Outcomes after aortic graft-to-graft anastomosis with an automated circular stapler: A novel approach

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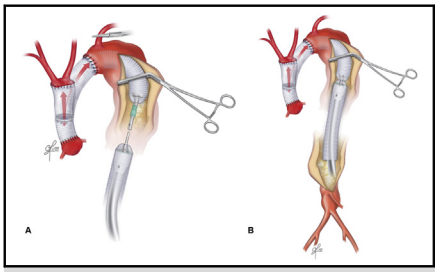
ABSTRACT

Objective: Patients with complex aortic disease often require multistaged repairs with numerous anastomoses. Manual suturing can be time consuming. To reduce ischemic time, a circular stapling device has been used to facilitate prosthetic graft-to-graft anastomoses. Objectives are to describe this technique and assess outcomes.

Methods: From February 2009 to May 2014, 44 patients underwent complex aortic repair with a circular end-to-end anastomosis (EEA) stapler at Cleveland Clinic. All patients had extensive aneurysms: 17 after ascending dissection repair, 10 chronic type B dissections, and 17 degenerative aneurysms. Stapler was used during total arch repair as an end-to-side anastomosis (n = 36; including first stage elephant trunk [ET] in 32, frozen ET in 3) and an end-to-end anastomosis during redo thoracoabdominal repair (n = 11). Three patients had the stapler used during both stages of repair. Patients underwent early and annual follow-ups with computed tomography analysis.

Results: There were no bleeds, ruptures, or leaks at the stapled site, but 2 patients died. Complications included 7 reoperations not related to the site of stapled anastomosis and 6 tracheostomies, but there was no paralysis or renal failure. Mean circulatory arrest time was 16 ± 5 minutes. Mean follow-up was 26 ± 17 months and consisted of imaging before discharge, at 3 to 6 months, and at 1 year. Planned reinterventions included 21 second-stage ET completion: Endovascular (n = 18) and open (n = 3). There were 4 late deaths.

Conclusions: Use of an end-to-end anastomotic automated circular stapler is safe, effective, and durable in performing graft-to-graft anastomoses during complex thoracic aortic surgery. Further evaluation and refinement of this technique are warranted. (J Thorac Cardiovasc Surg 2016;152:1052-7)



Descending aortic graft-to-graft anastomosis with an automated circular stapler.

Central Message

The use of an end-to-end anastomotic stapler is a safe and effective technique for graft-to-graft anastomosis during aortic surgery.

Perspective

Patients with extensive aortic disease often require multistage repair involving numerous anastomoses. A durable aortic graft-to-graft anastomosis can be safely performed with an end-to-end anastomotic automated stapler during complex aortic reconstruction.

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Patients with extensive aortic aneurysms often require multistage repairs that involve numerous anastomoses.[1-4] Minimizing circulatory arrest time, as well as cardiac, systemic, and spinal ischemic times, during these complex repairs improves outcomes.[1] Automation of any of these anastomoses could save time.

Stapling devices are currently used routinely in gastrointestinal surgery and have largely replaced the conventional hand-sewn anastomosis.[5-8] We have used a circular endovascular end-to-end anastomotic (EEA) stapler to perform prosthetic graft-to-graft anastomosis during both first and second-stage elephant trunk procedures (Figure 1). We describe the use of this technique and review outcomes.

MATERIALS AND METHODS

Between February 2009 and May 2014, a total of 44 patients underwent complex aortic repair with a circular EEA stapler (Covidien EEA Stapler; Medtronic, Inc, Minneapolis, Minn) used to perform 47 anastomoses (36 end-to-side and 11 end-to-end). Mean age was

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Abbreviations and Acronyms
EEA = end-to-end anastomosis
CT = computed tomography

61 ± 14 years. All patients had extensive degenerative thoracoabdominal disease involving the aortic arch, the thoracic descending aorta, or the thoracoabdominal aorta. Seventeen patients had chronic residual dissection after a previous history of emergency acute type A repair, 10 were seen with chronic type B dissection, and 17 had degenerative thoracoabdominal aneurysm. Mean preoperative maximum aortic diameter was 58 ± 10 mm (Table 1).

During the index operation, the EEA stapler was used to perform an end-to-side graft-to-graft anastomosis in the aortic arch in 36 patients (82%) and an EEA in the descending aorta in 8 (18%). In addition, 3 patients who had first-stage elephant trunk construction done with the EEA stapler went on to have their second-stage performed in an open fashion, again with the EEA stapler used for the distal graft-to-graft anastomosis. These 47 graft-to-graft anastomoses comprise the experience reported here.

The 36 end-to-side anastomoses included first-stage elephant trunk (n = 32), frozen elephant trunk (n = 3), and total aortic arch repair (n = 1). Four of the patients with descending aortic disease had the index operation performed as an elephant trunk completion but did not have the stapler used during their first-stage elephant trunk repair. The other 4 patients with index descending aortic disease had previous open descending repair for graft-to-graft anastomosis. Of the 11 descending EEA stapler anastomoses, 7 were performed as an elephant trunk completion procedure.

Twenty-seven patients underwent 33 concomitant procedures at the time of the index operation, including coronary bypass (n = 9), aortic valve replacement (n = 7), tricuspid valve repair (n = 1), patent foramen ovale closure (n = 1), pulmonary trunk repair (n = 1), ligation of the left atrial appendage (n = 2), and open distal aortic fenestration (n = 12). The last procedure was performed at the time of the first-stage elephant trunk and involved resection of the dissection flap in the retrocardiac segment of the descending aorta to facilitate endovascular elephant trunk completion at a later stage.[4]

All patients required multiple anastomoses for additional procedures, such as reimplantation of the aortic arch head vessels and coronary grafts. Altogether, 303 anastomoses were performed in 44 patients (average of 7 anastomoses per patient) during the index operation at which the EEA stapler was used to perform 1 of the graft-to-graft anastomoses.

Operative Technique

End-to-side aortic arch repair. With the patient under general anesthesia, and after cannulation of the right axillary artery and sternotomy, the patient was placed on cardiopulmonary bypass and cooled to 22°C.[9] During a period of circulatory arrest and selective antegrade brain perfusion, the aortic arch vessels were reconstructed as a unit or independently with single and multibranched Dacron polyester fabric grafts, respectively. Another Dacron polyester fabric tube graft was then inverted on itself and inserted into the distal arch. It was then sutured in position as a modified elephant trunk.[2] The aortic elephant trunk graft was then reduced back into the mediastinum. At this point, the EEA stapler (Figure 1) was used to connect the aortic arch vessel graft to the main aortic elephant trunk graft in an end-to-side fashion (Figure 2 and Video 1).

Depending on the diameter of the aortic arch vessel graft, either 21- or 25-mm × 2.5-mm EEA stapler was selected. The anvil was quickly secured in the aortic arch vessel graft with a polypropylene purse-string suture.

FIGURE 1. End-to-end anastomotic stapler device.

Next, the cartridge-carrying instrument was introduced from proximal end of the main aortic graft and the center rod passed through a small stab incision. The center rod was fitted into the anvil shaft, the instrument was tightened, and the stapler was deployed (Figure 2, *A*). Firing the stapler placed a double staggered circle of titanium staples between the 2 grafts and cut a circular orifice to supply the aortic arch vessel graft (Figure 2, *C*). The instrument containing the graft "doughnuts" was removed, and the anastomosis was visually inspected. The aortic arch vessels were then deaired, the graft was crossclamped proximal to the EEA stapler anastomosis, and full-flow perfusion and rewarming were resumed. A few sutures were typically placed to ensure graft-to-graft hemostasis after perfusion was resumed. Proximal aortic reconstruction was then completed during the rewarming phase.

End-to-end descending aortic repair. With the patient under general anesthesia and with a double-lumen endotracheal tube and a spinal drainage catheter in place, a thoracoabdominal incision was made through the sixth intercostal space. The diaphragm was incised radially, and the retroperitoneum was dissected to obtain sufficient exposure of the thoracoabdominal aorta, with the extent depending on the pathology. The left common femoral artery and the left inferior pulmonary vein were cannulated for atriofemoral partial bypass and active cooling. After clamping of the distal descending aorta, the previous proximal descending graft was clamped or the proximal descending aorta was opened and the elephant trunk graft was quickly grasped and clamped.[2] An appropriate multilimb graft was brought to the field. Depending on the diameter of these grafts, either a 21- or 25-mm × 3.5-mm EEA stapler was selected. The anvil was tied into the distal end of the previously placed elephant trunk graft with a polypropylene purse-string suture. The cartridge-carrying instrument was introduced into the multilimb graft, and a polypropylene purse-string suture was tightened down around the center rod. The center rod was then mated into the anvil shaft, the instrument was tightened, and the stapler was deployed. This created an end-to-end, graft-to-graft anastomosis (Figure 3). After reimplantation of the intercostal arteries, the aortic clamp was repositioned. A few sutures were sometimes needed to secure graft-to-graft hemostasis. The distal anastomosis was created in the standard fashion, either as separate grafts to each of the visceral arteries (preferred technique) or with a Carrel patch to the visceral vessels.

Follow-up and Imaging

All patients with aortic disease were followed up with routine computed tomographic (CT) imaging surveillance at discharge, within the first 3 months, at 12 months after surgery, and then annually thereafter.