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ABSTRACT

Purpose: Porcelain aorta is an indication for axillofemoral bypasses; however, they have definitive flaws. We present a new method for achieving aortofemoral bypasses.

Methods: The portion of the distal aorta for anastomosis is wrapped with a double teflon mesh, and fixed to the adventitia with continuous sutures. The adventia of the anastomotic site is cut over the mesh until the calcified surface is disclosed. Margins of the mesh and the peeled adventitia are fixed along the anastomotic margin with continuous sutures. After the aorta and distal arteries are occluded by balloon catheters, an opening on the bared calcification is made by an airdrill and enlarged by a laminectomy rongeur. The anastomosis is performed between a graft and the mesh-reinforced adventitia using continuous sutures. Over 6 years, this method has been applied to 9 diabetic and/or dialysis patients with porcelain aorta. The indication were disabling claudication in 3 and limb salvage in 6.

Results: There were no anastomotic complications or operative death, and satisfactory mid-term results with a range of 3-62 months after surgery were obtained. One patient died of coronary heart disease 3 years postoperatively, but the grafts retained a good function.

Conclusion: The present method is safe and effective; more liberal application of this method may help improve outcome and quality of life.

INTRODUCTION

An aortofemoral bypass is the procedure of choice for aortoiliac occlusion; however, patients' high-risk and/or certain local factors prevent use of this conventional procedure. Porcelain aorta, which is frequently found in diabetic and/or dialysis patients, is an absolute local factor, and in such cases axillofemoral bypasses have been preferred as an easier and less invasive alternative procedure. However, when compared with aortofemoral bypasses, axillofemoral bypasses have the following definitive flaws: a lower patency rate,1 a significant incidence of specific complications such as proximal disruption2 or thromboembolism,3 and probably a higher graft infection rate and restrictions on physical activities, which decrease the patient's quality of life. Current aggressive approaches of percutaneous and surgical coronary revascularization have attained acceptable immediate-term outcomes for diabetic and/or dialysis patients with ischemic heart disease.4,5 This improvement in longevity and quality of life may be negated in such patients when axillofemoral bypasses are performed due to porcelain aorta. In opposition to recent reports of the compatible long-term patency of axillofemoral bypasses,6,7 there is acknowledgement that the indication for aortofemoral bypasses should be extended. With this background, current advances in vascular techniques may not justify axillofemoral bypasses only because of a porcelain aorta. In the present paper, we report a safe and reliable anastomosis method which enables aorto-femoral bypasses in patients with porcelainized aorta.

MATERIALS AND METHODS

Patients

Between May 1995 and March 2001, 220 patients with chronic lower limb ischemia underwent bypasses for aortoiliac occlusive disease. Of the 220, 12 were diagnosed, due to encircling calcification seen on a preoperative routine CT scan, as having a porcelain aorta for which

axillofemoral bypass was expected (Fig. 1). Of these 12, 9 received the method we are reporting. This group included a long history of diabetes in 7, dialysis caused by diabetes in 3, and dialysis caused by glomerulonephritis and polycystic kidney in one each. The remaining 3 had axillofemoral bypasses because of high risk or lack of preoperative cardiac evaluation. Mean age of the 9 patients was 66.3±9.2 years (range: 48-74 years), and there was only one female. The indications for operation were longstanding disabling claudication in 3 patients and limb salvage in 6. Preoperatively, all of the patients were subjected to screening magnetic resonance angiography (MRA) for carotid artery stenosis and dipyridamole-stress-thallium imaging for coronary artery disease, and subsequent coronary angiography if necessary. The procedures included 8 aortofemoral (-femoral)-popliteal or crural bypasses and one unilateral femoral bypass. In the preoperative examination, coronary artery disease was found in 4 patients, of which two required off-pump coronary artery bypass grafting followed by aortofemoro-popliteal bypasses or preoperative percutaneous coronary intervention.

All of the patients were followed up every 3 months for the first 2 years and every 6 months thereafter. The graft patency was easily comfirmed by palpation of the graft pulses and duplex scan, and by MRA imaging in selected cases. Aneurysm formation at the proximal anastomosis was evaluated by routine postoperative CT scans and/or three dimensional reconstruction from spiral CT data at 1 and 6 months, and annually thereafter.

Operative Technique

A lower paramedian incision was made, and the distal abdominal aorta was exposed through a retroperitoneal approach. Two vessel loops were applied to the expected anastomotic site of the aorta, and the adjacent lumbar arteries were ligated and dissected. After the distal aorta was dissected free from the vena cava and surrounding tissue, the anastomotic site was wrapped

with a double teflon mesh (#0117841, Bard, USA). The longitudinal suture line of the wrapped mesh should be located at the left posterolateral aspect of the aorta, and fixed to the adventitia with continuous 4-0 polypropylene (PP) sutures (Fig. 2A); the distal and proximal margins of the mesh were tacked to the adventitia of the aorta with 4-0 PP, as well. After intravenous heparin administration, the left iliac artery was ligated to prevent atheroembolism due to the aortic occlusion balloon catheter (12F-10, IDEAS FOR MEDICINE, FL, USA), which was then inserted through an uncalcified spot proximal to the ligation. A 5 French Fogarty thrombectomy balloon catheter or embolectomy-irrigation balloon catheter (DL-5F-IE-40, IDEAS FOR MEDICINE) was also inserted from the common femoral artery for occlusion of the right common iliac artery. When it seemed impossible to insert the aortic occlusion balloon from the left iliac artery because of organized thrombus, the right common femoral artery was used. On palpation of the aorta, when the porcelain aorta had crevices and was compressible, a cross-clamp using the Fogarty hydrogrip clamp was applied at the crevices parallel to the opposed calcification plates. After the occlusion balloons were adequately placed distal and proximal to the anastomotic site, the adventitia at the anastomotic site was cut over the mesh by a sharp-bladed knife until the calcified surface was disclosed. The adventitia was peeled from the calcified surface sufficiently to provide a sufficient suture margin for anastomosis. The peeled adventitia and the margin of the mesh were fixed along the anastomosis with continuous sutures of 4-0 PP (Fig. 2A). After the occlusion balloons were inflated to an adequate size proximal and distal to the anastomotic site, an opening on the bared calcification at the anastomotic site was made by an air-drill with a diamond tip (Fig. 2B), and enlarged by a laminectomy rongeur to an adequate anastomotic caliber (Fig. 2C). Before use of the rongeur, it was important to check the balloons so as not to burst them. If the inflated balloons were visible

through the anastomotic opening, or if there was excessive bleeding from the aortotomy, the occlusion balloons were redeployed at an adequate position. Bleeding from the anastomotic opening during aortic balloon deflation during the redeployment was easily controllable by occlusion with a fingertip. The calcification at the anastomosis should be removed by about 5 mm greater than the fixed adventitial caliber. The anastomosis was performed between an 8 mm-diameter polyester graft and the mesh-reinforced adventitia using 4-0 PP continuous sutures (Fig. 2D). Before deflation of the occlusion balloons, an application of fibrin glue to the anastomotic site was useful for control of oozing, and for enhancing adhesion between the adventitia and the mesh. Anastomosis to a porcelain femoral artery was performed in the same manner.

RESULTS

All of the 9 patients had porcelain calcification in the infrarenal abdominal aorta and most of the iliac and femoral arteries. Of the 9 patients, a proximal aortic clamp was applicable at a crevice in a gentle manner in 3 patients, but the remaining 6 required application of a balloon occlusion technique. Inferior vena cava was adherent to the porcelain aorta in 2 cases, but there was no serious bleeding during the dissection, nor complications during anastomotic procedures such as bursting of the occlusion balloon with excessive hemorrhage. Oozing through the mesh-adventitia complex occurred in one dialysis patient, but complete hemostasis was attained through a 10-minute manual compression. The mean clamp time for the proximal anastomosis was 30.6±8.6 minutes. Amount of bleeding during aortic anastomosis was minimal in 8 patients, but one dialysis patient had blood loss over 300 ml due to inadequate balloon occlusions for the opening of lumbar arteries at the anastomotic site. With 17.4 months of mean follow up period (range 3 - 62), all of the grafts were patent and continued a good function, and

no pseudoaneurysms or dissections were recognized (Fig. 3). Although one patient died of coronary heart disease 3 years after surgery, 8 patients returned to daily life or full-time work.

DISCUSSION

Rubin et al. reported anastomotic technique for small caliber porcelainized arteries and its significant long-term results,8 whereas there were no reports regarding anastomosis to procelain aorta. In the present method, the distal aorta is chosen as the site of the proximal anastomosis because of its easier accessibility, and noninterference with the inferior mesenteric artery perfusion. When the distal aorta occasionally adheres to the inferior vena cava, special precaution should be taken to avoid damage to the distal inferior vena cava. In the graft anastomosis to the porcelain aorta, a side-to-end fashion should be employed for technical safety. In patients with bilateral iliac artery occlusion, end-to-end aortic anastomosis for aorto-bifemoral bypass is technically possible; however, when accidental rupture of the proximal occlusion balloon happens, rush exsanguination from the aortic stump may lead to cardiac arrest. In cases requiring bifemoral bypasses, aortofemoral and femoral graft-femoral crossover bypasses through an anterior extraperitoneal route along the pubic margin are recommended as an alternative procedure.

We used teflon mesh for the anastomotic reinforcement. Robicsek9 reported an external grafting procedure for thoracic aortic aneurysms, with acceptable long-term results. In the procedure, aneurysms were dissected free, and wrapped with longitudinally opened polyester grafts. However, Dhillon et al.10 reported cases with late aneurysmal rupture after the wrapping operation, stating that the ruptures were probably a consequence of the expansible hemodynamic forces associated with pulsatile flow within the aorta. In terms of the favorable healing properties of the wrapping material, Tanabe et al.11 reported acceptable long-term

results regarding mesh wrapping in eight patients with aortic aneurysms, and emphasized that mesh materials exhibited excellent compatibility, durability, and healing properties in long-term clinical observation. Based on these reports, we employed the double layer mesh in order to increase the effect of reinforcement and to achieve good healing.

Axillo-femoral bypasses have been performed on patients with high operative risk and/or local factors which increase the possibility of anastomotic complications or technical difficulties. Heavily calcified and unclampable aorta is a definitive local factor in determining whether or not to employ axillofemoral bypasses; however, there are many active workers among dialysis patients, who commonly have a porcelain aorta but are not necessarily high risk and would not be satisfied with the results of axillofemoral bypass. This is a reasonable alternative to axillofemoral bypassing, although the long-term patency of this technique has not been conclusively proven to be superior to axillofemoral bypassing and its use adds the additional concern about possible late formation of anastomotic false aneurysms at the proximal site.

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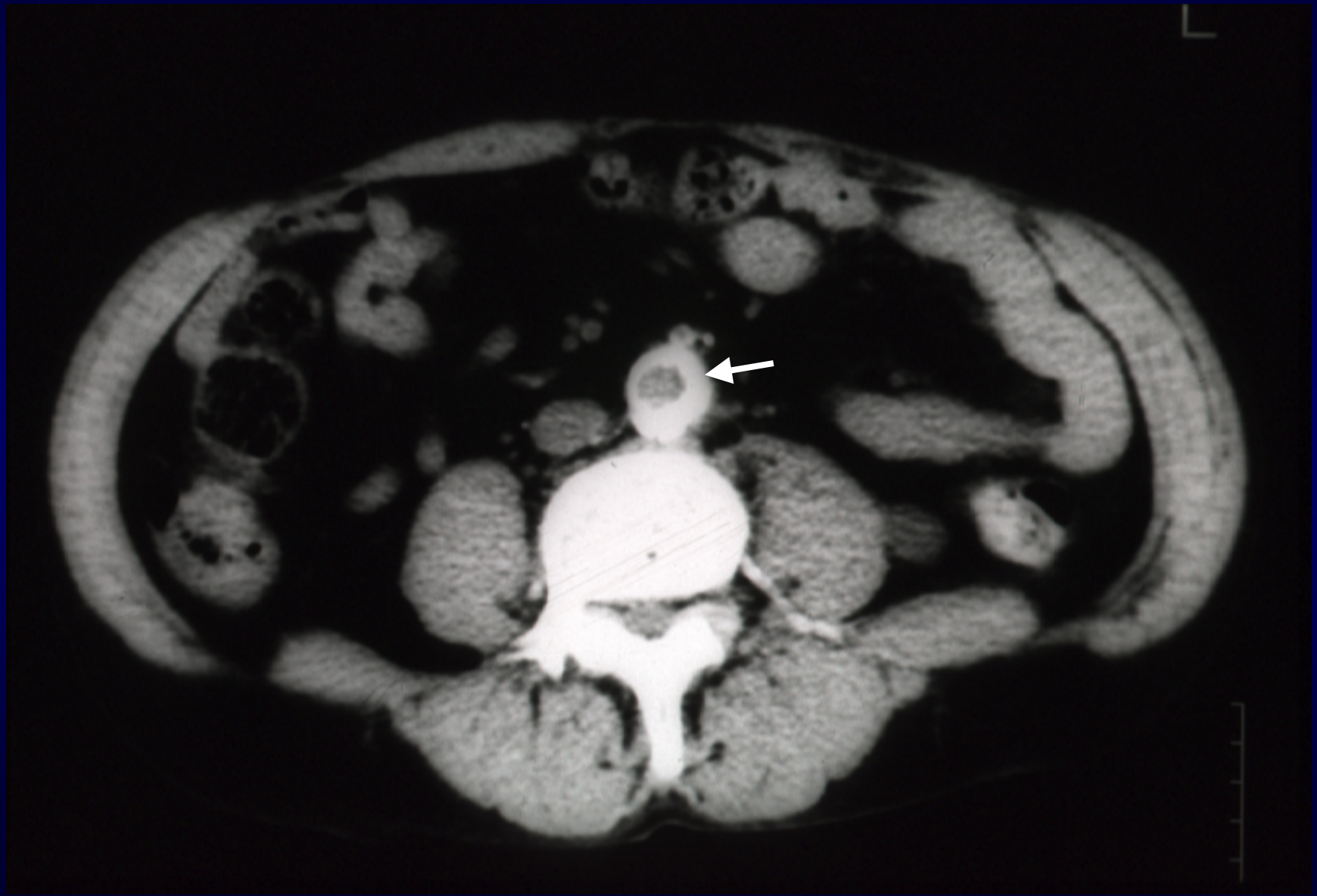
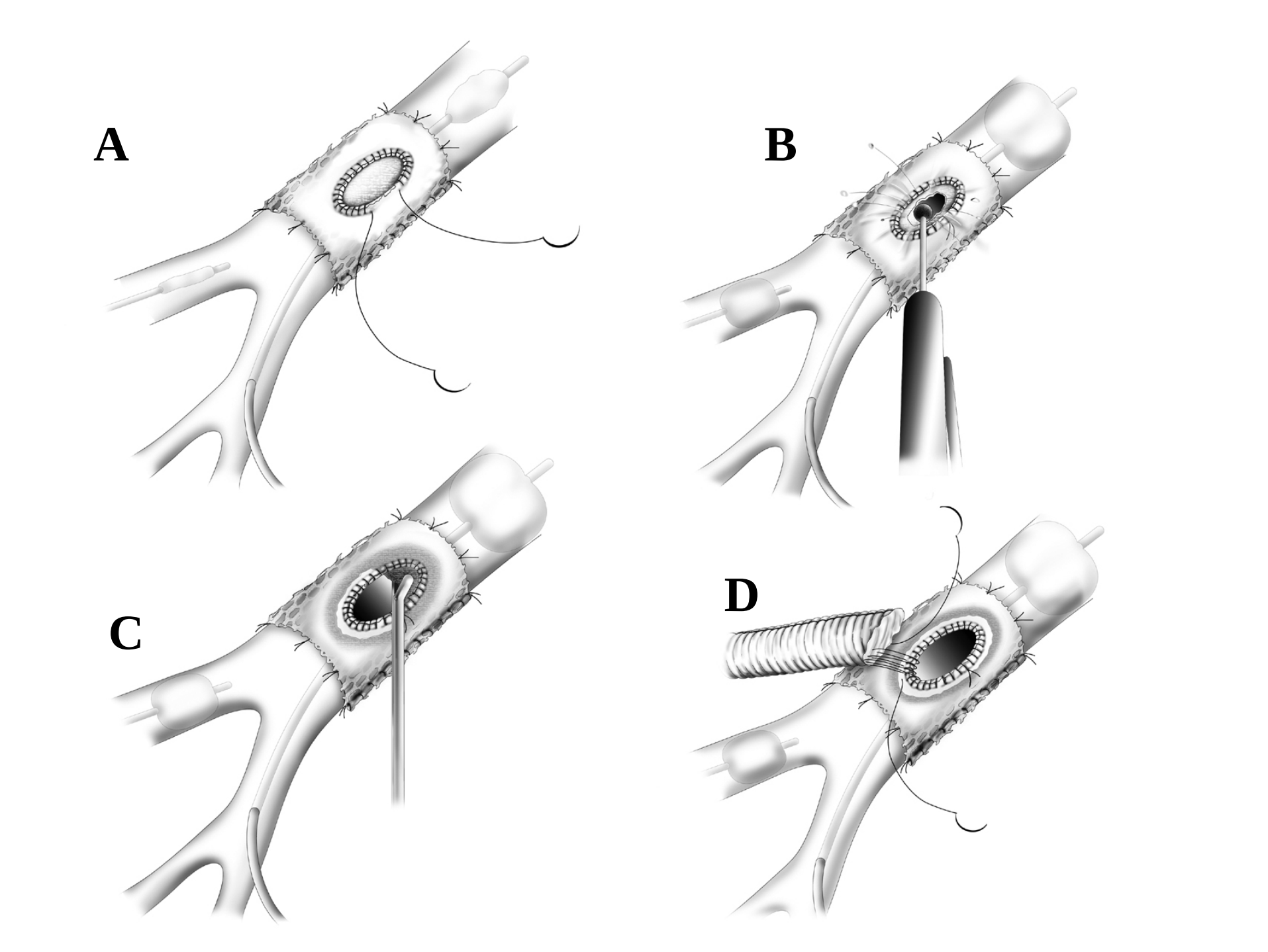
LEGENDS

Figure 1: Porcelain aorta (arrow) seen in a 48-year old dialysis patient.

Figure 2: Anastomotic techniques. A, mesh wrapping of anastomotic site: the longitudinal suture line should be located at the posterolateral aspect of the aorta; the mesh is fixed with the adventitia at the suture line and the proximal and distal margins; B, exposed calcification is penetrated by an airdrill; C, the opening is properly enlarged for anastomosis by a laminectomy rongeur; D, anastomotic suturing is performed between a polyester graft and the mesh-reinforced adventitia.

Figure 3: Postoperative arteriogram of aorto-right femoral bypass by the present procedure (arrow=proximal anastomosis of bypass using a polyester graft)

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