Operative Techniques in
Thoracic and
Cardiovascular Surgery

Anatomic Repair of Recurrent Aortic Arch Obstruction

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Children undergoing repair of aortic coarctation are at lifelong risk of developing recurrent aortic obstruction. Several surgical techniques have been described to address this challenging problem. Some centers have used extraanatomic aortic bypass techniques to avoid dissection on the previously operated field. We have favored a technique that relies on anatomic reconstruction. Although a repeat end-to-end anastomosis via a thoracotomy is possible in some cases, we have found that a strategy using a median sternotomy, cardiopulmonary bypass, and antegrade cerebral perfusion yields the best results. This technique allows for complete relief of obstruction and concomitant repair of intracardiac anomalies and limits the use of conduits in growing children.

Several different surgical techniques are used at Texas Children's Hospital for anatomic repair of recurrent aortic obstruction. These techniques (aortic arch advancement, ascending sliding arch aortoplasty, patch aortoplasty, and interposition graft plasty) are described in this article. The particular technique used is based on the age of the child, prior surgical interventions, the mobility of the aorta, and the anatomy of the defect.

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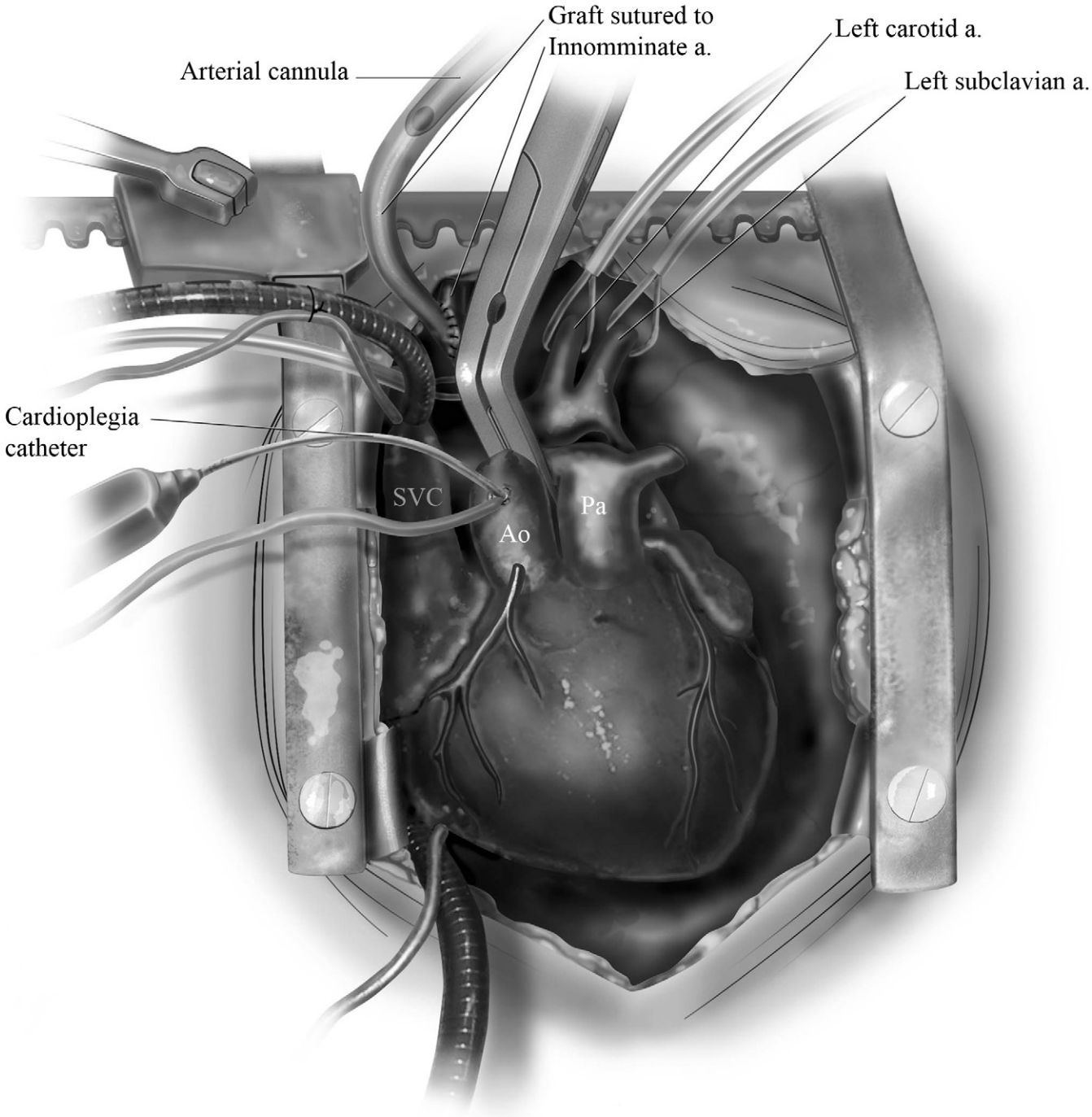

Figure 1 A median sternotomy is performed. The ascending aorta, aortic arch, brachiocephalic vessels, and descending aorta are dissected as much as possible before instituting cardiopulmonary bypass. Particular attention must be taken to make every effort to preserve the left recurrent laryngeal nerve that will be traveling around the aortic arch. An appropriately sized Gore-Tex graft is sutured to the innominate artery and the arterial cannula is inserted into the graft. Bicaval cannulation is achieved and cardiopulmonary bypass is initiated. Further dissection is carried out as the patient is cooled to 18°C. Antegrade cardioplegia is administered into the aortic root after application of an aortic cross-clamp. A right atriotomy is performed and the left heart is vented through the atrial septum. Cardioplegia is repeated every 20 minutes via an antegrade cardioplegia catheter in the aortic root or a handheld device. The head vessels and descending aorta are controlled with tourniquets or clamps and a period of antegrade cerebral perfusion is started. a. = artery.

Setup

All techniques involve a similar setup with median sternotomy, cardiopulmonary bypass, and antegrade cerebral perfusion (Fig. 1). Deep hypothermic circulatory arrest is kept at a minimum by suturing a graft to the innominate artery and providing antegrade cerebral perfusion during the aortic reconstruction.

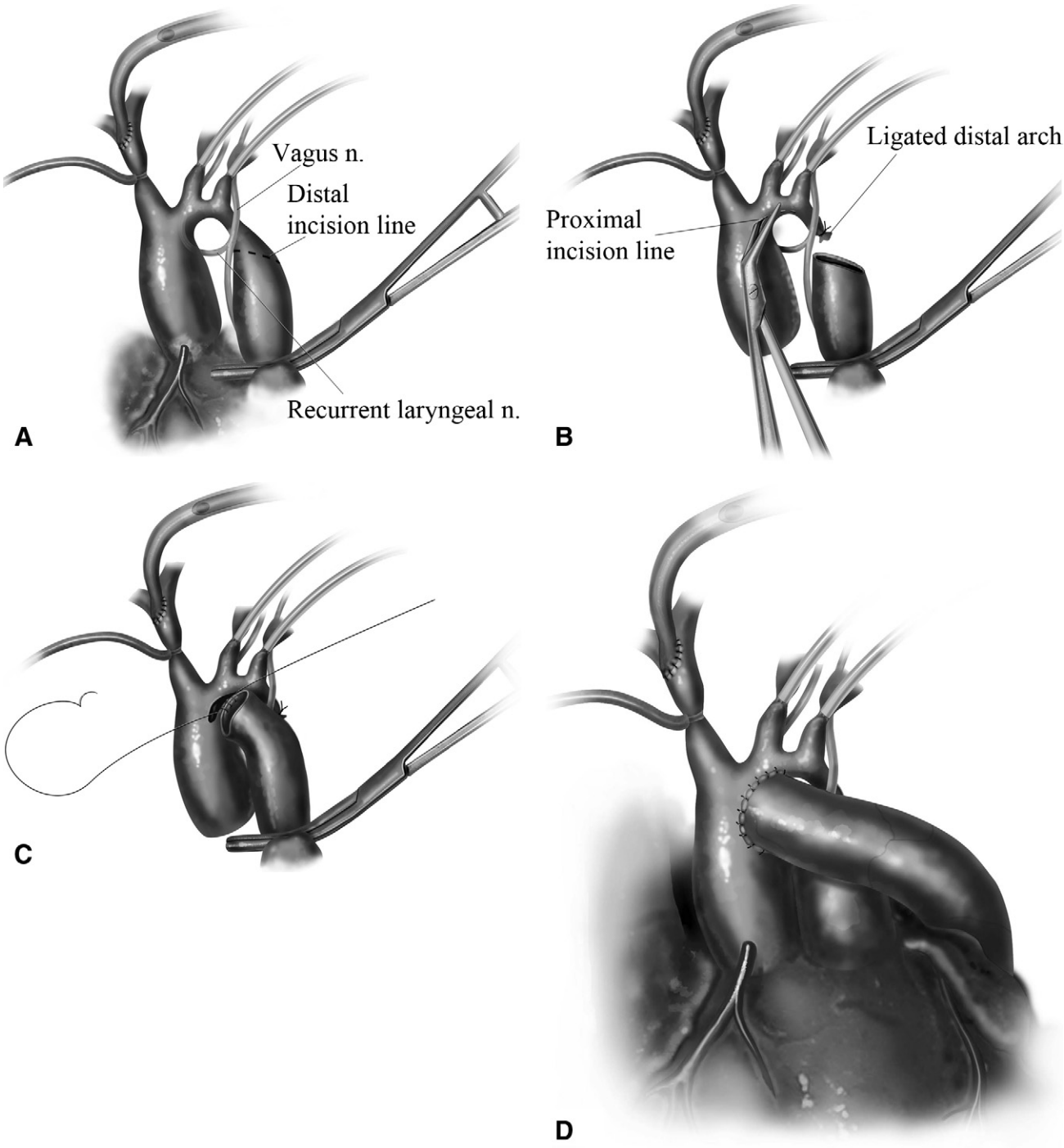

Figure 2 Technique of aortic arch advancement. (A) The descending aorta is divided a few millimeters distal to the coarctation site. The proximal end is tied off just distal to the left subclavian artery. (B) A longitudinal incision is performed on the left aspect of the distal ascending aorta and proximal arch to correspond to the diameter of the descending aorta. (C) The descending aorta is brought forward and anastomosed to the ascending aorta using a continuous 6-0 or 7-0 Prolene suture. (D) The completed anastomosis. n. = nerve.

Aortic Arch Advancement

The technique of aortic arch advancement is useful mainly for infants and toddlers that have an elastic enough aorta to allow translocation of the descending aorta into the distal ascending aorta/proximal arch without tension. Full dissection of the aorta as distal as possible allows for greater mobility (Fig. 2).

Ascending Sliding Arch Aortoplasty

The technique of ascending sliding arch aortoplasty involves enlarging the coarctation site by sliding the ascending aorta posteriorly. This technique is favored over aortic arch advancement in children beyond infancy to decrease tension in the anastomosis, as the elasticity of the aorta decreases with age (Fig. 3).

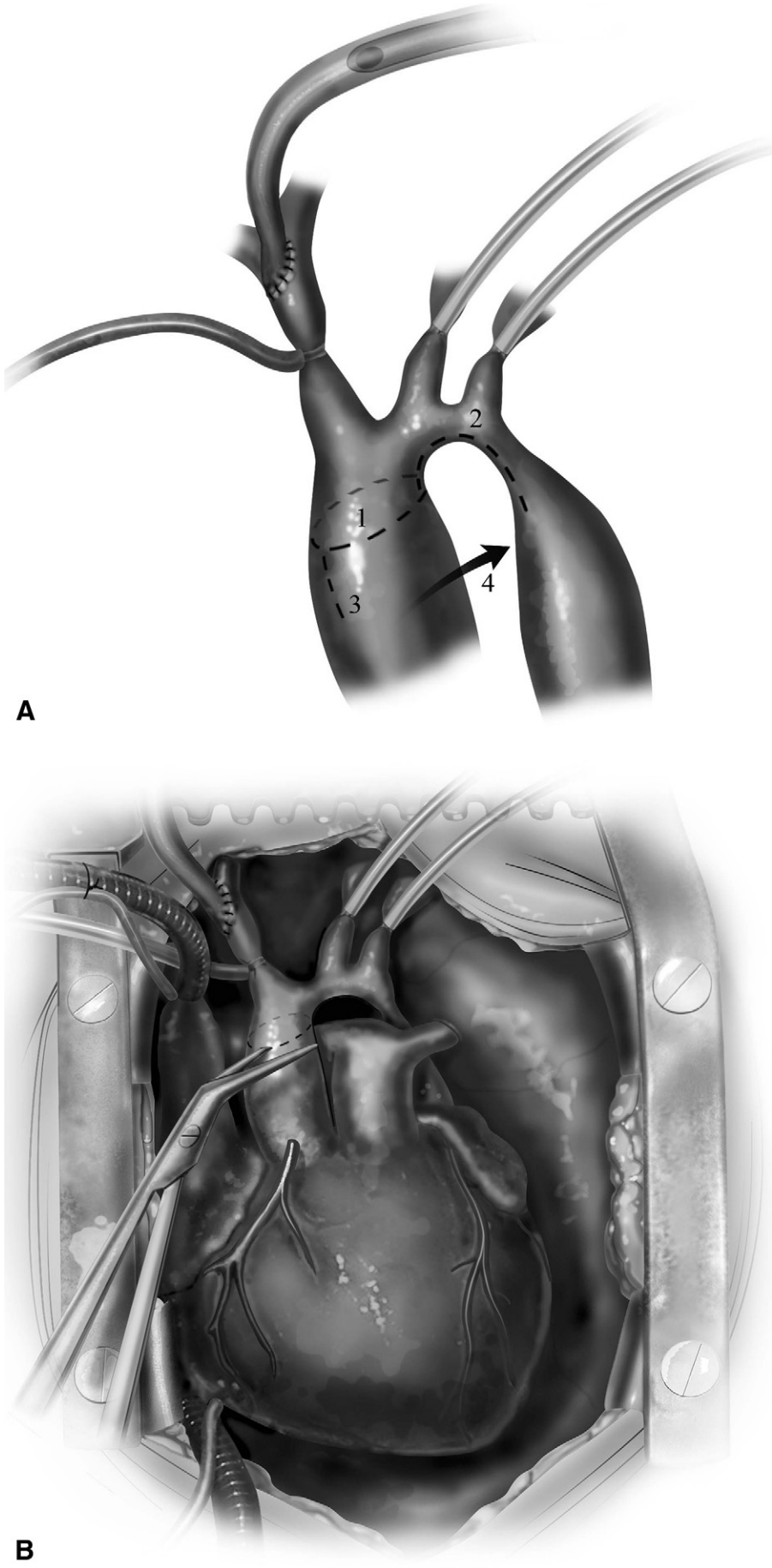

Figure 3 Technique of ascending sliding arch aortoplasty. (A) The overall goal of this technique is to enlarge the coarctation site by sliding the ascending aorta posteriorly through a set of separate incisions. (B) The ascending aorta is divided just proximal to the innominate artery. The incision is performed in a slightly oblique fashion to include part of the undersurface of the aortic arch.

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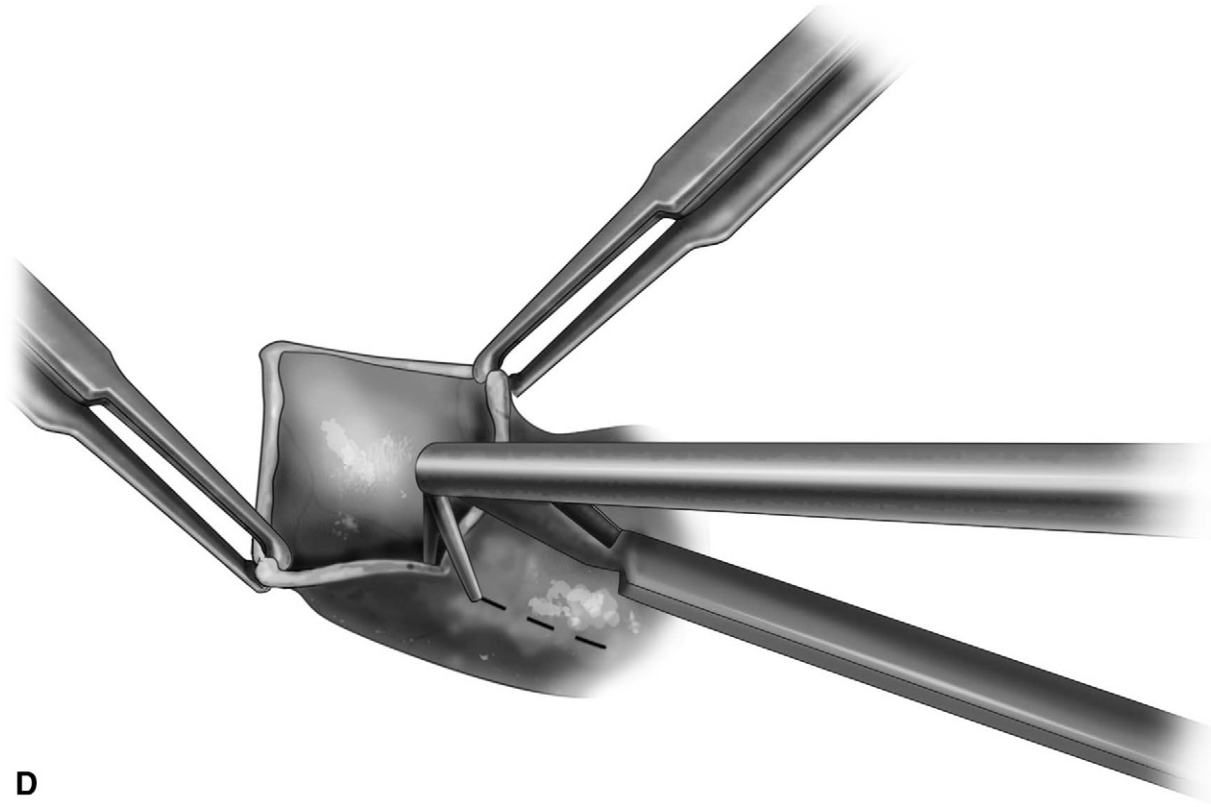

D

Figure 3 (*Continued*) (C) An incision is made on the undersurface of the arch extending from the prior incision to a few centimeters past the coarctation segment on the descending aorta. (D) A longitudinal incision is performed on the right aspect of the ascending aorta extending proximally from the cut edge for a few centimeters to enlarge the ascending aorta.

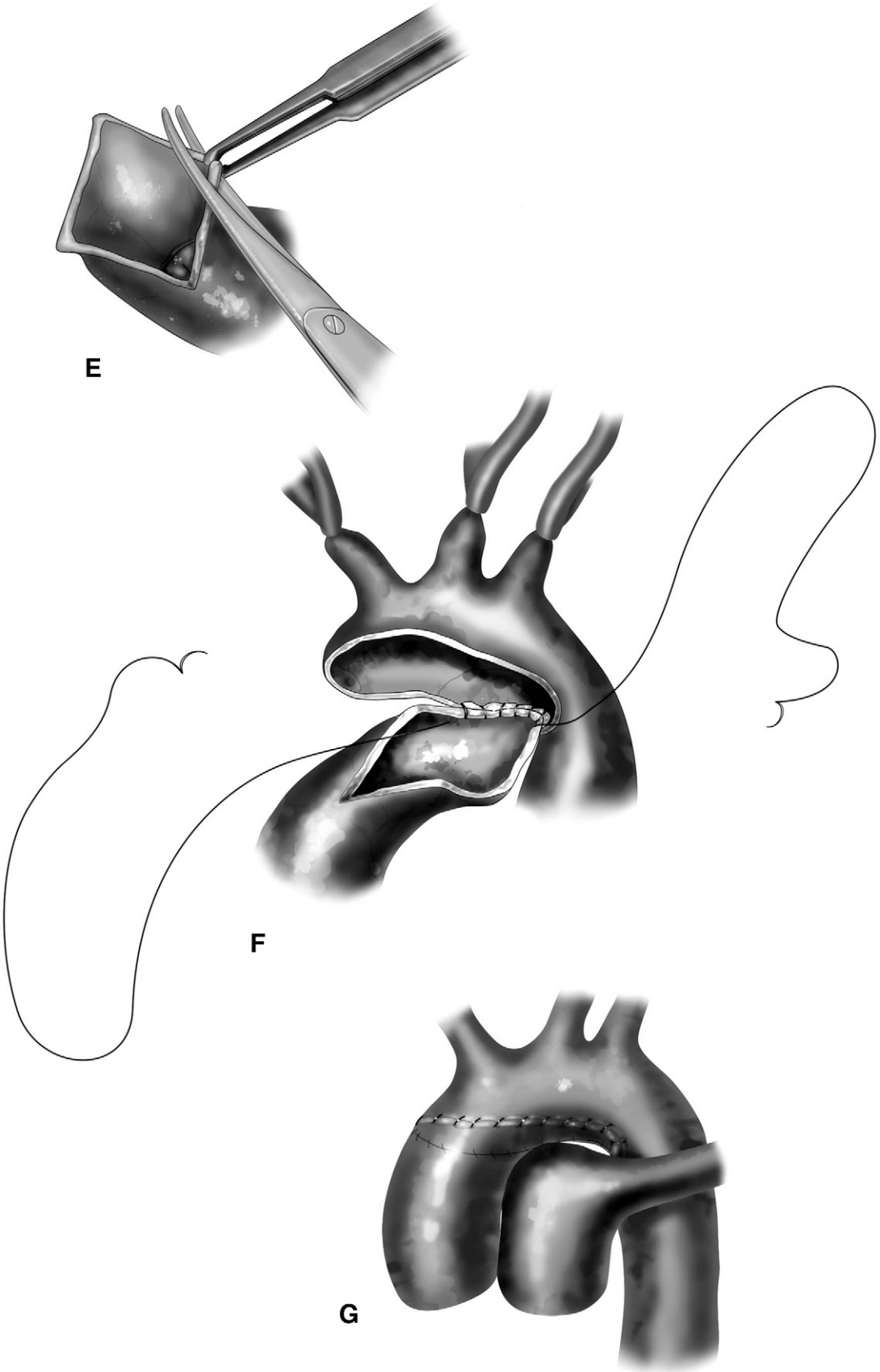

Figure 3 (*Continued*) (E) The corners of the ascending aorta are trimmed. (F) An anastomosis is performed between the ascending aorta and the incision encompassing the undersurface of the aortic arch and proximal descending aorta, with the apex of the ascending aorta corresponding to the apex of the descending aortic incision. (G) The completed anastomosis.

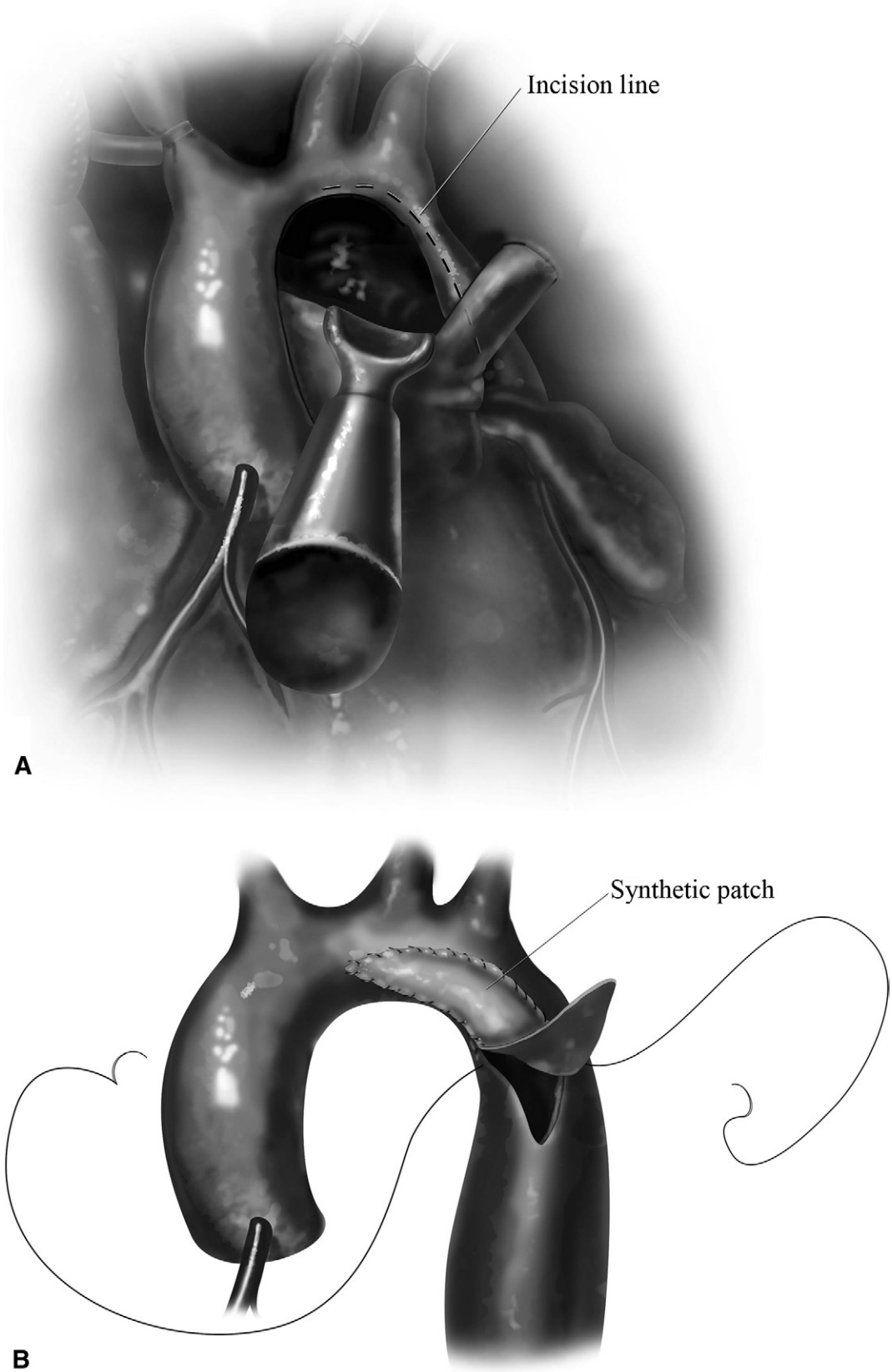

Figure 4 Technique of patch aortoplasty. (A) A longitudinal incision is created on the aortic arch and descending aorta encompassing a few millimeters on each side of the coarctation site. (B) A patch of glutaraldehyde-treated pericardium, Dacron, or Gore-Tex is used to enlarge the coarctation site.

Patch Aortoplasty

Patients with restricted mobility of the tissues precluding an arch advancement of the aorta or an ascending sliding arch aortoplasty or those with an extensive area of coarctation may benefit from patch enlargement of the coarctation site (Fig. 4).

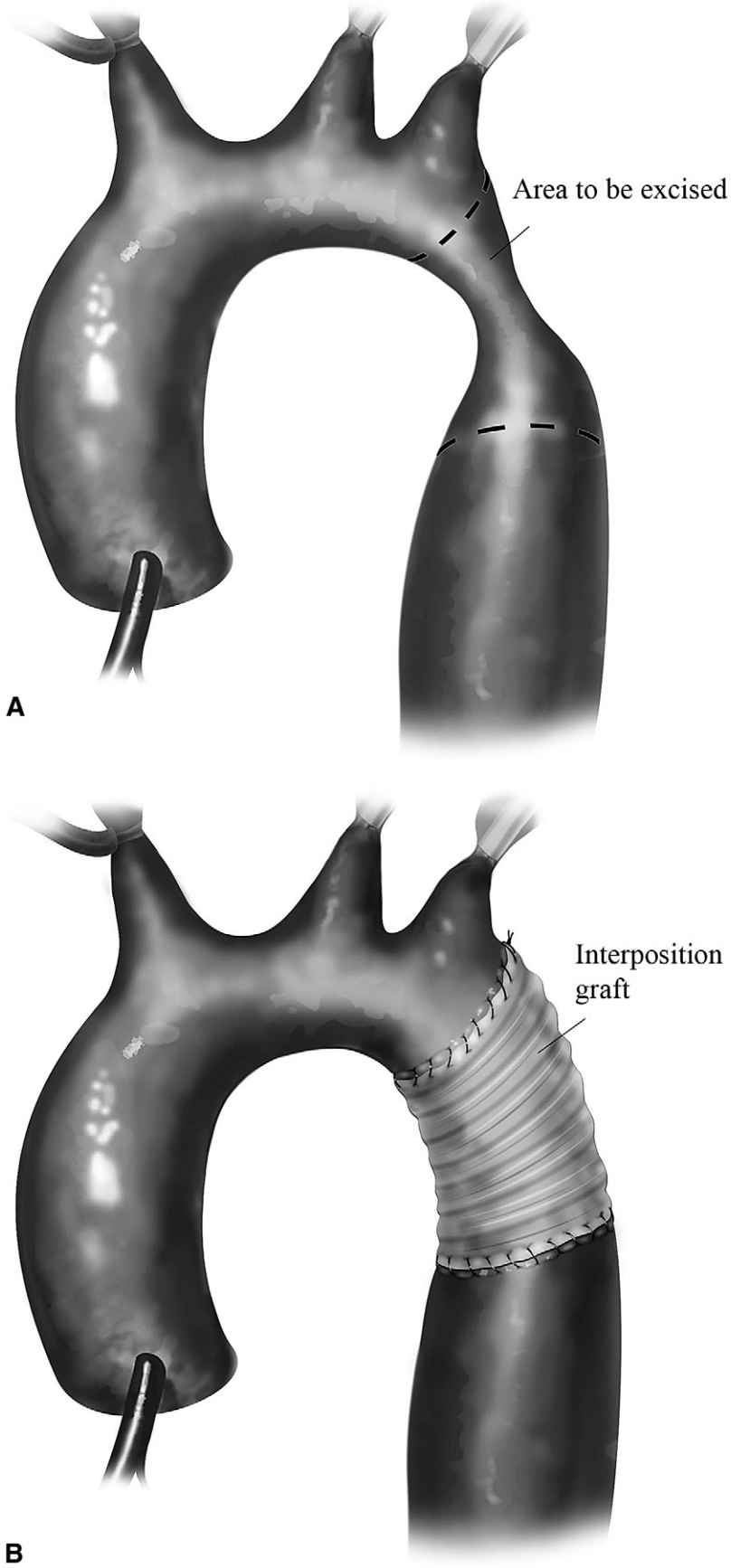

Figure 5 Technique of interposition graft placement. (A) The aorta is divided proximal and distal to the coarctation segment, excising the segment. (B) An adequate cuff must be left proximally to allow suturing of the interposition graft. A Dacron graft is used for this technique.

Interposition Graft Placement

Placement of an interpositional graft is an alternative technique useful in cases with a long coarctation segment, particularly in patients who have previously undergone a subclavian flap procedure. This technique is avoided if possible in young children because it does not allow for growth of the conduit (Fig. 5).

Results

Our group recently published the results of using anatomic techniques to repair recurrent aortic obstruction.[1] The report included 21 patients aged 7.8 ± 5.4 years (range, 0.2-15 years) with recurrent aortic arch obstruction. The procedure was performed via a thoracotomy in 2 patients; one underwent re-resection and end-to-end anastomosis and the other underwent a patch aortoplasty. The remaining 19 patients required a median sternotomy and cardiopulmonary bypass to perform aortic arch advancement (n = 10), patch aortoplasty (n = 8), or interposition grafting (n = 1). There was one perioperative death. No patients had required subsequent aortic interventions at 85 months postoperatively and only 2 patients had a 10 mm Hg arm-to-leg pressure gradient.

The technique of ascending sliding arch aortoplasty was recently described by our group.[2] This report included 8 patients aged 18 months to 15 years, of which 3 had prior procedures for aortic coarctation. There were no mortalities or major morbidities and no patient had recurrent or residual obstruction at 36 months' follow-up.

Conclusions

Anatomic repair of recurrent aortic obstruction can be safely performed using one of the techniques described in this article. Anatomic repair is almost always feasible for the treatment of recurrent obstruction even when the initial repair has included placement of an interposition graft. We have successfully treated patients with previous interposition grafts using the patch plasty technique or placed a new interposition graft in an anatomic position.

Although some recurrent obstructions may be repaired using an extended end-to-end anastomosis technique via a left thoracotomy, we have found that a median sternotomy with cardiopulmonary bypass allows an easier anatomic reconstruction with good results. Antegrade cerebral perfusion has allowed us to perform complex aortic reconstructions without the use of deep hypothermic circulatory arrest. The decision of which particular technique to use depends on the age of the patient, the anatomy of the obstruction, prior surgical interventions, and the elasticity of the tissue.

References

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2. McKenzie ED, Klysik M, Morales DL, et al: Ascending sliding arch aortoplasty: A novel technique for repair of arch hypoplasia. Ann Thorac Surg 91:805-810, 2011