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Trapdoor Thoracotomy as a Surgical Approach for Aortic Arch Aneurysm

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Since 1991 ten patients, 9 male and 1 female, with aortic arch aneurysm underwent surgical therapy with trapdoor thoracotomy. The mean age was 67.4 ± 9.1 (standard deviation) years at operation. In addition to the aortic arch repair, we also performed seven descending aortic replacements. We performed one partial arch replacement, one total arch replacement, and one aneurysmorraphy and wrapping of the aortic arch aneurysm. We experienced 1 case of paraplegia, no hospital death, and no long-term mortality.


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The trapdoor incision was popularized for approaching diseases of the hilar and the subclavian region, especially in the setting of vascular trauma of the subclavian region. Since 1991, ten patients with aortic arch aneurysm (mean age, 67.4 ± 9.1 years; 9 male and 1 female) underwent surgical therapy using this approach.

Results

Ten patients, 9 male and 1 female, with aortic arch aneurysm underwent surgical therapy with this thoracotomy. The mean age was 67.4 ± 9.1 (standard deviation) years at operation. In addition to the aortic arch repair, we performed seven descending aortic replacements: four without reconstruction of the left subclavian artery and three with reconstruction of the left subclavian artery.
Table 1. Patient Characteristics

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (y)</th>
<th>Sex</th>
<th>Procedure</th>
<th>Assisted Bypass</th>
<th>Op (h)</th>
<th>CPB (min)</th>
<th>ACC (min)</th>
<th>Bl (mL)</th>
<th>Result</th>
<th>Compl</th>
<th>POS (days)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>77</td>
<td>M</td>
<td>Arch, LCA, LSA</td>
<td>Temporary bypass</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>1,000</td>
<td>Alive</td>
<td>...</td>
<td>119</td>
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<tr>
<td>2</td>
<td>48</td>
<td>M</td>
<td>Desc ao</td>
<td>V-A, br perf</td>
<td>4.5</td>
<td>74</td>
<td>67</td>
<td>431</td>
<td>Alive</td>
<td>...</td>
<td>41</td>
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<tr>
<td>3</td>
<td>72</td>
<td>M</td>
<td>Desc ao</td>
<td>V-A, br perf</td>
<td>4.5</td>
<td>72</td>
<td>71</td>
<td>663</td>
<td>Alive</td>
<td>Paraplegia</td>
<td>155</td>
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<td>4</td>
<td>73</td>
<td>M</td>
<td>Desc ao</td>
<td>V-A, br perf</td>
<td>7</td>
<td>86</td>
<td>66</td>
<td>560</td>
<td>Alive</td>
<td>...</td>
<td>46</td>
</tr>
<tr>
<td>5</td>
<td>61</td>
<td>M</td>
<td>Desc ao, LSA</td>
<td>V-A, br perf</td>
<td>5</td>
<td>85</td>
<td>80</td>
<td>560</td>
<td>Alive</td>
<td>...</td>
<td>25</td>
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<tr>
<td>6</td>
<td>70</td>
<td>M</td>
<td>Desc ao, LSA</td>
<td>V-A, br perf</td>
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<td>67</td>
<td>52</td>
<td>600</td>
<td>Alive</td>
<td>...</td>
<td>23</td>
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<tr>
<td>7</td>
<td>71</td>
<td>F</td>
<td>Total arch</td>
<td>V-A, br perf</td>
<td>8</td>
<td>82</td>
<td>50</td>
<td>2,000</td>
<td>Alive</td>
<td>...</td>
<td>30</td>
</tr>
<tr>
<td>8</td>
<td>59</td>
<td>M</td>
<td>Desc ao, LSA</td>
<td>V-A, br perf</td>
<td>5</td>
<td>58</td>
<td>55</td>
<td>600</td>
<td>Alive</td>
<td>...</td>
<td>23</td>
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<tr>
<td>9</td>
<td>77</td>
<td>M</td>
<td>Desc ao</td>
<td>V-A</td>
<td>5</td>
<td>60</td>
<td>50</td>
<td>600</td>
<td>Alive</td>
<td>...</td>
<td>53</td>
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<tr>
<td>10</td>
<td>66</td>
<td>M</td>
<td>Arch aneurysmorrhaphy</td>
<td>None</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>500</td>
<td>Alive</td>
<td>...</td>
<td>62</td>
</tr>
</tbody>
</table>

Average 67.4 6.2 58.4 49.1 741 57.7

ACC = aortic cross-clamp time; Bl = bleeding amount; br perf = brain perfusion; Compl = complication; CPB = cardiopulmonary bypass time; Desc ao = descending aorta; LCA = left carotid artery; LSA = left subclavian artery; Op = operating time; POS = postoperative stay; V-A = venoarterial assisted bypass.

artery. We performed one partial arch replacement with reconstruction of the left carotid artery and left subclavian artery, one total arch replacement, and one aneurysmorrhaphy and wrapping of the aortic arch aneurysm with reconstruction of the left subclavian artery. No hospital death and no long-term mortality was found. The mean operating time was 6.2 ± 1.6 (standard deviation) hours, the mean assisted bypass time was 58.4 ± 32.2 minutes, and the mean aortic cross-clamp time was 49.1 ± 27.7 minutes. The mean total bleeding amount was 741 ± 468 mL. The mean postoperative stay was 57.7 ± 44 days. No recurrent nerve or phrenic nerve paresis was seen (Table 1).

**Postoperative Complications**

We experienced 1 early case of flail chest because of multiple rib fracture and sternum fracture; this patient needed 25 days of ventilation. One case of paraplegia (unknown reason) was seen, and necessitated a long postoperative stay. The mean postoperative stay of the remaining 8 patients was 37 days.

**Assisted Bypass**

Eight patients underwent assisted bypass with a roller pump system (from right atrium [via femoral vein] to femoral artery). Antegrade brain perfusion to each of the aortic arch branches (perfusing 5% of cardiac output to one branch) was used. No extracorporeal circulation was used in the other 2 patients; in these patients an anastomosis between the aorta and the graft was performed under the partial clamp technique.

**Comment**

There are some difficulties in operations for giant aortic arch aneurysm by median sternotomy or posterolateral thoracotomy. In these cases the trapdoor approach offers a better surgical view for dividing the aortic arch branches.

This incision was popularized for approaching diseases of the hilar and the subclavian regions, especially in the setting of vascular trauma of the subclavian region [1]. This thoracotomy was called book thoracotomy or flap thoracotomy, because the chest wall was not intended to be folded backward, but simply spread at the sternal division with a standard thoracic retractor [2]. Nazzaro and associates [3] reported operating on hilar lung cancer or tumors of the cervicothoracic junction using this approach. Pranikoff and colleagues [4] reported the successful and complete excision of cervicothoracic neuroblastoma with this approach affording excellent visualization of the entire cervicothoracic region.

**Drawbacks**

We cannot perform additional cardiac operations (coronary artery bypass grafting, valve operation). We need an additional intercostal thoracotomy to visualize all the descending thoracic aorta (10 cm distal from the isthmus). We also investigated the following three points: (1) division of cervical muscle (sternocleidomastoid), (2) ligation and division of internal mammary artery, and (3) bone (rib and sternum) fracture.

**DIVISION OF CERVICAL MUSCLE (STERNOCLEIDOMASTOID).** The division of the sternocleidomastoid muscle caused no problems because it was reattached and the patient could move his or her neck and head with no difficulty postoperatively. We did not need to divide the omohyoid muscle, anterior scalene muscle, and jugular vein because the incision was performed for aortic arch aneurysm, not traumatic vessel injury.

**LEFT INTERNAL MAMMARY ARTERY LIGATION.** No patient had an indication for coronary artery bypass grafting. It is unlikely that a 66-year-old patient who has no angiographic coronary artery disease would become a candidate for coronary artery bypass grafting. Wound infection or healing delay were not seen postoperatively as a result of the left internal mammary artery ligation and division.
BONE FRACTURE (RIB AND STERNUM). A complication of flail chest because of the fractures of the sternum and some ribs was seen in 2 patients at an early stage. They needed 25 days and 2 days of assisted ventilation and 30 days and 3 days before tracheal tube extubation, respectively. Lately we have tried to give gradual and tender traction to the trapdoor using an octopus retractor, and no further cases of flail chest have occurred in the last 8 patients. The postoperative ventilation time of the last 8 patients was 8 hours and the postoperative tracheal tubing time was 12 hours.

Outcome
The mean postoperative stay of 8 patients who had no paraplegia and no long-term ventilation was 37 days. In Japan, health insurance is quite different from that in the United States. The cost is very low for elderly patients who undergo treatment at their own expense. They can stay easily and comfortably in the hospital until any complaints (postoperative pain, intestinal disorder) disappear completely and they are able to walk without effort. Therefore the postoperative stays in our hospitals tend to be longer than those in the United States.

There were no problems in the assisted bypass with femoral artery and vein or in the pulmonary artery. The aorta was cross-clamped immediately after achieving a perfusion flow of 50% of the cardiac output, to prevent cerebrospinal infarction with the atherosclerotic debris. One patient had the complication of paraplegia in spite of blood perfusion to the distal half of the body. The reason for the paraplegia seemed to be infarction of the spinal cord (atheroembolism of the artery of Adamkiewicz) caused by atherosclerotic debris of the distal aorta. No left heart assisted bypass was performed because of one-lung ventilation.

Conclusion
The trapdoor incision offered a good surgical view to manipulate the aortic arch, and we have experienced no paresis of vagal arch, and we have experienced no paresis of vagal nerve, recurrent nerve, and phrenic nerve.

References
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