Adventitial inversion technique without the aid of biologic glue or Teflon buttress for acute type A aortic dissection

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Received 7 June 2005; received in revised form 19 July 2005; accepted 26 August 2005; Available online 4 November 2005

Abstract

Objective: This study was performed to evaluate the clinical usefulness of the adventitial inversion technique in acute type A aortic dissection, with special attention to the impact of this procedure on the postoperative status of false lumen evaluated by computed tomographic scan.

Methods: From March 2001 to November 2004, 18 consecutive patients underwent emergent surgery for acute type A aortic dissection. Supracoronary graft replacement was performed in all the patients (ascending aorta/hemiarch replacement: 13/18 = 72%, total arch replacement: 5/18 = 28%). The adventitial inversion technique was used for both the proximal and the distal stump constructions of the dissected aortic wall without the aid of Teflon felt or biologic glue. Aortic regurgitation was treated with resuspension of the aortic commissures.

Results: There were two hospital deaths and the overall hospital mortality rate was 11.1%. The mean postoperative blood loss was 635 ± 214 ml and no reexploration was required in any of the patients. Postoperative computed tomography showed closure of the false lumen in aortic root, aortic arch, and proximal descending thoracic aorta in all of the surviving patients. Postoperative echocardiography demonstrated no aortic regurgitation in any of the patients. Two patients died late postoperatively from unrelated causes to aortic dissection. The remaining 14 patients are doing well without a second-stage operation for aortic root or distal aortic lesions during the follow-up period of 7—51 months (mean: 28 ± 14 months).

Conclusions: The adventitial inversion technique provides an excellent immediate hemostasis and facilitates thrombotic closure of the proximal and the distal false lumen in the treatment for acute type A aortic dissection.

Keywords: Aortic dissection; Aortic surgery; Anastomosis; Biologic glue; Prosthesis

1. Introduction

For the surgical treatment of acute type A aortic dissection, it is essential to restore the integrity of the aortic wall to achieve secure anastomoses with the graft, complete hemostasis, and obliteration of the false lumen. On the other hand, persistent patent false lumen is considered to be an important factor that compromises the long-term prognosis after surgical repair of aortic dissection [1—5]. The adventitial inversion technique was first reported in 1995 by Flioten et al. [6] to solve the problem of bleeding due to tissue friability of acute aortic dissection. In 1998, Garcia-Rinaldi et al. [7] confirmed that this technique was safe and useful for the surgical treatment of acute aortic dissection. However, the fate of the false lumen after this procedure has not been reported. The purpose of this study was to present our early clinical results of the adventitial inversion technique, focusing on the impact of this procedure on postoperative aortic morphology evaluated by computed tomographic (CT) scan.

2. Materials and methods

2.1. Patients

From March 2001 to November 2004, 18 consecutive patients underwent emergent surgical treatment for acute type A aortic dissection. Seven patients (38.9%) were male, and the average age was 69.7 ± 10.9 years (range: 48—85 years). There was no patient who had clinical features of Marfan syndrome. Table 1 summarizes the type of aortic dissection and the preoperative characteristics of the patients. There were five patients who were accompanied by organ malperfusion: two had impairment of cerebral blood flow, two had acute myocardial infarction, and one had leg ischemia. Nine patients had cardiac tamponade, three had shock, and one had cardiac arrest requiring cardiopulmonary...
resuscitation preoperatively. All patients underwent CT scan and echocardiographic examination soon after the onset of acute aortic dissection, and all underwent emergent surgery within 24 h after onset. Mild to moderate aortic regurgitation was present in 9 of 14 patients (64%) who were diagnosed by preoperative echocardiography. Based on the preoperative contrast CT scan, together with observation during operation, a primary intimal tear was detected at the ascending aorta in 2 patients (11.1%), at the aortic arch in 10 patients (56.6%), and at the proximal descending aorta in 5 patients (27.7%). Intimal tear was not identified in one patient. The dissection extended proximally to the aortic root in all patients, and extended distally to the aortic arch in five patients, to the descending thoracic aorta in six patients, to the abdominal aorta in two patients, and to the common iliac artery in five patients.

2.2. Surgical techniques

2.2.1. Adventitial inversion technique for constructing aortic stump

The surgical technique used in this series principally consisted of resection of the aorta containing the primary intimal tear whenever feasible and obliteration of the false lumen. The adventitial inversion technique was used for both the proximal and the distal stump constructions of the dissected aortic wall in all patients. No Teflon felt strips or biologic glue was used for the reinforcement of aortic layers and obliteration of the false lumen.

2.2.2. Details of surgical procedures

2.2.2.1. Proximal repair. Extracorporeal circulation was instituted, with the arterial cannula placed in the femoral or right axillary artery, a single two-stage venous cannula placed in the right atrium, and a left ventricular venting cannula placed via the right superior pulmonary vein. The ascending aorta was cross-clamped just proximal to the innominate artery. During the retrograde infusion of blood cardioplegia, the aorta was transected and antegrade cardioplegia was administered selectively. The proximal repair was performed during the period of cooling by extracorporeal circulation. Aortic regurgitation caused by commissural detachment during the dissection process was initially repaired with resuspension of the aortic commissures using mainly 4-0 polypropylene (Prolene, Ethicon, Somerville, NJ, USA) sutures with Teflon pledgets placed on both sides of the intima. After the distal repair was completed, the gelatin-coated woven Dacron graft (Gelweave, Vascutek, TERUMO Co., Scotland, UK) was anastomosed to the reinforced aorta just above the level of intimal edge. The redundant adventitia was then inverted into the aortic lumen and tacked to the luminal surface of the intima by horizontal 6-0 polypropylene mattress sutures at the level of sinotubular junction. After the distal repair was completed, the gelatin-coated woven Dacron graft was anastomosed to the reinforced aorta just above the level of the previous horizontal mattress suture line using continuous 4-0 RB-1 polypropylene sutures (Fig. 1).

2.2.2.2. Distal procedure for ascending aorta/hemiarch replacement. When the patient was cooled down to a pharyngeal temperature of 20 °C, systemic circulation was arrested. The aortic clamp was removed to allow inspection of the inside of the aortic arch. For the distal aortic reconstruction, the procedure was tailored to resect the aorta containing the primary intimal tear. For ascending aorta or hemiarch replacement, the open distal method was employed under deep hypothermic circulatory arrest without cerebral perfusion. These procedures were generally completed within 30 min. During ressection of the diseased ascending aorta or inner curve of the arch, the margin of the intima was trimmed back 1.5 cm distal to the adventitial resection line. The redundant adventitia was then inverted inside over the intima and tacked with 5-0 polypropylene over-and-over sutures. The distal anastomosis is constructed.
between the graft and the reinforced aorta proximal to the previous suture line using continuous 4-0 RB-1 polypropylene over-and-over sutures without Teflon buttress or biologic glues (Fig. 2).

2.2.2.3. Distal procedure for total arch replacement. In the event that total arch replacement was necessary, selective cerebral perfusion was utilized for cerebral protection. The descending aorta distal to the origin of the left subclavian artery was transected completely. The adventitial inversion technique was also applied to make a reinforced aortic cuff with 5-0 polypropylene over-and-over sutures. A piece of woven Dacron graft was invaginated inward over itself and placed into the true lumen of the descending thoracic aorta and was attached to the reinforced aortic cuff using 4-0 RB-1 polypropylene over-and-over suture. Subsequently, the invaginated graft was pulled out and anastomosed to the branched arch graft and its third limb was anastomosed to the left subclavian artery. Antegrade systemic circulation was restarted through the fourth limb of the arch graft and the patient was rewarmed. Subsequently, individual reconstruction of the other cervical vessels was accomplished.

2.3. Follow-up

Contrast CT scan and echocardiography were performed to evaluate the aortic morphology and cardiac function, respectively, before discharge in all of the surviving patients. During the follow-up period at outpatient clinic, contrast CT scan and echocardiography were performed every 6—12 months for most of the patients.

3. Results

3.1. Descriptive perioperative data

Surgical procedures and results are shown in Table 2. The mean extracorporeal circulation time was 215 ± 73 min, the mean cardiac ischemic time was 136 ± 52 min, the mean selective cerebral perfusion time was 60.6 ± 67.0 min, and the mean cerebral ischemic time was 21.9 ± 7.1 min. The mean postoperative blood loss was 635 ± 214 ml and no reexploration was required in any patient.

3.2. Surgical mortality

There were two hospital deaths and the overall hospital mortality rate was 11.1%. One patient died of perioperative myocardial infarction due to severe coronary artery disease, which was proven by autopsy. Another patient, who was transferred to the operating room while receiving cardiopulmonary resuscitation, did not survive the operation.

3.3. Postoperative complications

There was one brain infarction caused by preoperative malperfusion. Transient postoperative delirium was observed in one patient. Although nine patients were extubated within 24 h, prolonged mechanical ventilation (>5 days) was required in two patients and one patient required a tracheostomy.

3.4. Postoperative CT scan and echocardiography

The status of the false lumen was evaluated in 16 patients by contrast-enhanced CT scan (Table 3). The aortic root was completely obliterated in all of the patients. The distal false
lumen was completely obliterated in 12 of 16 (75%) patients. In patients whose dissection process was extending to the aortic arch (four patients), the false lumen was completely obliterated after replacing the ascending aorta (one patient) or hemiarch (three patients). Similarly, in six patients whose dissection was extending into the descending thoracic aorta, the distal false lumen was completely obliterated after replacing ascending aorta (one patient), hemiarch (four patients), or total aortic arch (one patient). In six patients whose dissection process was extending distally below abdominal aorta, the false lumen was noted to remain perfused in the area apart from distal anastomosis in four patients after graft replacement of hemiarch (three patients) or total aortic arch (three patients). Even in these patients, the false lumen was obliterated at the level of proximal segment of the descending thoracic aorta, indicating that new intimal tear has not occurred by this technique at the site of the anastomosis. In the 16 patients who were followed up by CT scan for 1—44 months after surgery, aneurysmal enlargement, redissection, or pseudoaneurysm formation was found in neither the aortic root nor the distal aorta. Fig. 3 demonstrates preoperative and postoperative contrast-enhanced CT scan in case 12. Postoperative echocardiography demonstrated no aortic regurgitation in nine patients who had mild to moderate aortic regurgitation preoperatively.

Table 3
Status of false lumen evaluated by follow-up CT scan

<table>
<thead>
<tr>
<th>Case no.</th>
<th>Grafted segments</th>
<th>CT follow-up period (months)</th>
<th>Status of postoperative false lumen</th>
</tr>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Aortic root</td>
</tr>
<tr>
<td>1</td>
<td>AA</td>
<td>44</td>
<td>Closed</td>
</tr>
<tr>
<td>2</td>
<td>AA + TA</td>
<td>37</td>
<td>Closed</td>
</tr>
<tr>
<td>3*</td>
<td>AA + TA</td>
<td></td>
<td>Closed</td>
</tr>
<tr>
<td>4</td>
<td>AA + TA</td>
<td>26</td>
<td>Closed</td>
</tr>
<tr>
<td>5</td>
<td>AA + HA</td>
<td>34</td>
<td>Closed</td>
</tr>
<tr>
<td>6</td>
<td>AA + HA</td>
<td>33</td>
<td>Closed</td>
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<td>7</td>
<td>AA + HA</td>
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<td>8</td>
<td>AA + HA</td>
<td>17</td>
<td>Closed</td>
</tr>
<tr>
<td>9</td>
<td>AA + TA</td>
<td>6</td>
<td>Closed</td>
</tr>
<tr>
<td>10</td>
<td>AA + TA</td>
<td>12</td>
<td>Closed</td>
</tr>
<tr>
<td>11</td>
<td>AA + TA</td>
<td>13</td>
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</tr>
<tr>
<td>12</td>
<td>AA + HA</td>
<td>10</td>
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</tr>
<tr>
<td>13*</td>
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</tr>
<tr>
<td>18</td>
<td>AA + HA</td>
<td>1</td>
<td>Closed</td>
</tr>
</tbody>
</table>

*: No dissection was found in this segment preoperatively. AA: ascending aorta; TA: total arch; HA: hemiarch.
3.5. Prognosis

Two patients died of respiratory failure and congestive heart failure at 3 and 12 months, respectively, after surgery. The remaining 14 patients did well during the follow-up period of 28 to 914 months (range: 7–51 months). None of the patients who survived underwent a second-stage operation for aortic root or distal aortic lesions.

4. Discussion

The goals of surgery for acute type A aortic dissection is establishing a competent aortic valve, replacing the aortic segments in which the primary intimal tear has occurred, preventing antegrade flow into the false lumen, and having the patient survive the operation [8]. Furthermore, it is desirable that the procedure decreases late aortic or aortic valve complications, including aneurysmal enlargement in the proximal or distal aorta, redissection or pseudoaneurysm formation at the site of anastomosis, and reappearance of aortic regurgitation [3,4,8,9]. It is well recognized that the prognosis of patients with a patent distal false lumen is inferior to that of those patients with a thrombosed false lumen [1,3,4].

4.1. Different techniques of stump construction of the dissected aortic wall

Conventionally, the aortic wall is reconstructed by reapproximation of the dissected aortic layers with Teflon felt reinforcement [10]. Biologic glues, such as GRF glue, and more recently, BioGlue, have also been used to obliterate the false lumen and to secure graft anastomoses in an aorta that has become fragile as a result of the dissection process [11,12]. Despite the significant survival benefits of using these adjuncts in the treatment of acute aortic dissection, several detrimental effects have also been recognized. The use of Teflon felt strips for reinforcement results in increased thickness, which requires the use of large needles and heavy sutures that can cause a new intimal tear at the anastomotic site with blood flow leaking into the false lumen, which will remain patent postoperatively [6,7]. Biologic glues have been reportedly associated with cerebral or coronary embolization, persistent patent false lumen, and tissue necrosis leading to redissection or pseudoaneurysm formation [13—19].

4.2. Impact of adventitial inversion technique on hemostasis and aortic morphology

In the present study, adventitial inversion technique enabled us to perform accurate and smooth suturing of the graft to the dissected aorta with 4-0 polypropylene on an RB needle. Woven Dacron-aorta anastomoses held sutures well and provided complete hemostasis. More importantly, the false lumen, identified preoperatively in the aortic root, aortic arch, and proximal segment of the descending thoracic aorta was completely closed at the time of discharge in all surviving patients. The possible mechanism for patent distal false lumen noted in four patients in our series are the presence of the second intimal tear in the remote area below the descending thoracic aorta, which is independent of the anastomotic technique. Ergin et al. [20] found a 56% patency rate for the distal false lumen in sutured anastomoses and concluded that the anastomotic technique is an important factor related to complications of the distal false lumen. Nguyen et al. [21] also reported the similar patency rate for distal false lumen after open repair using either Teflon felt reinforcement (68%) or GRF glue (55%).

We speculate the adventitial inversion technique carries several advantages on the surgical treatment of acute aortic dissection as follows. First, because the adventitia is very pliable tissue, it can fill in the tiny gap along the suture line, providing a leakproof anastomosis between the aortic cuff and graft. Second, by avoiding the use of felt strips, it is not necessary to use large needles and heavy sutures, which markedly decreases the risk of new intimal tears at the anastomotic site. Finally, the suture line between the graft and the aorta is isolated from the false lumen by fine 6-0 or 5-0 polypropylene stitches, which would help obliterate the false lumen.

4.3. Radical versus conservative approach for acute type A aortic dissection

In order to decrease late aortic complications and the reoperation rate, some suggest that extended operative...
procedures, such as routine aortic arch replacement and total aortic root replacement or valve sparing aortic root reconstruction, should be performed [22—25]. In our experience, as long as the primary intimal tear was resected, there was no patent false lumen left postoperatively in either the aortic root or aortic arch in any of the patients using adventitial inversion technique. Therefore, ascending aorta/ hemiarch replacement with supracoronary tube graft would suffice for most of the patients with acute type A aortic dissection in the absence of Marfan or annuloaortic ectasia.

4.4. Limitations of this study

The main limitation of the present study was that it was retrospective in nature without control group. Furthermore, the follow-up period is relatively short to prove the superiority of this technique in preventing late pseudoaneurysm formation or redissection compared to conventional anastomotic techniques using felt strips or biological glues. A large-scale prospective randomized clinical controlled study would be necessary to address these issues.

5. Conclusion

The adventitial inversion technique provides an excellent immediate hemostasis and facilitates thrombotic closure of the proximal and the distal false lumen in the treatment for acute aortic dissection. This technique is a promising alternative procedure to Teflon felt or biologic glues for the proximal and the distal false lumen in the treatment for acute aortic dissection. This technique is a promising alternative procedure to Teflon felt or biologic glues for acute aortic dissection. This technique is a promising alternative procedure to Teflon felt or biologic glues for acute aortic dissection. This technique is a promising alternative procedure to Teflon felt or biologic glues for acute aortic dissection. This technique is a promising alternative procedure to Teflon felt or biologic glues for acute aortic dissection. This technique is a promising alternative procedure to Teflon felt or biologic glues for acute aortic dissection.

References


Editorial comment

Reinforcing the anastomotic cuff in aortic dissection

The dissected aorta is prone to anastomotic complications such as bleeding and dehiscence. The aortic wall is friable due to medial cystic necrosis, fragmentation of the elastic lamellae, focal fibrosis, and the dissecting hematoma between the middle and the outer third of the media. Yet the adventitial layer remains intact [1]. Current methods to reinforce the