Long-term outcomes after entry closure and aneurysmal wall plication for type B aortic dissection

Yuji Miyamoto*, Toshihiro Ohata, Masataka Mitsuno, Mitsuhiro Yamamura, Hiroe Tanaka, Yasuhiko Kobayashi, Masaaki Ryomoto, Shinya Fukui

Department of Cardiovascular Surgery, Hyogo College of Medicine, Hyogo, Japan

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Abstract

Objective: To examine the long-term outcomes after entry closure and aneurysmal wall plication for type B chronic dissecting aortic aneurysm. This procedure uses no artificial graft and preserves all intercostal arteries. Methods: We reviewed the records of 40 consecutive patients who underwent this procedure between September 1983 and December 2002. The mean age at operation was 60 ± 12 years (range, 38–79 years). The mean follow-up period was 9.8 ± 5.1 years (range, 4–23 years). Follow-up was completed in 38 patients (95%). The latest computed tomography scans (n = 22) were obtained 9.5 ± 5.1 years (range, 3–18 years) after surgery. Results: There were no operative deaths and 14 late deaths, none of which were related to the aneurysm. No paraplegia or paraparesis occurred. The survival rate was 92 ± 4% at 5 years and 64 ± 9% at 10 years; 24 patients are still alive. Follow-up computed tomography revealed that the mean diameter of the plicated descending aorta was 31 ± 5 mm (range, 22–39 mm) except in four patients. One of the four patients required reoperation for recurrent aneurysm of the plicated aorta 3 years postoperatively. In the remaining three patients, the plicated aorta has become enlarged; however, these patients have not yet undergone reoperation. Reoperation for residual dissecting aneurysm was performed in another three patients whose plicated aorta was normal. Freedom from reoperation for residual dissecting aneurysm was 78 ± 5% at 10 years. Conclusions: This procedure produces excellent short-term outcomes and low long-term morbidity. It could be the procedure of choice in selected patients to prevent paraplegia, although graft replacement is currently the standard treatment for chronic aortic dissecting aneurysm.

Keywords: Chronic type B aortic dissection; Long-term outcome; Entry closure; Aortic plication; Paraplegia

1. Introduction

Uncomplicated acute type B dissection is usually treated conservatively, with generally satisfactory long-term results [1–3]. However, some lesions subsequently expand and become aneurysmal, especially when the false lumen was patent and the aortic diameter was greater than 40–45 mm preoperatively [4,5]. Graft replacement has been the standard operative technique for chronic dissecting aneurysm [6,7]. Unfortunately, several intercostal arteries are necessarily sacrificed during graft replacement, sometimes resulting in paraplegia. To avoid this discouraging complication, we have adopted a technique that preserves all of the intercostal arteries. In this study, we investigated the long-term outcomes after entry closure and aneurysmal wall plication for type B chronic dissecting aortic aneurysm.

2. Patients and methods

2.1. Patients

The clinical records of 40 consecutive patients who underwent entry closure and aneurysmal wall plication for type B chronic dissection between September 1983 and December 2002 were retrospectively reviewed (Table 1). During this period, no other surgical technique was used for type B chronic dissection at our institution. Follow-up information was obtained from the patients’ charts or by telephone. The mean age at operation was 60 ± 12 years (range, 38–79 years). Seventy-three percent (n = 29) were male and 27% (n = 11) were female. Nineteen patients had chronic DeBakey type IIIa dissections, 18 had DeBakey type IIIb dissections, and 3 had residual type B dissections after surgery for type A dissections. The mean follow-up period was 9.8 ± 5.1 years (range, 4–20 years). Follow-up was completed in 38 patients (95%). The latest computed tomography (CT) scans were obtained a mean of 9.5 ± 4.9 years (range, 3–18 years) after surgery.
2.2. Surgical technique

All operations were performed through a left thoracotomy. Patients were placed in the left-side-up position and posterolateral incisions were performed through the fourth or fifth intercostal space in most cases. The seventh intercostal space was also opened in five cases. Partial cardiopulmonary bypass (CPB) was used in 37 patients; in 3 patients, temporary right-side axillofemoral bypass was used initially. To establish CPB, an arterial cannula was inserted into the femoral artery, and a venous cannula was placed in the main pulmonary artery or femoral vein. CPB was performed at a tepid temperature (33–34°C).

Because most entries were several centimeters distal to the origin of the left subclavian artery, a proximal aortic clamp was applied between the left common carotid and the left subclavian arteries, and the left subclavian artery was clamped (Fig. 1a). The proximal aortic clamp was sometimes placed distal to the left subclavian artery. To preserve circulation to the intercostal arteries, the distal aortic clamp was initially applied to the middle of the descending aorta during entry closure, even when the aneurysm extended to the diaphragmatic hiatus or below. After entry closure, the distal clamp was moved to the lower descending aorta.

The false lumen was then opened longitudinally, and the entry was closed using interrupted mattress sutures and a buttressed Teflon felt strip. To prevent disruption of the entry, the stitches were placed from outside the aorta, passing through both the adventitia and the intima if possible. The entry was closed directly in 33 cases using this technique; however, in 7 cases, patch closure was performed because the entry was large and the intima was fragile. To reduce the diameter to 2–3 cm, the aneurysmal wall of the false lumen was tightly plicated around the true lumen using continuous horizontal mattress sutures and over-and-over running sutures (Fig. 1b). The plication was continued to the level of Th6 to Th10 (Fig. 1c). Both clamps were removed after the completion of plication to avoid backflow from the distal aorta through the distal entry, which occurs even after closing the primary entry if the clamps are removed before the plication is completed. This procedure uses no artificial graft and preserves all intercostal arteries.

2.3. Statistical analysis

Statistical analysis was performed using StatView, version 5.0 (Abacus Concepts, Berkeley, CA, USA). Quantitative variables approximating a normal distribution are presented as means ± SD. Continuous variables were analyzed using paired t-tests. Actuarial survival curves were constructed using the Kaplan–Meier method. P < 0.05 was considered to be significant.

3. Results

3.1. Operation

The mean operative time was 6.2 ± 1.7 h (range, 3.8–10.4 h). The mean CPB time was 68 ± 37 min (range, 31–144 min). The mean cross-clamp time was 58 ± 30 min (range, 14–120 min). Permanent axillofemoral bypass was necessary in two patients in whom lower body perfusion was inadequate after plication of the descending aorta. One patient had a new dissection in the left subclavian artery.

There was no in-hospital mortality. However, there were several incidences of morbidity, including stroke (n = 2), recurrent nerve palsy (n = 5), tracheostomy (n = 2), re-exploration for bleeding (n = 2), pneumonia (n = 3) and surgical site infection (n = 3). No paraplegia or paraparesis occurred after surgery.

3.2. Long-term results

There were 14 late deaths. The survival rate was 92 ± 4% at 5 years and 64 ± 9% at 10 years; 24 patients are still alive (Fig. 2). Five patients died of cerebral accidents, three of heart failure, and two of malignancy; four patients died of other causes. No late death was related to the dissecting aneurysm.

The results of follow-up CT scans (n = 22) are shown in Fig. 3. The preoperative aortic diameter was 55 ± 11 mm (range, 45–81 mm); this decreased significantly (P < 0.01) to 29 ± 4 mm (range, 22–40) after surgery. In 15 patients (68%), the plicated aorta had not become enlarged, and the false lumen had disappeared. In seven (32%), however, the false lumen was still patent; in three, the diameter of plicated
aorta remained less than 40 mm, but in four, the plicated aorta had become enlarged to diameters of 46, 50, 60 and 88 mm. Excluding these four patients, the mean diameter of the plicated descending aorta was 31.5 mm (range, 22—39 mm). The patient whose plicated aorta became enlarged to 60 mm underwent reoperation 3 years after the initial surgery. The patient whose plicated aorta became enlarged to 88 mm is 87 years old and does not want surgery. Because the number of documented cases of non-enlarged aorta was 15, it may be appropriate to conclude that the plicated aorta had healed in 15 out of 38 patients (39%).

Residual dissecting aneurysms became larger than 45 mm in diameter in eight patients. Three underwent graft replacement of the thoracoabdominal aneurysm 3, 9, and 20 years after the initial surgery. Freedom from reoperation for residual dissecting aneurysm was 85 ± 5% at 5 years and 78 ± 5% at 10 years.

4. Discussion

Although endovascular stent-graft placement is now an option [8], the standard surgical procedure for chronic type B dissecting aneurysm is currently graft replacement [6,7]. In the pioneering experience of Svensson et al. [9], operative morbidity and mortality were high. However, operative results have been improving because of innovations such as perioperative cerebrospinal fluid drainage, distal aortic perfusion, reattachment of critical intercostal arteries, permissive hypothermia, and hypothermic circulatory arrest [6,7,10,11]. The in-hospital mortality rate is now 4—10%, and paraplegia or paraparesis occurs in only 2.4—4.5% of patients [6,7,10,11]. In our series, there was no in-hospital mortality and no paraplegia occurred.

Using a technique similar to ours, Kawashima et al. [12] performed entry closure and aneurysmal wall plication with permanent axillofemoral bypass in 15 patients. They did not use CPB, but plicated the false lumen around the true lumen as tightly as possible to reduce the diameter to 2 cm or less. Their operative mortality rate was 20%, and no cases of paraplegia occurred. We used CPB, and the diameter of the plicated aorta was around 2—3 cm.

The major advantage of this technique is that it preserves all of the intercostal arteries. During graft replacement, these arteries are preserved or reattached if possible to prevent paraplegia, but some must be sacrificed. Reattachment of the critical intercostal arteries that connect to the artery of Adamkiewicz is thought to help prevent paraplegia, so preoperative assessment of this vessel is very useful. The artery of Adamkiewicz can be assessed noninvasively by magnetic resonance (MR) angiography and multi-detector row CT angiography, and the use of both techniques provided higher detection rates of 90—97% [13,14]. However, surgical reattachment of intercostal arteries is sometimes difficult, and the attached arteries may become occluded. Using our technique, all intercostal arteries are easily preserved, and paraplegia is unlikely to occur. Therefore, MR or CT angiography is not always necessary.

One concern regarding this procedure is long-term durability. If the entry closure is incomplete, the false lumen remains patent and may expand again, as in some of our patients. According to the follow-up CT, the false lumen was patent in 7 out of 22 patients (32%), and the plicated aorta had expanded in 4 of them. Thus, complete closure of the entry is important. However, in the aortic tailoring method, the intima is intentionally resected, and only the false lumen wall is used as the aortic wall [15,16]. In studies using this method, it was reported that collagen was deposited in the false lumen wall of the dissecting aorta, so that it was actually thicker than the wall of the true lumen. In three of our patients, a false lumen was patent, but the aorta had not expanded.

Another concern is blood flow to the lower body. In the conventional surgical technique, the distal end of the graft is anastomosed to both the true and false channels to prevent malperfusion of the visceral arteries. Obliteration of the false channel carries some risk of obstructing the major arterial branches. However, in chronic type B dissections, it was reported that the false lumen distal to the graft anastomosis is likely to be thrombosed when the graft is anastomosed to the true lumen only, and the visceral circulation was not compromised postoperatively [17]. With our technique, the blood runs mainly in the true lumen, and the false lumen is thrombosed. In cases of aortic dissection, we believe that several re-entries of the intimal flap exist.
around the celiac axis, and that visceral circulation is maintained with our technique.

In two of our patients, blood flow to the lower body was inadequate after the procedure, necessitating permanent axillofemoral bypass during surgery. We need to pay attention to the blood pressure in the femoral artery, especially when the true lumen is small. Kawashima et al. [12] established permanent axillofemoral bypass in all patients, because the plicated aortas were all less than 2 cm. Permanent axillofemoral bypass was not necessary in most of our patients. We think that a vessel diameter of 2–3 cm is appropriate for plication of the aorta.

This procedure has several disadvantages. A proximal aortic clamp is usually required between the left common carotid and the left subclavian arteries, at least distal to the left subclavian artery. Hypothermic circulatory arrest is not suitable for this procedure; theoretically, it is possible to complete the procedure under hypothermic circulatory arrest, but this seems questionable. A proximal aortic clamp may cause stroke or recurrent nerve palsy. It is uncertain whether all entries can be closed, as the intima around the entry may be fragile, even in the chronic phase. If entry closure is incomplete, the false lumen may re-expand. In our patients, the cross-clamp time ranged from 14 to 120 min, suggesting that some dissections were complicated and several large entries were present. Under these conditions, this procedure would be difficult and require a long time, whereas graft replacement would be simple and consistent.

In terms of paraplegia and in-hospital mortality, our technique yields excellent results, and the long-term outcome is relatively good. Graft replacement is the first choice for chronic type B dissecting aneurysm because the long-term results have been proven to be excellent. However, entry closure and aneurysmal wall plication could be the procedure of choice in selected patients to prevent paraplegia. The reattachment of intercostal arteries is not always possible, for a number of reasons: for example, (1) if the critical intercostal arteries are very small; (2) if the critical intercostal arteries exist around the predicted anastomosis site; and (3) if the aortic wall has advanced atherosclerotic change or severe calcification. In these situations, combination surgery of graft replacement and aneurysmal wall plication may be useful to preserve critical intercostal arteries.

5. Conclusion

Entry closure and aneurysmal wall plication is associated with excellent short-term outcomes and low long-term morbidity. It could be the procedure of choice in selected patients to prevent paraplegia, although graft replacement is the standard surgical method for chronic type B dissecting aneurysm.

References


Appendix A. Conference discussion

Dr M. Turina (Zurich, Switzerland): Maybe I missed it. How long of a time after the initial Type B dissection was the operation performed? How many of them were early and how many of them were late or very late?

Dr Miyamoto: Probably at 3 months after the onset of the acute dissection. But some of them are very late. We don’t know the exact duration after the acute onset because some of them came from another hospital.

Dr Turina: And you are still performing this procedure now?

Dr Miyamoto: Actually, no, because long-time outcome was not satisfactory.
Dr F. Beyersdorf (Freiburg, Germany): So your conclusion from the data which you have shown is that one should not use this kind of operation for treating type B dissections?

Dr Miyamoto: Basically, yes.

Dr P. Mortensen (Odense, Denmark): Before you started doing any operation, did you assess if there was a re-entry, or were you very sure that it was the only entry that you closed? You were sure that there were no other entries downstream in the aorta?

Dr Miyamoto: Of course, we closed the primary entry and sometimes two or three entries. And we believe that the re-entries exist around the celiac axis, and the visceral circulation will be maintained from the re-entries. But we don’t worry about the re-entries during this technique. We only close the primary entry.

Dr V. Kutay (Mugla, Turkey): I just want to learn that what is your opinion about those kinds of patients? Were those patients accidentally diagnosed at that time in the chronic phase or what was your clinical treatment strategy for those patients?

And did you see any retrograde extension of the aneurysmal sac to the ascending aorta?

First, I just want to make it shorter. Were those patients diagnosed at that time, since that time it was chronic, or you waited for the chronic phase to treat this?

Dr Miyamoto: Yes.

Dr Kutay: How long would it take to wait for that period to perform this operation after acutely to the chronic phase?

Dr Miyamoto: When the diameter of the aneurysm becomes 50 mm. Sometimes more than 45 mm we decided to operate the patient.

Dr Kutay: Did you see any patient extending the aneurysm sac proximally?

Dr Miyamoto: None before the operation. One retrograde dissection occurred after our operation.

Dr Kutay: Because I ask this question. We have, too, this kind of patient that they didn’t accept in the acute phase the surgical treatment, and we waited for the chronic phase. And in one patient and 7 months later in the other patient, we were seeing the extending growth of the aneurysm sac proximally.

And we have chosen to change the treatment strategy and the whole ascending aorta were replaced.

Dr Miyamoto: Of course, if the ascending aorta is involved, we cannot apply this procedure.