Open repair of chronic post-traumatic aneurysms of the aortic isthmus: The value of direct aorto-aortic anastomosis

Edouard Kieffer, MD, Jean-Pascal Leschi, MD, and Laurent Chiche, MD,
Paris, France

Purpose: This report presents our experience with open repair of post-traumatic aneurysms of the aortic isthmus using recent surgical techniques, including distal aortic perfusion and the preferential use of direct aorto-aortic anastomosis without interposition of prosthetic material.

Methods: From 1990 to 2004, the senior author (EK) patients (21 men; mean age, 40.3 years) who presented with post-traumatic aneurysms of the aortic isthmus were treated operatively, either with (20 patients) or without (3 patients) distal aortic perfusion, or endovascularly with a stent graft (3 patients). In 15 (75%) of the 20 patients treated with distal aortic perfusion, the technique consisted of resection followed by direct aorto-aortic anastomosis. Eight patients, including the three patients treated with simple clamping, had prosthetic replacement.

Results: No postoperative deaths or permanent spinal cord complications occurred. One patient required reoperation to control hemorrhage. Aortography or computed tomography angiography was performed on 12 of the 15 patients treated by direct aorto-aortic anastomosis, with a mean follow-up of 88.7 ± 8.9 months. No morphologic abnormality was found.

Conclusion: This study shows that low-risk patients with a chronic post-traumatic aneurysm of the aortic isthmus can be successfully treated with excellent long-term results by resection and direct aorto-aortic anastomosis without prosthetic interposition. In our opinion, endovascular repair should only be used in patients who present with absolute contraindications for open surgical repair. (J Vasc Surg 2005;41:931-5.)

By definition, chronic post-traumatic aneurysm of the descending thoracic aorta develops ≥3 months after injury.1,2 Because these lesions are relatively rare, few surgeons have extensive experience with their repair. With the exception of a few recent case reports,3-5 a consensus has progressively formed in favor of surgical treatment for all low-risk patients.6-15

Although endovascular aortic repair (EVAR) with stent grafts has been increasingly popular in recent years, especially in acute aortic trauma,16-19 its use for the treatment of chronic post-traumatic aneurysms of the descending thoracic aorta remains controversial. Some recommend EVAR only for patients with major surgical risks,20 and others tend to extend indications to all patients.16,21 This study was undertaken to clarify the results of open repair using recent surgical techniques, including distal aortic perfusion (DAP) and preferential use of direct aorto-aortic anastomosis without interposition of a prosthesis.

METHODS

From June 20, 1990, to July 31, 2004, the senior author (EK) treated 26 patients for chronic post-traumatic aneurysms of the aortic isthmus. This represents 9% (26/287) of all aneurysms of the descending thoracic aorta treated in our department during the study period. Excluded from the study were three patients who were treated with EVAR using stent grafts because of poor pulmonary function (2 patients) or older age (89 years) (1 patient). The study population was the remaining 23 patients who underwent open repair with DAP (20 patients) or without (3 patients). There were 19 men and 4 women, with a mean age of 40.2 years (range, 22 to 62 years).

Trauma was caused by traffic accidents in 21 patients (91%), a parachute accident in one patient, and falling from a building in one patient. Nineteen patients presented with multiple major associated injuries, and four presented with isolated aortic trauma. All aneurysms were located at the level of the aortic isthmus; the mean aneurysm diameter was 7.1 ± 2.5 cm.

In 17 patients (74%) the aneurysm was diagnosed several years after the accident, either as a coincidental discovery (14 patients)—usually by a plain chest radiograph showing a rounded, often calcified area in the upper mediastinum—or on clinical symptoms of chest pain in one patient and left bronchial compression in two. These patients were treated with a mean interval of 13.9 ± 8.5 years (range, 1.3 to 32 years) after the trauma. In six patients (26%), the diagnosis of traumatic rupture of the thoracic aorta was made in the emergency department, but surgery was postponed because of associated lesions, usually neurologic and pulmonary. These patients were treated within a mean interval of 4.6 months (range, 3 to 7 months) after the trauma.
Treatment consisted of open repair by posterolateral thoracotomy. Three patients (13%) were treated with simple aortic clamping (mean duration, 28.3 ± 8.1 minutes). Because of time limitations that prevented an extensive release of the aortic arch from being performed, reconstruction was accomplished by prosthetic grafting in all three patients. DAP was used in 20 patients (87%). The DAP technique varied according to surgeon’s preference. In 17 patients (85%), the procedure included partial cardiopulmonary bypass (CPB) that was established from the femoral vein to the femoral artery in 16 and from the pulmonary artery to femoral artery in one. In three patients (15%), a left heart bypass was used from left atrium to descending aorta in two patients and from left atrium to femoral artery in one patient. The mean duration of DAP was 48.3 ± 16.8 minutes (range, 15 to 75 minutes) and the mean duration of aortic clamping was 35.8 ± 11.7 minutes (range, 10 to 53 minutes).

In five patients (25%) operated on with DAP, reconstruction after the resection required prosthetic grafting because the aortic ends were too far apart for direct anastomosis, despite extensive release of the aortic arch. Reconstruction after resection was achieved by direct suture in 15 patients (75%). Direct suture (Fig 1) was facilitated by transection of the proximal aorta distal to the subclavian artery and dissection of the vagus and phrenic nerves, allowing mobilization of the aortic arch. Dissection of the posterior aspect of the aneurysm was avoided to preserve the recurrent laryngeal nerve.

RESULTS

Early results. There were no perioperative deaths. One transient paraparesis occurred in a patient treated with simple clamping and prosthetic grafting. Clamping time was 23 minutes. The deficit completely resolved within 1 week. At the end of the procedure, two patients required resection followed by vein (n = 1) or prosthetic (n = 1) grafting to repair iatrogenic lesions of the femoral artery. One patient underwent reoperation for postoperative bleeding from an intercostal artery. Three patients, including the one that underwent reoperation, required assisted ventilation for >48 hours. In all three cases, postoperative pneumonia resolved within a week. Two patients presented with clinically significant left recurrent nerve paralysis that resolved after a few months with orthophonic rehabilitation.

Late results. Two foreign patients who were treated with resection and prosthetic grafting (n = 1) or direct suture (n = 1) were lost to follow-up after the first month. The follow-up period for the remaining 21 patients was 62.7 ± 14.3 months (range, 3 to 156 months). No clinical complications occurred, including false aneurysm, infection, or anastomotic stenosis. Aortography or computed tomography angiography was performed within a mean period of 58.7 ± 8.9 months in 12 of 15 patients who underwent resection followed by direct suture. Findings showed no morphologic abnormality in any patient (Fig 2).
DISCUSSION

Chronic post-traumatic aneurysms are relatively uncommon. Treatment of these aneurysms is technically simple because aortic involvement is limited, without extensive collateral branching, and because most patients are relatively young and at a low-risk for surgery. In our experience, no postoperative deaths or permanent spinal cord complications occurred, and long-term results were satisfactory. Excellent results have also been reported in the literature.\(^6\)\(^-\)\(^15\)

The poor natural history of chronic post-traumatic aneurysm has been documented in previous studies by Bennett and Cherry\(^1\) in 1967 and by Finkelmeier et al\(^2\) in 1982. In a collected series of 60 untreated patients, Finkelmeier et al\(^2\) reported 20 deaths (33%) caused by aneurysm-related complications, with 17 ruptures that included two aortoesophageal fistulas. Such complications are unpredictable and often occur without warning in patients who remain asymptomatic up to the time of the complication that may develop many years after the traumatic event. A number of cases of rupture, aortobronchial or aortopulmonary fistula, aortoesophageal fistula, or pulmonary or esophageal compression have been reported. Less common complications include infection, embolization, and dissection of the descending thoracic aorta.

Because of the risk of complications, most practitioners currently recommend surgical treatment for all eligible patients regardless of the size of the aneurysm. Only a few authors\(^3\)\(^-\)\(^5\) still advocate surveillance for asymptomatic patients with small aneurysms, especially when they are calcified.

Two techniques are now being used for aortic aneurysm repair: conventional open repair and EVAR with stent grafts. Conventional repair is performed by a left posterolateral thoracotomy. Except for a few authors,\(^6\)\(^-\)\(^15\) there is little discussion on the use of DAP. Our preference is for partial femorofemoral CPB, mainly because it provides optimal oxygenation and can be converted into full CPB for deep hypothermic circulatory arrest. Left heart bypass can also be used.

The main advantage of DAP is that it provides ample time for mobilization of the aortic arch and the supra-aortic vessels. Under optimal conditions, mobilization is performed after complete division of the proximal aorta to allow complete release of the posterior and upper sides of the aorta and supra-aortic vessels. Mobilization of the distal descending thoracic aorta is prevented or limited by the intercostal arteries. Extensive aortic release is a prerequisite for the direct aortoaoarc anastomosis to be sutured after the aneurysm is resected. Because it takes time, it should probably not be performed when simple clamping is used.

Direct suture was feasible in 15 (75%) of the 20 patients in this series treated with DAP. Similar success rates have been reported by several other previous advocates of resection followed by direct suture: Roques et al\(^12\) reported 12 (63%) of 19 cases, Thevenet and Du Cailar\(^13\) reported of 12 (67%) of 18 cases, and Fernandez et al\(^22\) reported 27 (84%) of 32 cases.

Several factors may account for the high success rate of direct suture, including the presence of normal aortic tissue and transverse rupture with no loss of substance. The interval between the ends of the aorta varies, with shorter gaps being associated with partial as opposed to circumferential ruptures.

Since its introduction by Alley et al\(^23\) in 1961 and despite support in France by Fontan et al\(^24\) in 1972, direct suture is still not widespread for the treatment of chronic post-traumatic aneurysms of the aortic isthmus. The most common repair technique is resection followed by prosthetic replacement.\(^6\)\(^,\)\(^7\)\(^,\)\(^10\)\(^,\)\(^11\)
The main advantage of direct suture is that it avoids a number of potential complications associated with prostheses, such as infection, aortobronchial or aortoesophageal fistula, false aneurysm at the anastomoses, and late thromboembolism because of size differences between the prosthesis and the aorta. None of these complications has ever been reported in patients treated with direct suture.

In our opinion, the possibility of a successful direct suture in 60% to 75% of patients, with little or no operative risk, is a strong argument in favor of restricting the use of EVAR to patients who present with high surgical risks. A few reports involving only 30 patients treated by EVAR have already documented the risk of severe complications, including aortoesophageal fistula, endoleaks, left pulmonary atelectasis due to persistence of the aneurysmal sac, and symptomatic thrombosis of the left subclavian artery. A major additional problem with the use of EVAR is the short follow-up with stent grafts (at best a few years).

For these reasons we have preferred open repair in low-risk patients. We have used EVAR only for patients who were elderly or presented with severe respiratory insufficiency, both considered strong contraindications to open repair. This approach to patient selection has also been advocated by Demers et al, who reported the largest series with the longest follow-up of EVAR for post-traumatic aneurysm of the aortic isthmus: 15 patients with a mean follow-up of 55 ± 29 months.

CONCLUSION
The high success rate and low operative risks associated with resection followed by direct suture without prosthetic interposition strongly support the use of open repair for all operable patients with chronic post-traumatic aneurysm of the aortic isthmus. In our opinion, endovascular repair using stent grafts should only be used in patients with absolute contraindications for open repair.

REFERENCES
INVITED COMMENTARY

Richard P. Cambria, MD, Boston, Mass

Post-traumatic aneurysm of the distal arch is an uncommon lesion; the authors, acknowledged experts in central aortic surgery, treated but 26 patients over a 14-year period. A reasonable anticipation is that it will become a rare lesion as stent-graft repair of traumatic tears becomes widely applied (a certainty in my view). Indeed, some 25% of the authors’ patients were managed in circumstances where open surgical treatment for a recognized acute tear was delayed—a common paradigm dictated by severe associated injuries—yet one accompanied by some risk of interval rupture. This scenario is obviated by the availability of stent-graft repair, as described in recent articles in this journal (author references 16 and 19). Given the young patient age (mean, 40 years) and the superb clinical and anatomic results achieved, the authors’ conclusions are valid, yet no inferences as to the future utility of stent-graft repair are possible. Doubtless, the very practical issue of patient preferences and alternatives will be a genuine element as surgeons evaluate and advise these patients.

Certainly, expertly performed open repair is the gold standard, and variations in surgical technique and approach are addressed in the manuscript. There is consensus that such focal lesions, with two clamps in proximity on the arch/descending aorta, are best managed with a distal aortic perfusion technique. In the United States, the usual preference is for partial left heart bypass with a left atrium-to-femoral artery circuit. This is because the more complicated femoral vein-to-femoral artery circuit requires both an oxygenator and large heparin doses. The authors’ rationale for this, namely the potential need for hypothermic circulatory arrest to avoid aortic arch clamping, seems weak because determining the feasibility of a proximal clamp application is a decision that can nearly always be made on the basis of high quality preoperative imaging.

Despite the authors’ excellent results, it is unlikely that their approach will replace graft interposition, which is generally favored in the United States. We have found that complications of graft interposition are rare, and it avoids the more extensive dissection required for aortic mobilization and primary repair. Prosthetic graft interposition is more widely applicable, and in fact, was necessary in 25% of the authors’ cases.

Although the authors indicate that no local or anatomic late complications of primary repair have been reported, our experience with a variety of secondary problems after primary repair at the aortic isthmus does include false aneurysm formation after primary repair for trauma.

The superb late results the authors have achieved are likely due to their meticulous technique of mobilizing the arch extensively to achieve a tension-free anastomosis. This and the technical nuances of the open repair for this lesion introduce consideration of left vocal cord palsy, a common complication of surgery of the distal arch. The authors’ incidence of this complication of about 10% is admirable, even counterintuitive, when one considers the extensive dissection of the arch they advocate to facilitate primary repair. In fact, left vocal cord palsy is a frequent complication in our practice when the arch has to be controlled proximal to the left subclavian artery. Although local remediable procedures on the glottis can be effective treatment for this complication, young patients are unlikely to accept a significant risk of this complication of open repair, since it is totally avoidable with stent-graft repair.

While focusing on a particular and uncommon pathology, this report serves as a preamble, of sorts, to the imminent debate over open versus stent-graft repair of focal thoracic aortic pathology in young, low-risk patients. The authors have demonstrated that expert open surgery is safe and durable. Yet, recapitulating in a sense much of the debates about abdominal aortic aneurysm stent-graft repair, other outcome measures such as functional recovery, avoidance of vocal cord palsies, and post-thoracotomy pain syndrome will be important in the open versus stent-graft repair debate concerning the treatment of thoracic aortic pathology.