Aneurysm of the Distal Popliteal Artery and Its Relationship to the Arcuate Popliteal Ligament

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IN 1953 Gifford, Hines, and Janes demonstrated the high incidence of serious complications in patients with untreated aneurysms of the popliteal artery. They pointed out that arteriosclerosis was present in almost all the 100 popliteal aneurysms that they studied and that the aneurysms were not infrequently bilateral or multiple.

Popliteal aneurysms are seen predominantly in men more than 50 years of age and are usually asymptomatic until complications occur. These may be local swelling and pain, a prominent venous pattern or edema below the knee, or ischemia with intermittent claudication, ischemic neuritis, ulceration, and gangrene. The complications are results of local pressure from or rupture of the aneurysm, thrombosis within the aneurysm, or peripheral embolization from the aneurysm.

In 1916 Halsted and Reid experimentally produced circumscribed dilatation of an artery immediately distal to a partially occluding band and related this phenomenon to the dilatation of the subclavian artery observed in certain cases of cervical rib. Similar poststenotic dilatation has often been observed in other arteries. In the aorta it appears commonly distal to stenosed aortic and pulmonary valves and distal to coarctate segments. The physical phenomena that occur distal to a stenotic segment of artery were described by Holman in 1954 as follows:

A mass of fluid ejected through a narrow and limited constriction under high velocity strikes against a more slowly moving mass of fluid distal to the stenosis, resulting, first, in the conversion of high kinetic energy into high potential energy or lateral pressure and, second, in the lateral deflection of the rapid stream and even in a complete reversal in the direction of flow, thus producing eddies of alternating high and low pressure whose repeated impacts over prolonged periods against an elastic wall are capable of inducing structural fatigue and distention of that wall, resulting eventually and inevitably in the phenomenon of poststenotic dilatation.

To relate the phenomenon of post-stenotic dilatation to the pathogenesis of popliteal aneurysms, a review of the anatomy of the popliteal space is necessary (fig. 1). About two thirds of the way down the thigh, the femoral artery passes posteriorly and inferiorly through the tendinous hiatus of the adductor magnus and enters the popliteal fossa as the popliteal artery. Within the popliteal space the popliteal artery lies in loose fatty tissue and is freely mobile. According to Boyd and co-workers, the popliteal artery then enters a fibrous tunnel derived from the fascia on the deep surface of the gastrocnemius just above the level of the knee joint. The fascial covering narrows to form a definite fibrous band, ¼ to ½ inch broad, attached to the capsule of the knee joint at the level of the joint.

In addition to the fibrous band described by Boyd, which is posterior to the popliteal artery, there is another ligamentous structure, the arcuate popliteal ligament, which is anterior to the popliteal artery. The arcuate popliteal ligament arches upward on the lateral side of the popliteus muscle from the head of the fibula, crossing the popliteus muscle and blending into the ligaments of the posterior knee joint medially. This ligament is particularly sharp and prominent when the lower leg is fully extended.

The popliteal artery crosses the arcuate popliteal ligament posteriorly at the level of the knee joint or just inferiorly. It is at this point that arteriograms have shown thrombosis of the popliteal artery most often. As

270 Circulation, Volume XXIV, August 1961

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ANEURYSM OF POPLITEAL ARTERY

a corollary, it is distal to this point that popliteal aneurysms may occur. It is conceivable then that popliteal aneurysms may result not only from post-stenotic dilatation distal to the adductor magnus hiatus but also from post-stenotic dilatation distal to the arcuate popliteal ligament.

It should also be recognized that the popliteal fossa is a rather confined space covered with the strong sural fascia. Pressure applied posteriorly to the popliteal artery would compress the posterior tibial nerve and popliteal vein before the artery itself. Therefore it is hypothesized that in distal popliteal aneurysm the pressure resulting in post-stenotic dilatation of the artery arises anteriorly from the arcuate popliteal ligament, rather than posteriorly from a fibrous band as described by Boyd. Distal to the arcuate popliteal ligament the popliteal artery is cushioned by the popliteus muscle, and the artery terminates close to the inferior edge of the muscle, dividing into the anterior and posterior tibial arteries.

Probably the formation of aneurysm is accelerated in vessels that are atherosclerotic and are subjected to repeated trauma. In 1952 Palma,6 in his study of stenosis and stenotic arteriopathy of Hunter’s canal, suggested that pathologic changes occur because of repeated microtrauma secondary to systolic expansion of the vessel wall. Also, the effect of trauma to the popliteal artery during flexion and extension of the knee joint has been emphasized by Boyd and co-workers and Lindbom.7

Observations in two recent cases having aneurysms of the proximal and distal popliteal artery and in another case having bilateral distal popliteal aneurysms lend support to the etiologic role of post-stenotic dilatation in formation of such aneurysms.

Illustrative Cases

Case 1

A 70-year-old man with diabetes mellitus was referred to the Mayo Clinic because of severe burning pain, numbness, and coldness of 9 days’ duration in the right leg. He had been aware of claudication in both calves for about 1 year.
one to two blocks had produced pain in the left calf.

On examination he was normotensive. Pulsations were absent from the left popliteal, posterior tibial, and dorsalis pedis arteries. On elevation of the left foot, pallor was moderately severe; and venous filling time was prolonged. There was no palpable aneurysm.

A left femoral percutaneous arteriogram showed no filling in a segment supplied by the distal femoral artery and proximal popliteal artery. There was good filling distal to this segment.

On surgical exploration of the left popliteal space, the popliteal artery was thrombosed distal to the adductor magnus hiatus. Between the heads of the gastrocnemius at the level of the arcuate popliteal ligament there was a narrowed segment in the popliteal artery with a small aneurysm distal to this point. A segment of popliteal artery was excised, and an alcohol block of the left lumbosacral sympathetic ganglion was performed. Recovery was uneventful.

Four years later this man returned because of severe pain of 4 days' duration in his right calf. Since his last examination and surgery he had had claudication of both calves after walking three blocks rapidly.

Examination revealed exquisite tenderness, tenseness, and edema of the right calf with minimal edema of the ankle. There was moderate venous distention. In the left popliteal, dorsalis pedis, and posterior tibial arteries pulsations were present but moderately diminished in amplitude. The right pedal pulses were difficult to assess because of edema, but the pulsation of the right popliteal artery was prominent in the popliteal space and even in the upper part of the calf.

A diagnosis of acute right sural thrombophlebitis was made, and the possibility of its being secondary to a popliteal aneurysm was considered.

A right femoral arteriogram showed questionable evidence of a popliteal aneurysm. On surgical exploration, an aneurysm of the distal popliteal artery was palpable anterior to the medial head of the gastrocnemius. It measured approximately 6 cm in length and 3 cm in diameter. A right lumbar sympathectomy was first performed, and then the popliteal artery was cross-clamped and transected above and below the aneurysm. A Teflon graft was inserted. The patient's postoperative course was satisfactory.

Case 3

An 82-year-old man was referred to the Mayo Clinic because of pain, coldness, and numbness of 10 hours' duration in the right leg and foot. He was unable to move the toes of the right foot. He had known of the presence of an aneurysm of the right popliteal artery for 2 years, and for the same period he had experienced bilateral calf claudication on walking one half to one block.

On examination the blood pressure was 210 mm of mercury systolic and 90 diastolic. The right leg was cold below the knee and the right foot was markedly pale. The patient was unable to move his right foot or toes. On the right, popliteal, dorsalis pedis, and posterior tibial pulsations were absent; and on the left, dorsalis pedis and posterior tibial pulsations were absent and popliteal pulsations were reduced. There was marked pallor on elevation of the right foot and moderate pallor on elevation of the left foot. Venous filling time was greater than 60 seconds on the right and was 30 seconds on the left.

Conservative treatment with a hot room, whiskey, anticoagulants, and papaverine resulted in improvement of the right foot with increase of warmth, sensation, and motor power over a 2-day period. The anterior tibial muscle became edematous, however, and the venous pattern of the right leg became more prominent. After 6 days the right lower leg became more edematous and the popliteal pulsations more diffuse. A leaking popliteal aneurysm or venous thrombosis was suspected.

Ultimately gangrene of the right foot and leg developed, and a midtibial amputation was performed. Dissection of the specimen disclosed two popliteal aneurysms. The first was just distal to...
ANEURYSM OF POPLITEAL ARTERY


Being venturesome involves taking risks. The risks will vary with different disciplines. Chemists have been killed or seriously maimed in their efforts to discover new kinds of explosives. Bacteriologists have been rendered desperately ill or have died from diseases for which they have been endeavoring to find a cure. Workers with the X-rays, in the early days before the dangers were realized, lost the use of fingers and hands or became horribly mutilated by the destructive energy of that powerful agent. In other realms of research the dangers may not be so serious, but all research is fairly certain to involve at least the regrettable risk of losing time. "Uncertainty and loss of time," as Emerson wrote, "are the nettles and tangling vines of the self-relying and the self-directed." Since time runs in only one direction, the eager investigator always looks upon its loss with sorrow. In my own experience I have too often had only labor for my pains. If the time I have spent in fruitless efforts to obtain control of the workings of the thyroid gland could be added to the end of my days, my span of life would be prolonged, I feel sure, by some years.—WALTER B. CANNON, M.D. The Way of An Investigator. New York, W. W. Norton & Company, Inc., 1945, p. 29.
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