SECTION 8

TROUBLESHOOTING

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A. ENDARTERECTOMY

Coronary artery endarterectomy (CAE) is performed in extensively atherosclerotic coronary arteries where there is not enough space for distal anastomosis. The basic principle of coronary endarterectomy is the complete removal of the plaque.

Due to its larger diameter, endarterectomy of the right coronary artery (RCA) is performed more frequently than endarterectomy of the left anterior descending artery (LAD) or lateral wall arteries. When the plaque is pulled in both directions, the diagonal and septal branches emerging from LAD in two different planes may cause the plaque to rupture and form an intimal flap. This may cause thrombus or dissection in the coronary artery, resulting in distal lumen obstruction. In addition, as the atherosclerotic plaque in RCA is weaker than the plaque in the LAD, it is more likely to rupture. Single-vessel LAD endarterectomy outcomes are better than multiple-vessel endarterectomy.

The internal thoracic artery preferably should not be used as a patch during endarterectomy, as it is prone to heel distortion and compromises blood flow when a long arteriotomy is required.

1. Open endarterectomy technique

A wide longitudinal arteriotomy is made in the coronary artery beyond the limits of the stenosis. This has the advantage of completely removing of the plaque containing atheromatous material both in the main artery and side branches under direct vision, allowing the edges to be fixed. If iatrogenic dissection occurs during endarterectomy in the open technique, the flap can be identified and repaired simultaneously.

This technique takes more time than the closed one, but there is less chance of intimal flap formation; therefore, residual obstruction, dissection, and distal myocardial ischemia rates are lower. If endarterectomy is inadequate, the distal LAD and its side branches may become occluded (Figure 8.1).

2. Closed endarterectomy technique

A smaller arteriotomy, usually 5 to 10 mm, is performed to remove the atherosclerotic plaque by applying steady, gentle traction on the plaque proximally and distally. This procedure is faster and graft anastomosis is easier. With this technique, it is not possible to avoid intimal flaps and residual occlusions. However, in cases where complete removal of the plaque is not possible, the arteriotomy can be extended. Two simultaneous arteriotomies can be performed to shorten the ischemic time and make the procedure faster.

A plane is created between the calcified plaque and the elastic adventitial segment of the coronary artery wall with a thin endarterectomy elevator. The calcific plaque is dissected from the arterial wall circumferentially along the proximal and distal parts. With dissectors providing traction and contraction, the calcified plaque is gently retracted with a clamp or a pair of forceps. The calcific plaque is pulled proximally and, then, cut with scissors. The distal segment is slowly retracted until it separates from the intimal wall (Figure 8.2a-d).

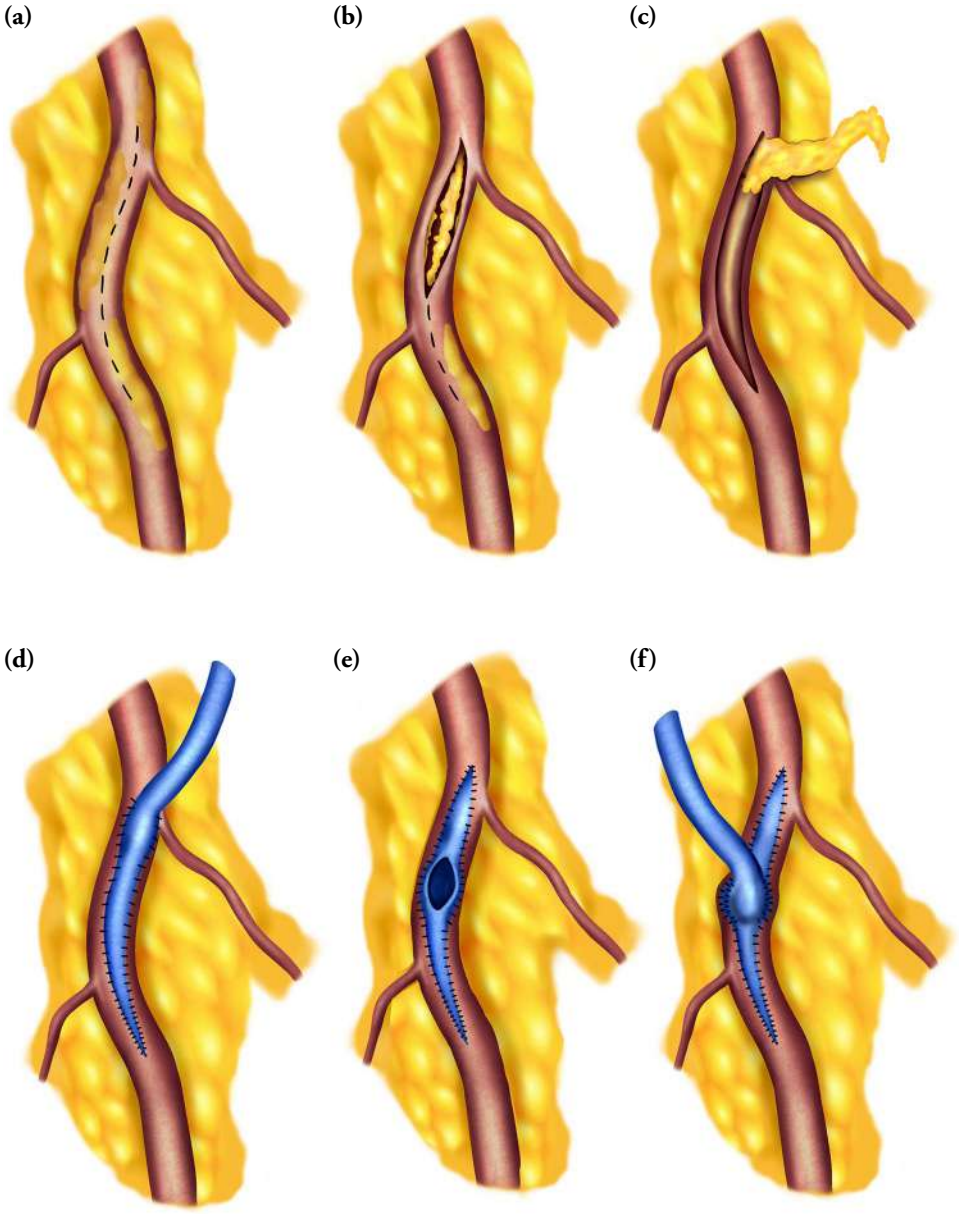

Figure 8.1. **(a-c)** In open endarterectomy, the entire atherosclerotic plaque is removed by opening a wide longitudinal arteriotomy. After the plaque is removed, **(d)** the graft itself can be used as a patch, or **(e)** a vein graft can be used as a patch, the arteriotomy is closed and **(f)** the graft is anastomosed on this patch. If left internal thoracic artery is to be chosen as the graft, using the patch technique can prevent narrowing or kink of the anastomosis.

B. REPAIR OF POSTERIOR WALL INJURY

If the posterior wall of the artery is iatrogenically injured during arteriotomy, it must be repaired. To repair it, the arteriotomy must be extended proximally and distally. This allows the injury to be located midway through the arteriotomy rather than closer to the proximal or distal lumen. Sutures are placed continuously with 7-0 polypropylene to the posterior wall of the coronary artery. Each

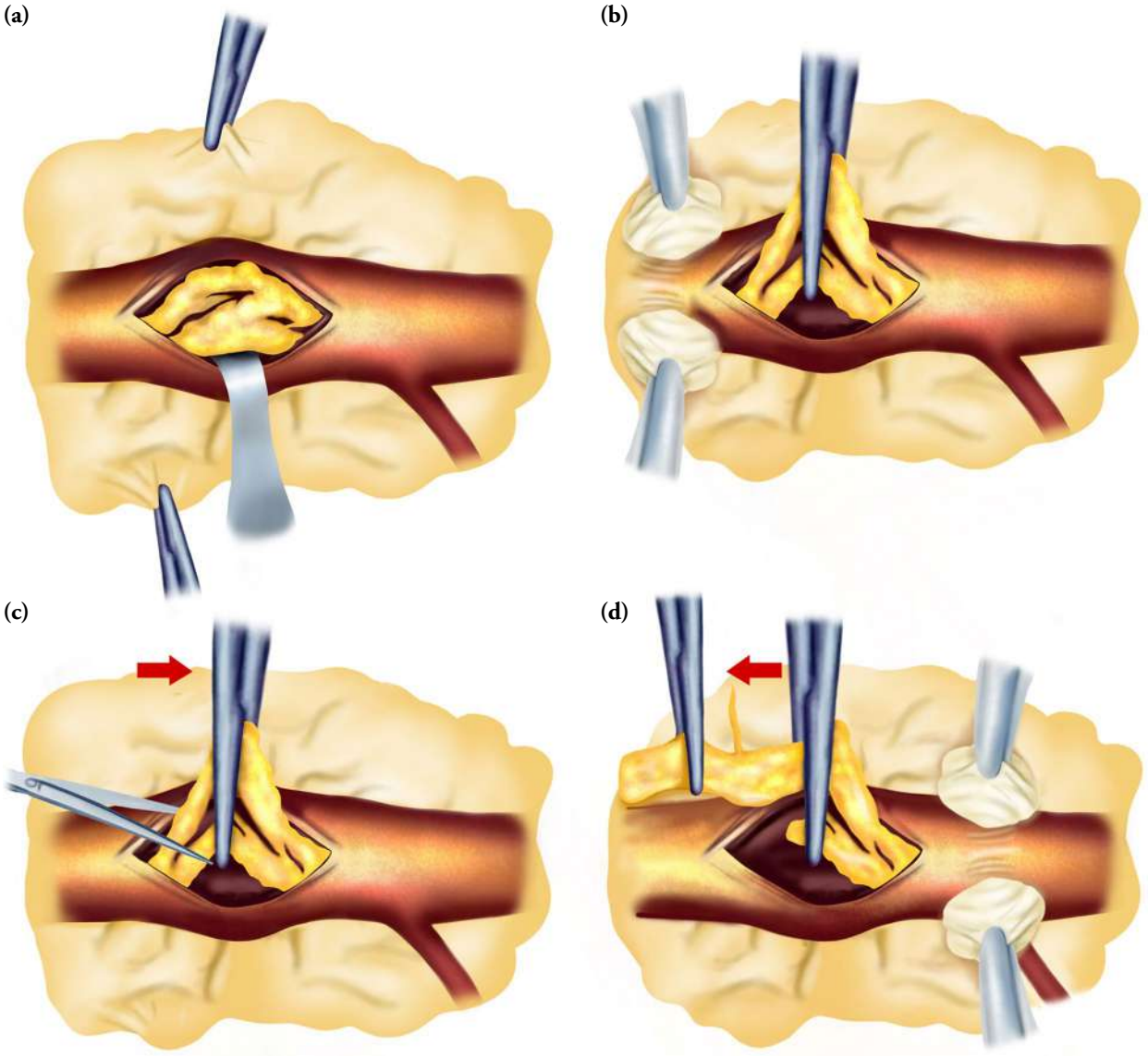

Figure 8.2. **(a)** In closed endarterectomy technique, a shorter arteriotomy is performed. **(b)** The plaque is removed in an appropriate manner with the help of elevators. It is released from the arterial wall by holding it with a forceps. **(c)** The proximal end is cut at a suitable point. **(d)** The distal end is tried to be completely removed, and at this stage it may sometimes be necessary to facilitate the releasing of the plaque by massaging it with gauze.

suture is passed through the epicardium and secured with a rubber-shod clamp. Afterwards, the vascular anastomosis is completed as usual. Sutures are tied immediately before giving cardioplegia or crystalloid solution. Thus, narrowing or deterioration of the coronary artery is prevented (Figure 8.3a-e).

C. REPAIR OF ANASTOMOTIC LEAK

It is of utmost importance to ensure adequate suture tension during anastomosis to prevent leaks

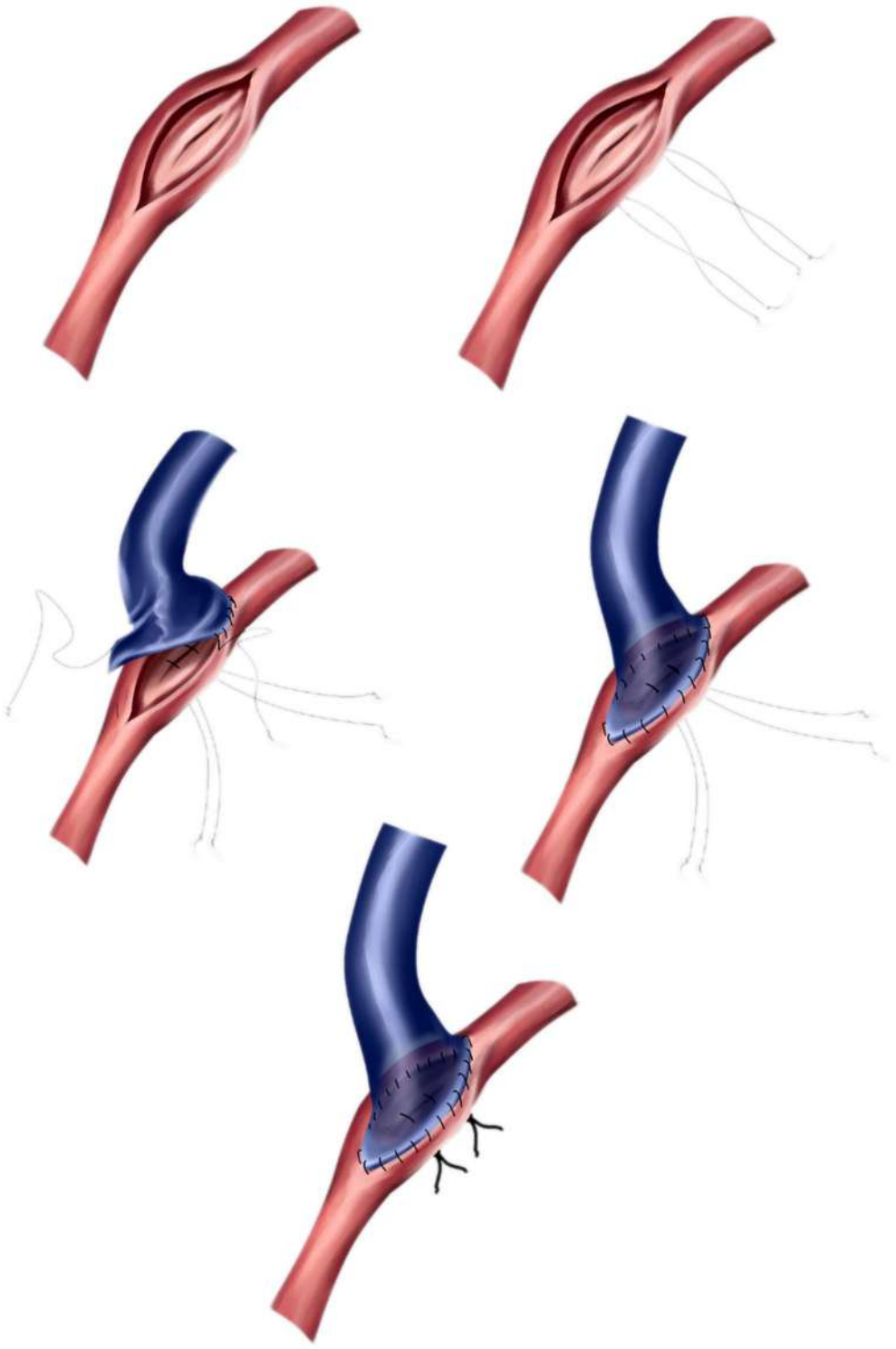

Figure 8.3. If the posterior wall is injured with a scalpel while performing arteriotomy, it may cause serious bleeding after the anastomosis and must be repaired before starting it. One or two 7/0 polyprolene sutures are placed from the inside of the arteriotomy to the posterior and lateral edges of the coronary artery leaving the damaged area in the middle. These sutures are placed in a U shape and tied after the anastomosis is completed to prevent traction of the artery.

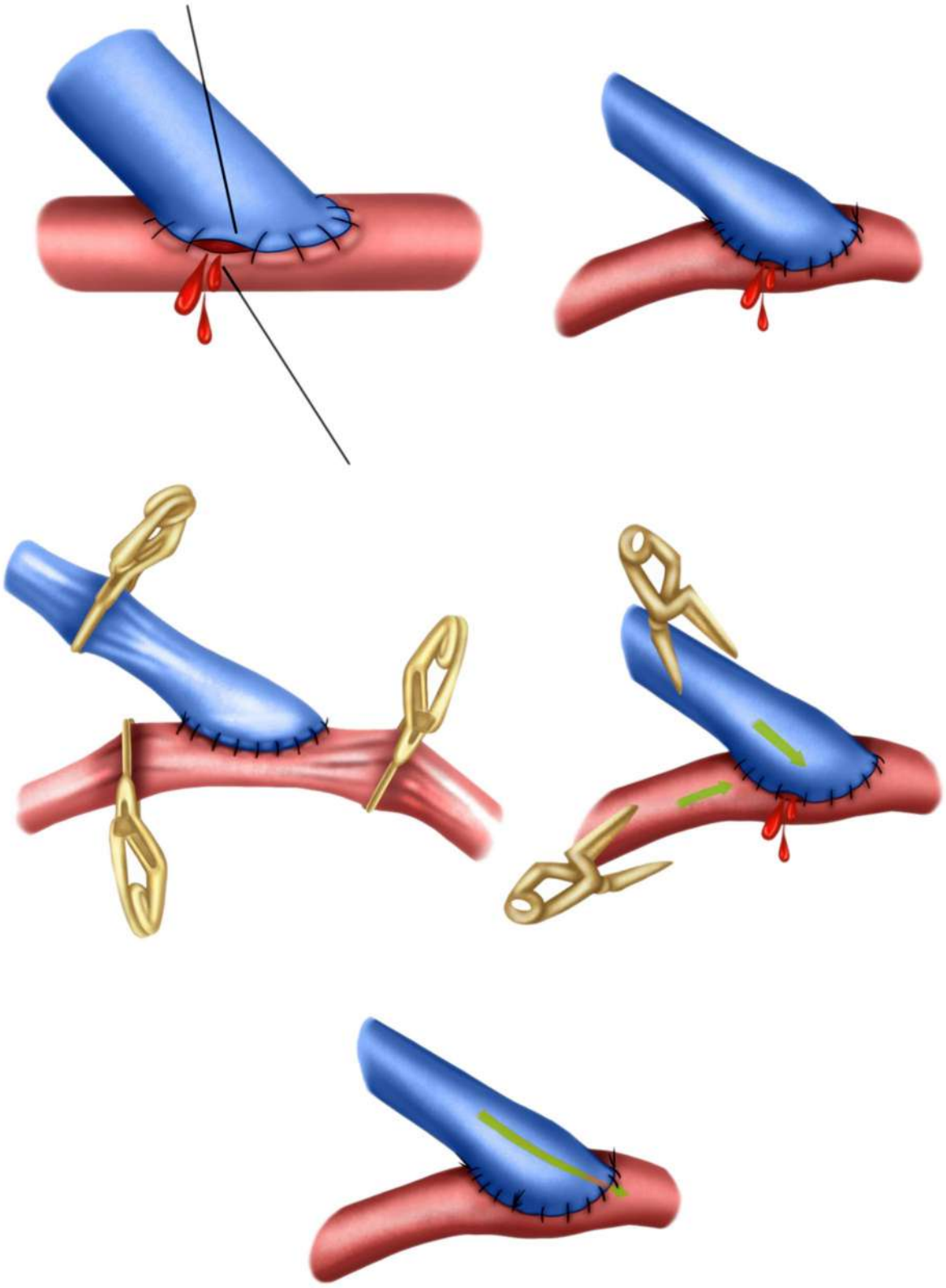

Figure 8.4. If necessary, additional stitches are placed clockwise around the anastomosis. While placing additional stitches, care should be taken not to remove them from the posterior wall of the artery.

in the posterior wall, which is more difficult to correct than the anterior wall. The sutures at the proximal part of the artery should be extremely close together to minimize the possibility of leakage. Subsequent placement of reinforcement sutures in this area is difficult and may narrow the anastomosis (Figure 8.5). If necessary, additional stitches are placed clockwise tightly around the anastomosis. While placing additional sutures, care should be taken not to not to pass through the posterior wall of the artery (Figure 8.4a,b). To minimize anastomotic leak, sutures can be passed from a very thin section of the surrounding epicardium tissue. Before tying the stitches, anastomotic leaks can be checked by administration of cardioplegia to the graft. The effect of heparin must be reversed by protamine to allow clotting to stop the bleeding caused by needle punctures. As a last resort, hemostasis will be achieved within 5 to 10 min after applying light pressure to the bleeding area with gauze. Once the suture lines are dry, sealing them with a bioadhesive is often beneficial, but if overapplied, it may obscure significant anastomotic leaks requiring suture repair (Figure 8.4c).

D. CHECKING THE PATENCY OF THE ANASTOMOSIS

Milking (Acland test)

It is a completely subjective method that depends on the surgeon's experience. The surgeon occludes the graft by taking it either between the first and second fingers of both hands or with the help of two forceps. Afterwards, he milks the graft in both

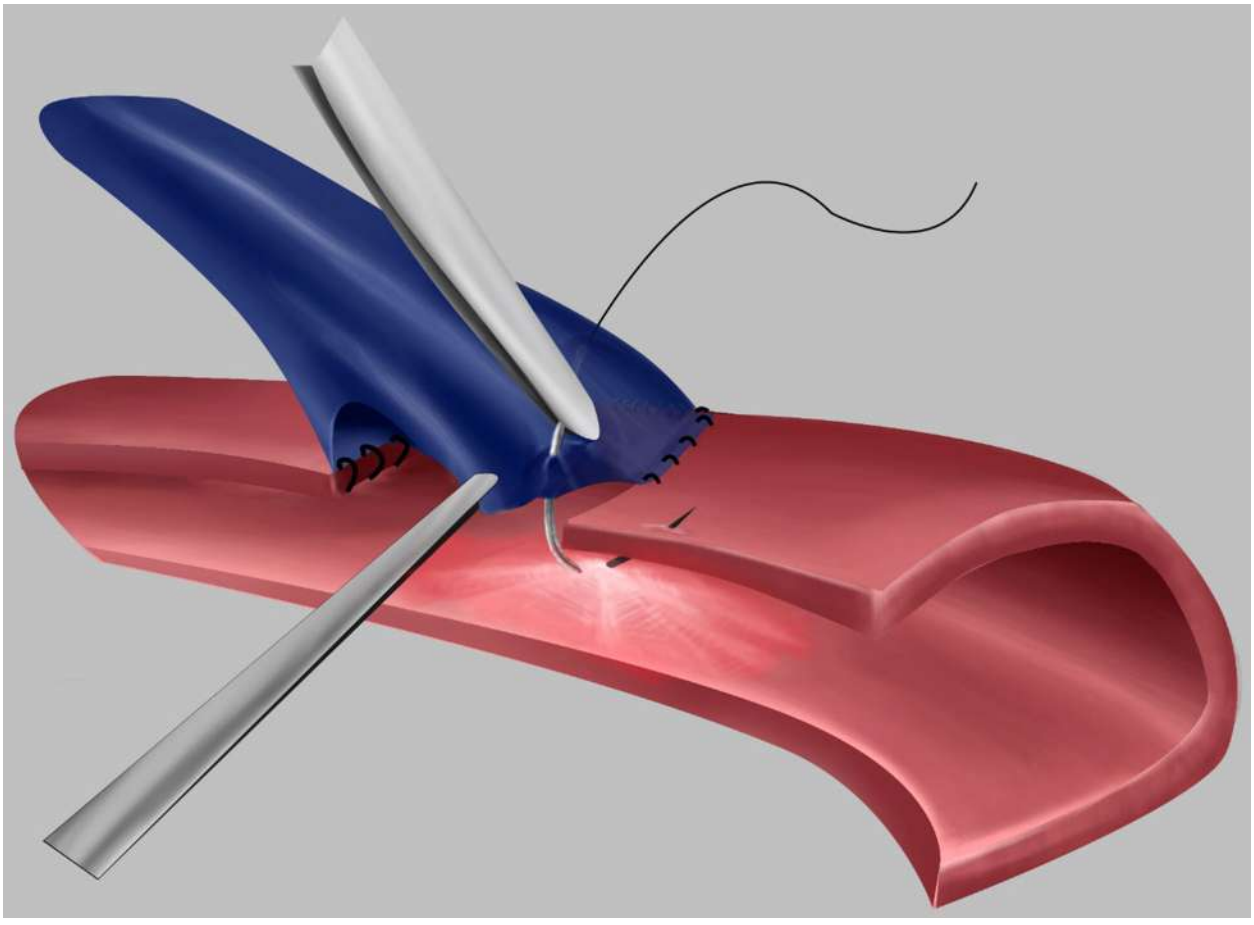

Figure 8.5. Subsequent placement of reinforcement sutures in this area may narrow the anastomosis.

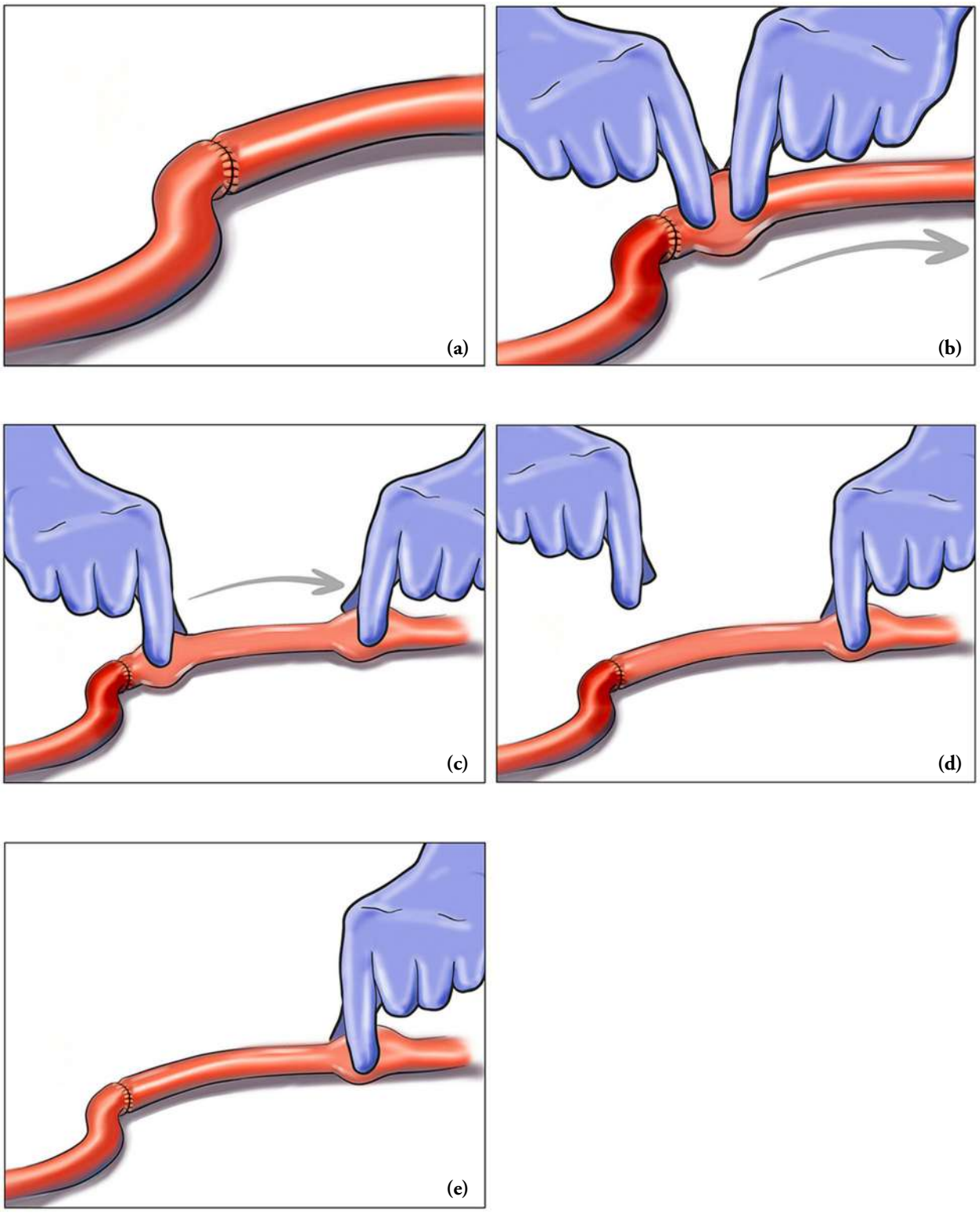

Figure 8.6. **(a)** Milking test can be applied to determine whether there is stenosis in the anastomosis. In this test, **(b, c)** if the vein is emptied with fingers or forceps **(d)** after the inflow part is opened, the vein does not fill, it is considered that no flow can pass through the anastomosis. **(e)** If it fills completely quickly, the anastomosis is considered to be sufficient.

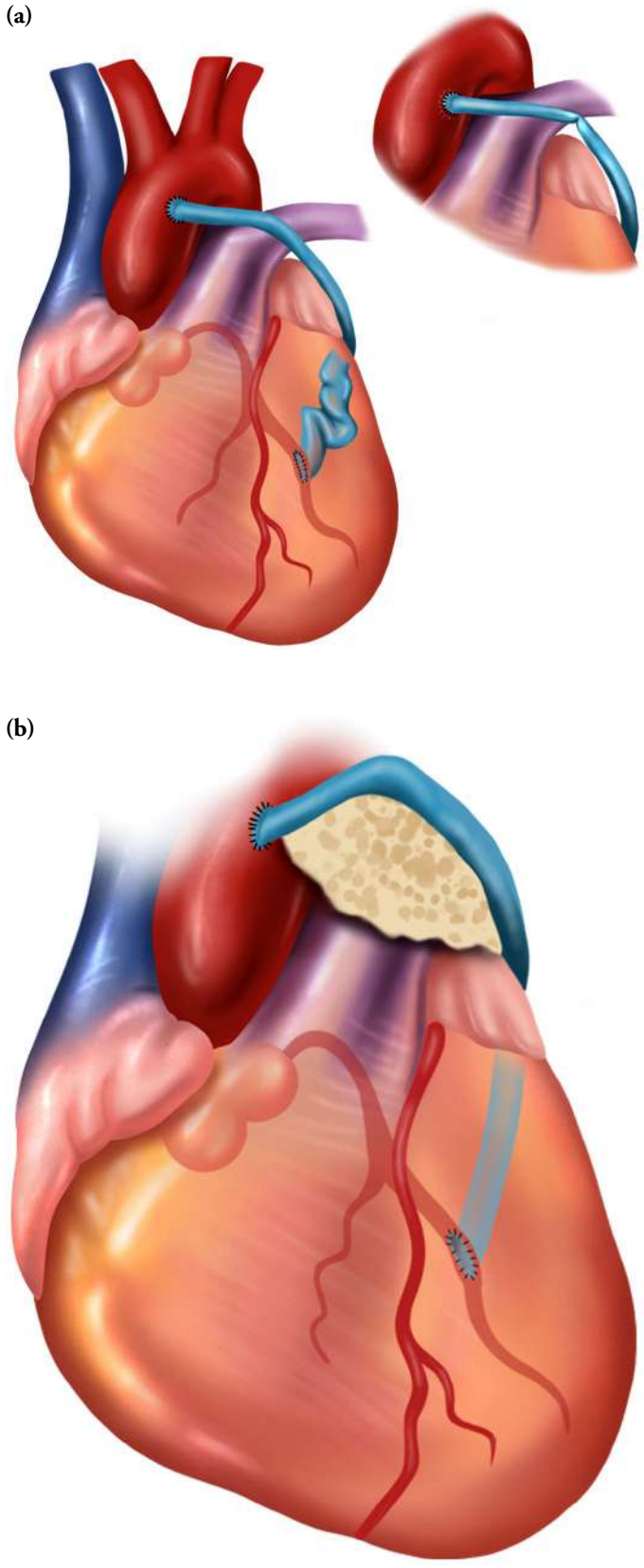

Figure 8.7. **(a, b)** Vein grafts, particularly if the proximal anastomosis is performed under cross clamp, may be longer than calculated after the cross clamp is removed. This length may cause kinking of the graft. As a solution, the vein can be lengthened and the anastomosis can be repeated after side clamping of the aorta. Another method is to anastomose the ends of the graft together after cutting off the excess part of the vein. If there is a slightly excess length, the graft can be shortened by positioning it behind the left atrial appendage, or kinking can be prevented by making a ball of surgical cellulose hemostats.

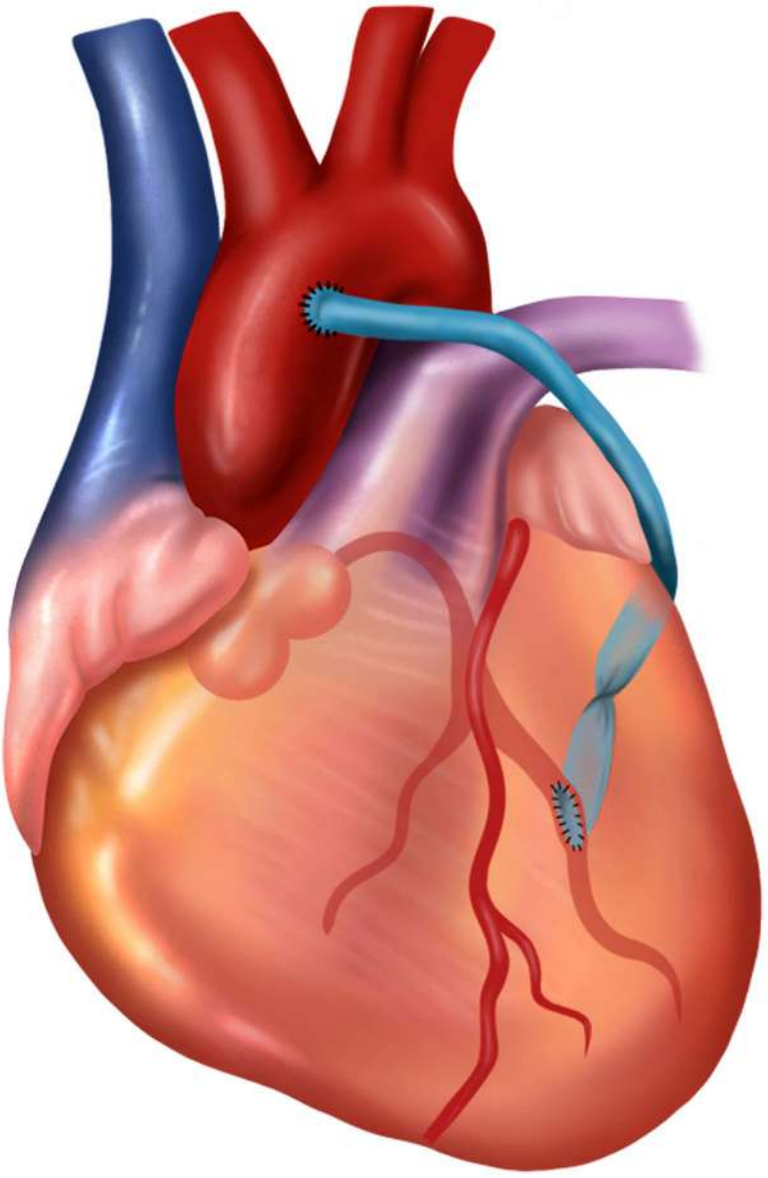

Figure 8.8. The graft may rotate on itself during anastomosis. In this case, either the proximal anastomosis is re-performed, or if this is impossible, the graft is cut, the rotation is corrected, and it is sutured in an end-to-end fashion again.

directions respectively and observes whether there is backfilling (Figure 8.6). Another subjective method is to feel the pulsation of the graft with fingers.

E. GRAFTS THAT ARE TOO SHORT OR TOO LONG

A graft that is too long will cause bending, while a graft that is too short will cause tension and tear in the aorta while the sutures are being placed. Saphenous vein grafts tend to shorten somewhat over time. The vascular graft should be cut at a point that will easily extend the length of the graft when the heart is completely filled. For this, an extra graft length of 1 to 2 cm is sufficient. If the graft is short, shrinkage may cause tension of the anastomosis and lead to an early occlusion of the graft. Therefore, it should be repositioned over the aorta. Alternatively, the shorter graft can be cut

obliquely, anastomosed with another piece of graft, and lengthened.

If the vein graft is too long, it may cause the conduit to bend or fold in on itself when the heart is placed back into the pericardial sac. Sometimes, while the graft seems to be at the appropriate length, it may fold when sternum is closed. In this case, before the graft is re-anastomosed to the aorta, the excess piece of graft must be cut and the graft must be shortened. In another method, a long graft is placed behind the left atrial appendage and can be held in place with a piece of Surgicel™. Also, long grafts can be positioned over the pericardium or epicardium with 6/0 or 7/0 sutures (Figure 8.7a,b).

F. ROTATION OF THE GRAFT AROUND ITS OWN AXIS

The graft may have rotated around itself 360° (Figure 8.8). In particular, for vascular grafts at the back of the heart, every precaution should be taken to ensure that the graft lies smoothly along its length without any bending/folding. When rotation occurs, the proximal anastomosis must be re-done. If this is not possible for any reason, the graft can be cut and rotated, and then an end-to-end anastomosis can be performed again. Some surgeons prefer to mark the graft with methylene blue to avoid this complication (Photo 8.1 and 2).

Photo 8.1. If the graft is marked with a sterile marking pen before anastomosis, possible complications as rotation or twisting can be prevented.

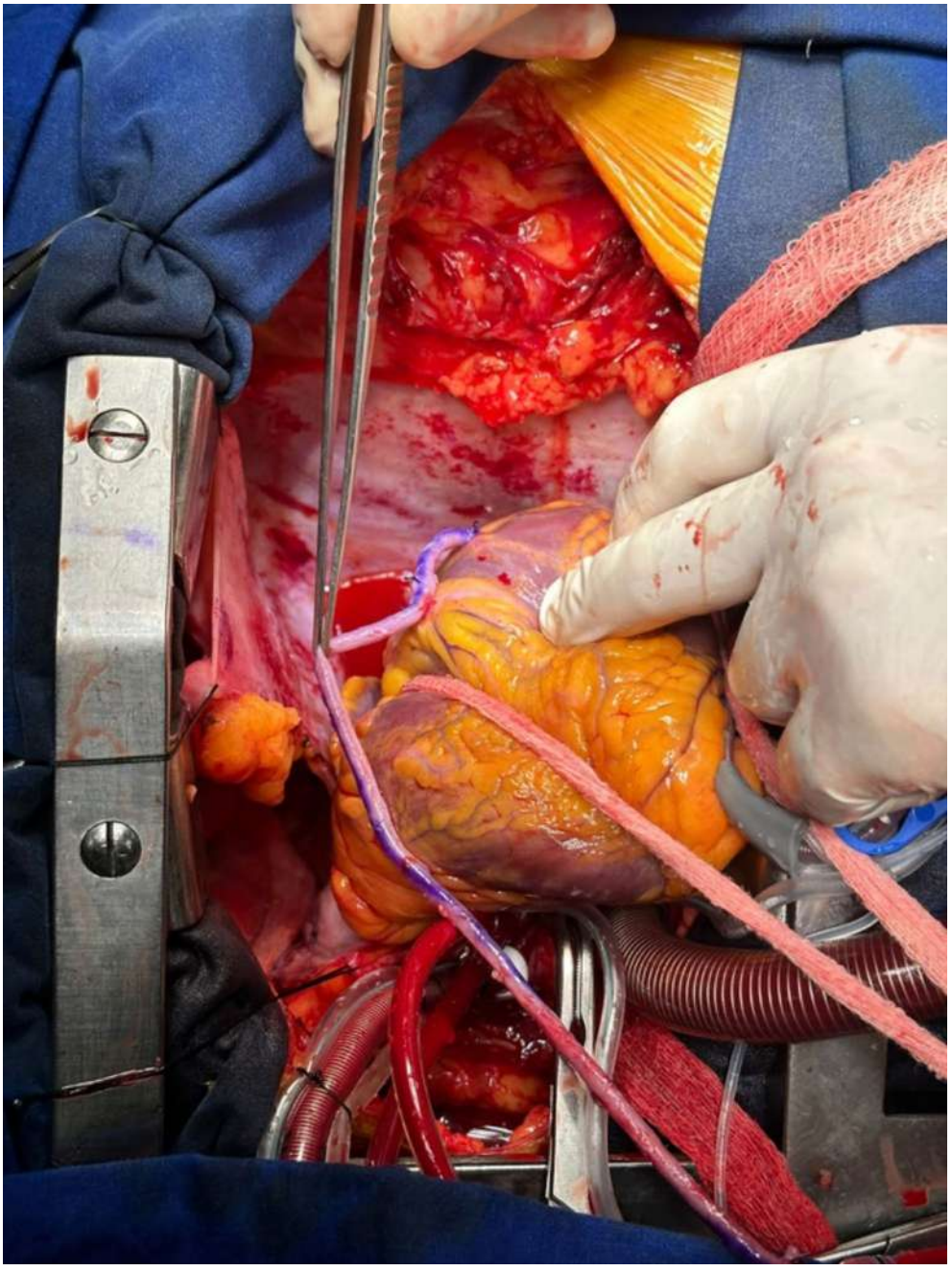

Photo 8.2. The possibility of kinking of the marked vein is very low.