Atherosclerosis and Thrombosis of the Distal Part of the Abdominal Aorta

Clinical and Surgical Considerations

By John W. Kirklin, M.D., Edgar V. Allen, M.D., Howard M. Odel, M.D., and Richard M. Shick, M.D.

DR. ALLEN: Partial or complete occlusion of the distal part of the abdominal aorta is characterized clinically by distress produced only by walking and relieved by standing. The amount of walking required to produce distress varies from patient to patient as well as from time to time in the same patient. Characteristically the distress involves the thighs, the regions lateral to the hip joints, the buttocks or, rarely, the distal part of the lumbar zone. The onset of distress is accelerated when the patient walks up an incline or stairs, or when he walks rapidly. This symptom complex is recognized as intermittent claudication. It differs from that ordinarily noted in association with chronic occlusive arterial diseases involving the legs only in that its location is more proximal; it is commonly designated as “high” intermittent claudication. In rare instances, similar distress is produced in addition by standing or by exercise while standing, such as making beds or scooping grain.

Presentation of Cases

Case 1. (Presented by Dr. Allen.) A 43-year-old woman examined at the Mayo Clinic in May, 1954, had noted inconstant paresthesia in the entire lower extremities for several years. For the past two years she had noted distress involving the entire left lower extremity and the left buttock and lesser distress in the right buttock provoked by continuous walking and relieved by cessation of walking.

General examination disclosed no abnormalities except those relative to the arterial circulation of the lower extremities. Slight diminution of pulsation was noted in the right femoral artery, with pronounced diminution of pulsation of the left femoral artery. Faint pulsation was detectable in both popliteal arteries but no pulsation could be felt in the dorsalis pedis arteries bilaterally and in the left posterior tibial artery. Only slight diminution in pulsation was present in the right posterior tibial artery. On elevation of the feet, a minimal degree of abnormal pallor of the skin of both feet was noted. The venous filling time of the right foot was 25 seconds and that of the left foot was 35 seconds. A systolic bruit was audible over both femoral arteries.

Results of the following procedures were normal: urinalysis, enumeration of erythrocytes and leukocytes, serologic test for syphilis and roentgenologic examination of the thorax. Values for blood urea, sugar and hemoglobin were normal. Values for blood fats, expressed in milligrams per 100 ml. were: cholesterol 293, cholesterol esters 130, phospholipides 320 and fatty acids 492. Roentgenologic examination of the abdomen showed calcification of the abdominal aorta. Aortography disclosed a filling defect in the terminal portion of the aorta; the iliac and femoral arteries filled normally.

A diagnosis was made of atheromatosis and thrombosis of the distal portion of the abdominal aorta and surgical treatment was advised. Dr. Kirklin, will you discuss the operative procedure?

Dr. Kirklin: The aorta appeared normal proximal to the level of the origin of the inferior mesenteric artery. Distal to that point it was severely sclerotic and just proximal to its bifurcation the aorta was “solid” and appeared to be almost completely occluded. The left common iliac artery was normal to palpation but the proximal portion of the right com-
mon iliac artery was involved with atheromatosis. The external iliac arteries were normal to palpation. The terminal portion of the aorta was mobilized; one lumbar artery and the inferior mesenteric artery were ligated and divided. A fine-toothed clamp of the Potts type was placed on the aorta about 2.5 cm. distal to the left renal vein and about 2.5 cm. proximal to the origin of the inferior mesenteric artery. Bulldog clamps were placed on the iliac arteries. The aorta was cut across about 1 cm. proximal to the origin of the inferior mesenteric artery. The common iliac arteries were sectioned and the aorta and proximal portions of the common iliac arteries were removed. A graft, comprised of the distal portion of an aorta, its bifurcation and the common iliac arteries, was inserted. At the conclusion of the operation excellent pulsation was detectable in both external iliac arteries. Lumbar sympathectomy was performed.

Pathologic examination of the surgical specimen showed that the distal 2 cm. of the aortic lumen was virtually completely obstructed by a nodular atheromatous mass. Atheromatous plaques were noted in the aorta and common iliac arteries; one plaque obstructed the orifice of the inferior mesenteric artery.

Dr. Allen: Much more occlusion of the aorta was found than was anticipated from study of the aortograms. Would you comment on this discrepancy, Dr. Kirklin?

Dr. Kirklin: Similar observations have been made in other cases in which the obstruction in the aorta demonstrated on direct examination was considerably greater than that assumed to be present as a result of aortography.

Dr. Allen: When the patient was examined 17 days after operation, pulsation in the peripheral arteries was normal, there was no abnormal pallor on elevation of the feet and the venous filling time of the feet was normal bilaterally. Relative to the surgical results, the patient wrote as follows: "One of the most noticeable changes since my operation is that I can walk without pain. The day after I was released from the hospital I walked 10 blocks and went through several stores without having to stop and rest because of pain, fatigue, dizziness or just plain inability to put one foot ahead of the other. Prior to operation I could walk a half block or possibly up to one block and then had to stop and rest for a few minutes until the pain and fatigue would leave, then start again only to repeat this procedure. Walking up a flight of stairs was a major job. I had had occasion to climb a flight of stairs since the operation with no noticeable strain on my legs. I am now lifting my feet instead of dragging them. For several years my feet and legs have always felt cold and if I became chilled it was most difficult to get my legs and feet warm even with the aid of hot baths, a heating pad and an electric blanket. Now I definitely have "hot" feet; in fact I feel a warmth all through my body that I never experienced before—really a little too warm. A cool morning breeze feels delightful now instead of creating shivers and goose pimples from head to toe. I just hope it continues."

Case 2. (Presented by Dr. Odel.) A research chemist, 53 years of age, registered at the clinic in March, 1954. He described gradually progressive "tiredness" in both legs and thighs that invariably occurred after he walked one block at a moderate pace; the distress increased with continuous walking and required him to stop. It then disappeared but recurred when he walked again. The clinical history was otherwise negative except for inability to have penile erection for two years. General examination disclosed extensive xanthomas of both upper eyelids. Arterial pulsation was greatly diminished in both femoral arteries and slightly diminished in the left posterior tibial artery; it was absent in both popliteal and dorsalis pedis arteries and in the right posterior tibial artery. Elevation of both lower extremities produced mild abnormal pallor of the right foot but none on the left. With dependency, venous filling occurred normally.

Results of the following tests were normal: urinalysis, enumeration of erythrocytes and leukocytes, and serologic test for syphilis. Values for blood sugar and hemoglobin were normal. The respective values for blood cholesterol, phospholipides and fatty acids in milligrams per 100 ml. were 420, 570 and 1,674.

A provisional diagnosis was made of arteriosclerosis obliterans, with the occlusive process in the iliac arteries or in the aorta itself or in both. Aortography revealed irregularity and narrowing of the abdominal aorta beginning distad to the renal arteries and including the proximal portions of both common iliac arteries. The distal portions of the iliac and the femoral arteries were filled normally (fig. 1, A and B). A diagnosis then was made of atheromatosis with segmental occlusion of the distal portion of the abdominal aorta and the common iliac arteries. Surgical treatment was advised.

Dr. Kirklin: The abdominal aorta and common iliac arteries were exposed through a midline incision. Pulsation appeared normal in the aorta to within 1 cm. of the bifurcation, where it abruptly became of poor quality. Direct recording of blood pressure in the aorta was done at points 8, 6, 4 and 2 cm. proximal to the bifurcation; the values obtained were approximately the same as in a radial artery, namely 160 mm. Hg systolic and 90 diastolic. The blood pressure in the common iliac arteries just distal to the bifurcation of the aorta was 125/90 on the right and 114/90 on the left. These readings indicated sharp reduction of the systolic blood pressure owing to the damping effect of the obstruction at the bifurcation of the aorta. The aorta was mo-
bilateral and, after placement of suitable fine-toothed clamps, was cut across just below the origin of the inferior mesenteric artery. The distal part of the aorta and the first centimeter of each iliac artery were then removed. The inferior mesenteric artery was temporarily occluded with a bulldog clamp. A preserved homologous bifurcation graft was sutured into place. Pulsation through the graft and into the iliac arteries appeared to be good at the conclusion of the operation. The second lumbar sympathetic ganglion on the right and the second and third ganglia on the left were removed. Pathologic study of the specimen showed extensive atherosclerosis of the aorta with an organized thrombus, approximately 1.5 cm. in diameter, situated at the aortic bifurcation and virtually obstructing the lumen.

Dr. Odel: When the patient was examined about two weeks after operation, peripheral arterial pulsation was normal or nearly so in the femoral, popliteal and posterior tibial arteries bilaterally. Painless pulsation was present in the dorsalis pedis arteries bilaterally. There was no abnormality of pallor on elevation of the feet, and the venous filling time was normal. The patient recently wrote, "My walking pains have never appeared again. However, there are still some kind of drawing pains in my right leg even when I am not walking."

Case 3. (Presented by Dr. Shick.) A 45-year-old white man was admitted to the clinic in April, 1954, complaining of pain in both hips and calves and impotence of 18 months' duration. The symptoms had begun insidiously and had become progressively worse. Pain appeared after the patient walked one and a half or two blocks and subsided after he rested for a few minutes. He had smoked excessively for several years but recently had discontinued use of tobacco on the advice of his physician.

Results of general examination were not remarkable except that the feet were cool and evidenced slight abnormal pallor on elevation. Filling of the veins in the left foot was slightly delayed after the extremities were changed from an elevated to a dependent position. Pulsation was felt in the abdominal aorta. Arterial pulsation was palpable in the femoral, popliteal, dorsalis pedis and posterior tibial arteries but was moderately to greatly impaired. A systolic bruit of moderate intensity was audible over the right femoral artery.

Urinalysis revealed moderate albuminuria. Aortography showed partial obstruction at the aortic bifurcation (fig. 2). The results of other studies, including measurement of blood hemoglobin, sugar, urea and lipides, enumeration of erythrocytes and leukocytes, roentgenography of the thorax and excretory urography, were normal. Roentgenograms of the abdomen and pelvis revealed no calcification in the abdominal aorta or iliac vessels. The clinical diagnosis was atheromatosis and thrombosis at the aortic bifurcation. Surgical treatment was advised.

Dr. Kirklin: Surgical exploration in June, 1954,
disclosed good pulsation in the abdominal aorta down to the actual point of its bifurcation. Beyond this in each common iliac artery the pulsation was greatly diminished. Minimal atherosclerosis was present in the aorta and iliac arteries above and below the involved segment. The distal 3 cm. of the abdominal aorta and the proximal 3 cm. of each common iliac artery were resected and continuity was restored by means of a Y-shaped homologous aortic graft. Bilateral lumbar sympathectomy was done. Immediately after the operation it was noted that the lower extremities were warmer than they had been and that the arterial pulsation was of good quality. Convalescence was uneventful and the patient was dismissed from the hospital on the tenth postoperative day.

Dr. Shick: The patient returned to the clinic in October, 1954, stating that he was able to walk more than a mile without distress and to obtain and maintain penile erection without difficulty. The lower extremities were warm and dry. No abnormal postural changes in color of the skin of the feet were noted and filling of the veins was prompt after the limbs were changed from an elevated to a dependent position. Pulsation was felt in the abdominal aorta; no bruit was audible. Arterial pulsation in the lower extremities was normal. Aortography revealed the aortic bifurcation to be well filled and normal in size (fig. 3).

**Comment**

Dr. Allen: The results of operation in these three cases were excellent, as they have been in several similar instances. However, surgical results are not uniformly good and it is well to
iliac arteries were occluded. The occluding masses were "fished out" of the interior of these distal arteries prior to anastomosis. The patients derived no benefit from this procedure. It might be argued that the resection was not carried far enough distal but it was impossible to resect entirely past the occluded region, which extended at least as far down as the inguinal ligaments. It is probably fruitless to perform resection under such circumstances. My colleagues and I are still gaining experience in the indications for resection of the abdominal aorta for thrombosis and replacement with a graft, and our ideas are not entirely crystallized relative to some aspects. For example, I do not know how much can be gained from such an operation when the aorta is occluded, the iliac arteries are patent and the more distal parts of the arteries are occluded.

Dr. Allen: Sometimes the roentgenograms do not show filling of the iliac and femoral arteries when clinically they appear to be patent, although they are pulseless because pulsation has been damped by occlusion in the aorta. How do you handle such a situation, Dr. Kirklin?

Dr. Kirklin: We have operated in such cases. Resection and grafting have been done if the distal portions of the iliac arteries were found to be patent. If the arteries are occluded as far distal as the inguinal ligaments, bilateral lumbar sympathectomy only has been performed.

Dr. Odel: Do you believe, Dr. Kirklin, that sympathectomy alone could account for the good results in the three cases that we have reported?

Dr. Kirklin: It has been known for many years that sympathectomy improves arterial circulation to the skin of the extremities. However, our experiences indicate that sympathectomy alone does not cause the improvement noted in these three cases.

Dr. Allen: I agree. Most patients cannot walk farther after sympathectomy than they could before. Complete relief of intermittent claudication after sympathectomy must be extremely rare; I cannot remember such an instance. Also sympathectomy rarely causes an increase in arterial pulsation. It is safe to
conclude that removal of the diseased aorta was responsible for the relief of intermittent claudication and for most of the improvement in arterial circulation in these cases.

Physician: Why do you do sympathectomy, Dr. Kirklin?

Dr. Kirklin: Even in carefully selected patients there may be impoverishment of the circulation to the feet that will not be benefited by resection and replacement of the aorta only. Sympathectomy may cause substantial improvement in circulation. Also sympathectomy is performed to prevent, in some degree, the ischemia that may develop subsequently owing to atherosclerosis and thrombosis of arteries in the legs.

Dr. Shick: Dr. Kirklin, what do you do when arteriography demonstrates occlusion of the aorta as far proximad as the origin of the renal arteries? Can you make an anastomosis under those circumstances?

Dr. Kirklin: Fortunately we are not confronted often with such a situation. Yet it is possible to remove a thrombus from the aorta just distal to the origin of the renal arteries and then complete the operation in the usual way. This was done in a recent case in which the atheromatosus occlusion extended to within 1.5 cm. of the derivation of the renal arteries. The portion of aorta between this point and the origin of the renal arteries was pulseless and contained a soft mass. A clamp was placed across the aorta about 1 cm. distal to the renal arteries and the aorta was transected about 0.5 cm. beyond the clamp. The bit of aorta extruding beyond the clamp had a normal-appearing wall but was occluded by a soft organized thrombus that was separated readily from the intima of the aorta. The thrombus was grasped with forceps and the clamp was loosened; traction on the thrombus in addition to the pressure within the proximal part of the aorta produced forceful dislodgment of the thrombus from the segment of aorta between the origin of the renal arteries and the point of transection. The clamp was quickly tightened and the operation concluded in the usual way.

Physician: What about thromboendarterectomy?

Dr. Kirklin: Some surgeons prefer this operation to resection and grafting. We performed thromboendarterectomy on several patients before we began to perform resection and grafting; pulsation returned to the arteries of the legs of two such patients. One of these patients died two and one half months later of rupture of the aorta near the proximal end of the region of the thromboendarterectomy, although reinforcement of the aorta with fascia had been employed at the time of operation. Because of this experience and because of certain theoretic disadvantages to thromboendarterectomy, my colleagues and I prefer resection and grafting at present.

Physician: What happens to the graft?

Dr. Kirklin: The considerable amount of experimental work done on the fate of preserved homologous aortic grafts can be summarized by saying that, in general, the graft serves essentially as an inert scaffold for the ingrowth of specialized tissues from the host. In time the graft is replaced by the tissues of the host and does not persist as a transplanted structure.

Physician: Are the results good when an iliac artery is resected for segmental occlusion and replaced by a graft?

Dr. Kirklin: Investigation of this problem is being continued but, for reasons not currently clear, substantial improvement in circulation has not often occurred after operation in our cases of isolated segmental occlusion of the common iliac arteries. The small size of the common iliac artery may have some bearing.

Physician: At a conference some time ago Dr. Allen mentioned arteriospastic claudication. Does that situation apply in cases such as those presented?

Dr. Allen: For several years my associates and I have been intrigued by the following situation. A patient has well-documented intermittent claudication, yet pulsation in the peripheral arteries is normal. After exercise, such as walking or rising repeatedly on the toes, arterial pulses of the feet disappear, the veins of the feet are empty and collapsed and the skin of the distal portions of the feet is pallid. At this time a systolic bruit may be heard for the first time over the femoral arteries or a bruit previously audible may be
sharply accentuated. This is the syndrome of arteriospastic claudication, which we have observed to occur on occasion with aortic thrombosis, as well as in the absence of aortic thrombosis but with segmental occlusion of the iliac or femoral arteries. I cannot be entirely certain that arteriospastic claudication is an unequivocal sign of segmental arterial occlusion but it well may be because the two are commonly associated.

Physician: What is the mortality rate?

Dr. Kirklin: We have performed resection and grafting for acquired occlusion of the abdominal aorta in 18 cases; there have been no deaths and no serious complications.

Physician: Are patients satisfied with the results of operation?

Dr. Allen: Very much so. Several patients have written to express gratitude and great satisfaction with the results of operation. As far as I know, none regret the experience if the results have been good. They have not lamented the pain, loss of time and expense of operation. One patient wrote: “I feel like I am floating on a cloud—I feel much younger.” However, none of us are naïve enough to believe that the surgeon is curing atherosclerosis. He is removing atheromatous and thrombosed arteries and replacing the defect with a graft. Atheromatosis certainly is present in other regions when it is found in the aorta. Therefore, one may anticipate the normal consequences of atheromatosis whatever they may be and whenever they may occur. We will need much more time than we have had to determine the incidence and severity of impoverished circulation to the legs that may result from atherosclerosis in the arteries of the legs.

The current situation may be summarized as follows: The syndrome of occlusion of the distal portion of the abdominal aorta or the segments of the iliac arteries or both may be recognized clinically. Demonstration of details depends on aortography. The distal part of the abdominal aorta or portions of the iliac arteries or both may be removed surgically and replaced by a homologous graft. The risk of operation to the patient is minimal. When operation is performed on carefully selected patients, the results are extremely pleasing to patient, surgeon and internist.
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