Recovery of Cardiomegaly After Treatment of Traumatic Popliteal Arteriovenous Fistula

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Circulatory distress can occur in the long term after the formation of a traumatic arteriovenous fistula (AVF), but cardiac failure rarely occurs in a patient with an AVF in the lower extremity. The present patient underwent surgery to treat a traumatic popliteal AVF 9 years after sustaining the injury. Although the patient was asymptomatic with regard to cardiac circulation, cardiomegaly was noted and it resolved promptly after the surgical treatment. Cardiac insufficiency should be borne in mind even when a patient is asymptomatic because young patients have a high tolerance for cardiac overload. (Circ J 2009; 73: 776–778)

Key Words: Arteriovenous fistula; Cardiac failure; Cardiomegaly; Trauma; Youth

Traumatic arteriovenous fistula (AVF) occurs infrequently after arterial injury. Although the initial symptoms are frequently mild, the shunt flow increases with time and the patient becomes aware of a thrill or swelling over the affected area. Cardiac symptoms are eventually noted when compensation cannot cover the increased cardiac load. However, AVF in the extremity rarely leads to cardiac failure because the artery affected is relatively small. We describe a patient who was treated surgically for a long-standing popliteal AVF, in whom cardiomegaly promptly resolved after the operation. We also discuss the etiology and technical aspects of the treatment.

Case Report

A 32-year-old man visited hospital complaining of swelling of the left leg, particularly below the knee. He had also noted redness, local heat and skin pigmentation. Nine years before, he had been involved in a traffic accident and had suffered a compound fracture of the left tibia with bone exposure. The fracture had been stabilized using a metal plate and nails, and since then he had been asymptomatic. However, several years later, he became aware of swelling of the left leg, which had gradually increased. The current presentation occurred after another traffic accident, which was not severe.

Physical examination revealed marked swelling and skin pigmentation of the left leg below the knee and a thrill in the popliteal fossa. The patient complained of heaviness in the left leg, but was otherwise asymptomatic and had no shortness of breath. Chest roentgenography revealed cardiomegaly with a cardiothoracic ratio (CTR) of 61% (Figure 1A). Ultrasonic cardiography (UCG) revealed normal cardiac function with an ejection fraction (EF) of 77%, although the left atrium and ventricle were enlarged (Table). Enhanced computed tomography revealed distinct enlargement of the popliteal vein with early enhancement (Figure 2A). Angiography revealed an AVF between the

Figure 1. Chest X-ray. (A) Preoperative view shows cardiomegaly with a cardiothoracic ratio (CTR) of 61%. (B) Within 1 month of operation, the CTR has decreased to 46%.
Table. Preoperative and Postoperative Cardiac Dimensions on Ultrasonic Cardiography

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<thead>
<tr>
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<th>Preoperative</th>
<th>Postoperative</th>
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<tbody>
<tr>
<td>LVDD (mm)</td>
<td>56.6</td>
<td>48.1</td>
</tr>
<tr>
<td>LVDS (mm)</td>
<td>30.1</td>
<td>31.0</td>
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<tr>
<td>LAD (mm)</td>
<td>42.9</td>
<td>34.4</td>
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<tr>
<td>EF (%)</td>
<td>77.0</td>
<td>67.2</td>
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LVDD, left ventricle dimension in diastole; LVDS, left ventricle dimension in systole; LAD, left atrium dimension; EF, ejection fraction.

left popliteal artery and the corresponding vein (Figure 2B). The proximal vein was enlarged because of the increased blood flow, and the left iliac to femoral artery was also enlarged. The nail that had been used to stabilize the tibial bone was located distant to the AVF. On the basis of these findings, traumatic AVF was diagnosed. Although the patient did not complain of circulatory distress during daily activity, a decision to operate was made because of increased blood flow through the AVF with time, associated with increasing cardiomegaly and arteriomegaly in the affected limb, suggesting a risk of subsequent cardiac failure.

The popliteal artery and vein were approached from the popliteal fossa using a sigmoid-shaped skin incision with the patient in the prone position. To avoid injury arising from isolation of the artery and vein and inflammation resulting from the previous trauma and operation, air tourniquets were placed above and below the knee joint. The location of the AVF was confirmed by intraoperative echography. The artery and the vein were isolated around the AVF, heparin was administered intravenously and the tourniquets were inflated to a pressure of 250 mmHg. The enlarged vein was incised and the fistula was confirmed via the lumen. The fistula, with a diameter of 3 mm, was completely divided from the vein and closed with monofilament sutures. The popliteal vein was then reconstructed to establish venous blood flow. The superficial femoral vein was also found to be enlarged, but was left untreated. Postoperative chest roentgenography and angiography 1 month later confirmed that the patient’s cardiomegaly had reduced dramatically to 46% of the CTR (Figure 1B), although the arteriomegaly was unchanged. UCG also demonstrated a decrease in the size of both the left ventricle and atrium, with a decrease in the EF to 67% (Table). The blood flow in the artery was smooth, but the superficial femoral vein was thrombosed. At 18 months after surgery, the patient was doing well.

Discussion

Acquired AVF is usually a complication of injuries such as stab wounds or bone fractures, and rarely after surgical procedures. A connection between the lacerated artery and the adjacent vein forms as a result of the injury, developing into an AVF with time. Therefore, the connection is usually single and the increasing shunt flow eventually causes cardiac failure! Two possible causes of the AVF in the present patient can be considered. The edge of the fractured bone may have injured the popliteal artery and vein when the patient was involved in the first traffic accident; however, as no roentgenography films taken at the time of the traffic accident were available, this could not be confirmed. The other possibility was laceration of the artery during surgery to fix the fractured bone, especially with the use of nails, as has been reported previously! The surgeon who carried out the operation had not noticed any unexpected bleeding, and the nails used to stabilize the bone with the plate were located distant to the fistula. Therefore, this possibility also seemed unlikely. However, the formation of a high-flow AVF with a single channel suggested a traumatic, acquired AVF.

Acquired AVF is considered to lead to increased blood flow through the fistula with time, eventually causing cardiac failure, which differs from congenital AVF, a condition that rarely causes systemic circulatory distress and is mainly characterized by local symptoms because of the multiple connections. The present patient did not have circulatory distress suggestive of cardiac insufficiency, although cardiomegaly with arteriomegaly was prominent. Suspected impending cardiac failure was the major reason for deciding on surgical treatment. Enlargement of the arteries of the affected limb was the characteristic angiographic feature, and suggested that blood flow through the AVF had been increasing on a long-term basis. The low resistance of the popliteal vein in comparison with the femoral veins would cause increased blood flow via the iliac and femoral arteries, which would also cause enlargement of these proximal arteries. An increase in the size of an artery decreases its resistance, which in turn leads to a further increase in blood flow. Such positive feedback eventually induces cardiac overload, and when the cardiac compensation reaches its limit, cardiac failure occurs. The prompt relief of the cardiomegaly, together with lowering of the left ventricular EF, after the surgical treatment indicated that the present patient was in a hyperdynamic condition preoperatively, despite being asymptomatic. The residual arteriomegaly in the postoperative period suggests that it had preceded the cardiomegaly, as mentioned earlier. As circulatory overload would continue until the acquired AVF was closed, surgical treatment was justified even though the patient was asymptomatic.

Catheter intervention is a treatment option that has developed rapidly in recent years; but as the AVF in this case...
was located just behind the knee joint, placement of the device to close the fistula might have caused injury to the popliteal artery with the frequent flexion of the knee joint. Therefore, operative treatment was considered the best choice. The popliteal vein was enlarged because of excessive blood flow, and severe adhesion of the artery to surrounding structures such as the nerves and muscles was anticipated. As extended isolation would have caused laceration of the vein and excessive bleeding, isolation was kept to a minimum. The tourniquet occlusion technique was used to obtain a bloodless field and minimize the isolation. Another approach for reducing the degree of operative injury would be to incise the dilated popliteal vein to close the fistula. The dilated vein was located just above the artery in the operative field. Circumferential isolation of the popliteal vein to reach the AVF from the outside would have lacerated the dilated, thin-walled vein. Therefore, the fistula was closed via the lumen of the vein. This procedure also made it possible to avoid injury to surrounding organs, especially nerves.

Although the patient had no cardiac symptoms, the effect of fistula closure was remarkable and the preexisting cardiomegaly resolved in 1 month. AVF in the extremity rarely causes cardiac insufficiency, but it can occur when the fistula remains untreated for a long period. Cardiac insufficiency should be borne in mind, even when a patient is asymptomatic, because young patients have a high tolerance for output cardiac load.

References