**Secondary Procedures**

In our series, 28% of patients who underwent balloon embolectomy for in electrolytes and acid-base balance occur. The sudden return of acidicosis with a high potassium content can have adverse effects on myocardial function. The necessity of using buffering agents and antiarrhythmic agents should be anticipated at the time of clamp removal. Electrolyte levels should be closely measured in the postoperative period, and the presence of ischemic muscle necrosis, restoration of limb flow may result in the introduction of myoglobin into the systemic circulation. Unless cleared from the kidney, precipitation of myoglobin in the tubules may severely impair renal function.

Myoglobinuria may be recognized by the absence of red blood cells in the urine or with a positive urinary guaiac test. If myoglobinuria is suspected, the patient should be treated with intravenous hydration sufficient to establish a diuresis of 100 ml per hour, as measured by indwelling bladder catheter output.
needed additional surgical pro-
ceedures included repeat-
ectomy, balloon angioplasty or for-
new technologies. Initial improvement fol-
cation in a postoperative limb
thrombosis, and surgical explo-
with repeat thrombectomy is indi-
ally that shows marginal viability
rations. In recent years, investigators have
produced a multitude of percutaneous
thrombectomy devices and techniques
for clot removal without open surgery.
An extensive review of these technolo-
gies, authored by Sharafuddin and Hicks,
is available. These new treatment modal-
ities include:
1. Percutaneous aspiration thrombec-
tomy, by which suction is applied
through a large lumen catheter to re-
move thromboembolic material.
2. Pull-back thrombectomy and clot
trapping, by which thrombus is re-
trieved with a balloon or basket into a
trapping device for safe removal.
3. Rotational and hydraulic recirculation
thrombectomy, which involves the mi-
crofragmentation of thrombus by the
action of a high shear stress hydrody-
namic vortex.
4. Fluid jets without hydrodynamic reci-
culation to break up clot.
5. Thrombectomy achieved by the action
of ultrasound, laser, and radiofrequency
energy to lyse thrombus.

A new and promising approach is embo-
died in a unique device, the TRELLIS,
that traps the fresh thrombotic occlusion
between two balloons. Rotational mixing by
this catheter system and lytic infusion inter-
faces with the fragmented thrombus. This
pharmaceutical combination enables
targeted drug delivery and dissolution of
thrombus.

New thrombectomy devices and
techniques will continue to emerge.
Each new technology must be carefully
studied and compared with standard
thrombectomy techniques to determine
its clinical utility and to help define its
role in the treatment of thrombotic arte-
rial occlusions.

SUGGESTED READING

ment of peripheral arterial embolization. Am Heart J 1990;119:1090.

Berni GA, Bandyk DF, Zierler RE, et al. Strept-
okinase treatment of acute arterial occlus-

Fogarty TJ, The technique of thrombectomy and
other uses of the Fogarty catheter. In:

Fogarty TJ, Chin A, Shoor PM, et al. Adjunc-
tive intraoperative arterial dilatation: simpli-

Fogarty TJ, Daily PQ, Shuway N, et al. Expe-
rience with balloon catheter technique for ar-

Fogarty TJ, Herrmann GD. New techniques for
clot extraction and managing acute throm-
boembolic limb ischemia. In: Veith FJ, ed. Criti-


Sharafuddin MJ, Hicks ME. Current status of percutaneous mechanical thrombectomy.

Sharafuddin MJ, Hicks ME. Current status of percutaneous mechanical thrombectomy.

Sharafuddin MJ, Hicks ME. Current status of percutaneous mechanical thrombectomy.

Tawes RL Jr, Beare JP, Scribner RG, et al. Value of postoperative heparin therapy in periph-

Tawes RL Jr, Harris EJ, Brown WG, et al. Arte-
rial thromboembolism: A 20-year perspec-

Sarac TP, Hillman D, Arko FR, et al. Clinical and
economic evaluation of the trellis thrombec-
tomy device for arterial occlusions: prelimi-

EDITOR'S COMMENT

Hill and Zarins have provided a very
perspective on arterial embolism and
along with an up-to-date discussion of
management. I would first like to make a
point about the picture of acute embolic oc-
currence of a normal arterial and some of the
discussed in this chapter. As the authors
state, it is usually possible, based on clinical pres-
ence, to make the distinction between embolic occlusion and what they describe as thrombosis. In my view, this distinction is
important. If the diagnosis of acute emb-
olism of a previously normal artery can be
made based on clinical presentation, it is
advantage of the patient. Under those
circumstances, time is of the essence and, by making the diagnosis on the clinical picture, precious time can
be saved by getting the patient promptly to the oper-
ning room with the expectation that the embolism and
propagated thrombus can be easily removed with restoration of normal or near-normal arterial perfu-
sion. If, however, the patient is taken to the operating
room with a diagnosis of acute arterial occlusion, but the
underlying problem is arterial thrombosis super-
imposed on pre-existing peripheral vascular disease,
management in the operating room can become much
more complex and needlessly compromised because of
inadequate information.

The question, therefore, is how does one make
this distinction? Let's take the most common exam-
ple of acute occlusion of the superficial femoral ar-
tery. This occurs because an embolism from the
heart has lodged at the common femoral bifurca-
tion. Because the superficial femoral artery was
previously perfectly normal, there is no collateral
 circulation and therefore the limb below the knee
is immediately extremely ischemic. This results in
the classic picture of severe pain, pallor (no capil-
lar filling), paresthesias, and paralysis. Such limbs
are cadaveric in appearance and there is no ques-
tion about the nonviability of the limb. Often,
there is a pounding "waterhammer" pulse palpable
in the common femoral artery. Under those cir-
stances, and with the ancillary management as
described by the authors, the patient may be taken

(continued)