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Detection and Treatment of Acute Thromboembolic Events in the Lower Extremities

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Acute procedural thromboembolic events are serious complications affecting both short- and long-term outcome. Patients at high risk include those undergoing catheter-based interventions for acute limb ischemia and long segment de novo or stented occlusions of the lower limb arteries. Additionally, debulking procedures and angioplasty/stenting of complex lesions in patients with advanced disease have also been associated with a higher risk of distal embolization and in situ thrombosis. This article includes a discussion of detection methods as well as preventive and treatment strategies.
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Acute thromboembolic events (ATE) during peripheral endovascular interventions are an emerging challenge. The number of peripheral interventions is increasing because of factors such as demographic changes, increasing prevalence of metabolic disorders, and a shift from an open surgical to an endovascular approach in patients with symptomatic peripheral arterial disease. As such, the number of procedural ATEs is also expected to grow. The clinical significance of ATE, however, in terms of worsening of symptoms or the outcome of intervention, is not well studied in the lower limbs. Although showering of emboli with occlusion of the terminal arterial branches in the foot is considered a poor outcome, the significance of the loss of a tibial vessel in a patient with claudication and 3-vessel runoff is not as clear. As a general rule, interventionists should look for and treat distal embolization when it is angiographically apparent. Davies and colleagues, in a retrospective analysis of their experience, report that distal embolization during superficial femoral artery (SFA) interventions resulted in a significantly lower limb salvage and freedom from recurrent symptoms.[1] In situ thrombosis was associated with lower patency rates in the same study.

In this article, the risk factors, detection, and preventive and treatment strategies for ATE are reviewed with emphasis on the technical aspects of the therapy.

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Risk Factors

Procedural ATE can occur during any intervention. The incidence increases with increasing complexity of the lesion as well as with the device used. The expected clinical outcome of thromboembolic complications is also poorer in patients with more advanced disease. Although the overall risk of ATE is low, the number of events is expected to grow. Factors contributing to this trend include interventional management of more complicated lesions such as chronic total occlusions (CTO) of native and stented vessels, as well as increasing use of complex tools such as atherectomy devices. In a single center registry, lesion severity, presence of thrombus, and prior amputation, all indicators of advanced disease, were predictors of distal embolization in peripheral interventions.[2] Below is a brief description of recognized risk factors for ATE during lower limb interventions.

Interventions for Acute Limb Ischemia

One of the most common causes of distal embolization is catheter-based interventions for acute limb ischemia. During catheter-directed thrombolytic therapy (CDT), partial flow may be established as a result of therapy, with residual clot migrating downstream. This phenomenon can temporarily occlude the collateral flow into the foot, causing exacerbation of symptoms. Flow is usually reestablished with continuation of thrombolytic therapy. The incidence of permanent embolization with angiographic loss of runoff vessels during CDT is reported to be between 7% and 12%,[3,4] which is likely an underestimate because asymptomatic distal emboli occur during the management of acute clot but the data are neither

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captured nor reported because of the asymptomatic nature of the events. Similarly, distal embolization with segmental or total loss of a tibial vessel may remain initially asymptomatic because of the presence of other runoff vessels. It should be noted, however, that asymptomatic distal embolization is not a benign event. Lower rates of limb salvage, primary and secondary patencies, and freedom from recurrent symptoms have been reported in association with procedure-related ATE.[1]

In relation to the treatment of patients with acute limb ischemia, another common cause of distal embolization is angioplasty or debulking of underlying lesions "uncovered" after CDT. Angiographic stenoses after CDT may contain or be entirely composed of organized thrombus.

Chronic Total Occlusions

Treatment of iliac and SFA CTOs has also been associated with ATE. Older studies on recanalization of iliac CTO reported high rates of ATE, but more contemporary publications indicate rates as low as 2.5% to 4.1%.[5,6] As might be expected, however, studies using an embolic protection device (EPD) report a much higher rate of embolic detection in filters during aortoiliac interventions.[7]

In the SFA the reported rates of ATE vary widely and range up to 90%.[8] This variability stems from inconsistent definitions of embolization and nonstandard thresholds for treating it. Some authors suggest that any Doppler signal during continuous sonographic monitoring or capture of any debris in an EPD constitutes "distal embolization." Others consider the development of clinical symptoms or angiographic loss of a runoff vessel the only indication of significant embolization. In the study by Müller-Hülsbeck using EPDs, 90% of devices contained debris ranging from 90 to 2000 μm after SFA interventions.[8] It is unclear, however, whether most of the microscopic debris generated during routine interventions has any clinical sequela.

Recanalization of Occluded Stents and Stent Grafts

Although failed stents and stent grafts are most likely caused by neointimal tissue ingrowth or stent-adjacent lesions, the presence of a clot at various stages of organization should be considered when treating these lesions. The tactile feeling during passage of a wire through a previously stented segment should provide clues as to the likelihood of the presence of thrombus. Acute and subacute clots are usually softer and more easily crossed. In such cases, recanalization without preventive measures may lead to macroscopic thromboembolism.

Use of Atherectomy and Debulking Devices

Use of some atherectomy or debulking devices may also increase the risk of distal embolization.[9-12] These studies[9-12] report capture of macroscopic debris in 60% to 100% of EPD using either SilverHawk atherectomy (ev3/Covidien, Minneapolis, MN) or excimer laser ablation (Spectranetics, Colorado Springs, CO). In studies not using EPD, the reported rates of distal embolization range from 0% to 14%.[13,14] Although not rigorously studied, it appears that the length and complexity of the lesion increase the risk of ATE during atherectomy. This risk can be minimized by careful attention to appropriate patient selection, use of EPDs, and overcoming the learning curve for these technologies.

Detection of Procedural Thromboembolic Events

The reported incidence of ATE varies depending on the diagnostic method used. Using continuous Doppler ultrasound, Lam et al observed embolic signals in 100% of patients undergoing lower extremity arterial interventions.[15] Embolic signals were detected during every stage of the procedures, including wire passage, balloon angioplasty, stenting, and atherectomy. The number of signals was proportionally higher during plaque excision and debulking. Despite this finding, only 1 of 60 patients in this analysis suffered from what the authors considered "clinically significant." Studies using EPDs report a similarly high percentage of distal emboli.[8-12] The clinical relevance of distal embolization, however, has only been partially validated when the loss of antegrade flow is detected by contrast angiography.[1] Without a better understanding of the long-term consequences of emboli detected by Doppler or EPD, conclusive statements regarding their clinical impact cannot be made. It is prudent, however, to perform complete arteriography before and after any upstream interventions, especially in patients and interventions considered at high risk for distal emboli. Deteriorations in antegrade flow should be treated aggressively.

Prevention and Treatment of ATE

The first step in preventing procedure-related ATE is to recognize who is at risk. Most patients undergoing peripheral interventions do not require special measures other than appropriate anticoagulation and standard good practices, such as routine flushing of sheaths. In general, careful manipulation of devices across stenotic lesions, use of lower profile catheters and wires, and minimization of the number of balloon inflations using long balloons all reduce the risk of distal emboli.

Anticoagulation and Antiplatelet Therapy

In patients at higher relative risk of ATE, sufficient levels of anticoagulants should be administered to keep the activated clotting time (ACT) above 250 seconds during the intervention. Although our preferred anticoagulant of choice during such cases is bivalirudin, the use of heparin would also be adequate provided ACT is measured at regular intervals and maintained above 250 seconds. There has been no randomized comparative study between unfractionated heparin and bivalirudin in peripheral interventions but reported experience with the latter reveals safety and efficacy that are equivalent to or better than that of heparin.

Use of aspirin before and after interventions in patients with peripheral arterial disease should be routine. Although