Case Report

Surgical Treatment of Aneurysm of the Aortic Arch
Report of Two Operated Cases with Synthetic Prostheses

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The technique of resection and transplantation of the thoracic aorta, especially of the ascending aorta or the aortic arch has been behind the time because of its influence to the heart, problems concerning the cerebral circulation, spinal cord damages and difficulties of the technique itself. Since DeBakey et al.1) reported operative methods for resection of aneurysm of the ascending aorta or the aortic arch with temporary bypass graft or with extracorporeal circulation, several cases of this kind of operation have been reported.2)

Recently, 2 cases with aneurysms of the ascending aorta and the aortic arch have been operated with the use of prosthesis in our hospital and the cases will be herewith presented.

CASE REPORTS

Case 1. A 49-year-old Japanese male was admitted to Tokyo University Hospital on January 27, 1960, with the chief complaints of chest pain, dyspnea and pressure feeling in left shoulder. Chest pain and pressure feeling of left shoulder were first noted in August 1959 and reappeared in January 1960. A year before the present admission, a routine chest X-ray film demonstrated an aneurysm of the thoracic aorta. Because of these symptoms he had to stay in bed for the most of the time.

About 30 years ago, the patient had syphilis and developed lymphogranuloma inguinale at the same time but did not have a series of antisyphilitic therapy.

On admission, the blood pressure was 130/100. Bilateral carotid pulses were normal to palpation. No thrill could be felt on the left anterior chest wall. Slight cardiac enlargement was noted and a soft apical systolic murmur was heard. No vocal cord paralysis was present. No venous distension was noted in the neck. The examination of the abdomen revealed no tenderness or rigidity. The liver, the spleen and the kidneys were not palpable, and there was no abnormal mass.

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On laboratory examinations, urinalysis was normal except for the positive urobilinogen, and routine blood works revealed no significant findings. Serological test for syphilis was positive. Total serum protein and A/G ratio were within normal limits and blood sedimentation rate was 42 mm. per hour. The liver function tests were normal and blood urea nitrogen was 40 mg. %.

Routine chest X-ray including posteroanterior and left lateral aspect revealed

an aneurysm of the aortic arch (Fig. 1). This was confirmed by angiocardiography. There was no evidence of bony destruction. Retrograde aortogram through the right brachial artery showed an aneurysm involving the ascending and transverse portions of the arch.

On February 12, 1960, resection of the aneurysm was performed under general anesthesia, without hypothermia in patient supine position. Median sternotomy was done.

A large aneurysm involving the ascending aorta, the aortic arch and the middle part of the descending thoracic aorta was exposed.

Excision of the entire arch including the aneurysm with restoration of continuity by a graft seemed feasible. Further incision was made in the fourth intercostal space, forming a T-shape incision which gave excellent exposure of the entire aortic arch.

The pericardium was opened and the innominate, left carotid, and subclavian arteries were isolated and tapes were placed around these arteries. The left innominate vein was almost completely occluded where it crossed in front of the aneurysm, and it was ligated and severed twice. An aortic clamp was applied to the anterior wall of the ascending aorta.

End-to-side anastomosis was performed between a crimped Teflon tube, 20 mm. in internal diameter and 150 mm. in length, and the clamped area of proximal aorta. In the same way, anterior wall of the descending aorta was clamped and the distal end of the prosthesis was implanted to this clamped area (Fig. 2-a).
The ascending aorta was doubly clamped just distal to the shunt and severed. Upper end of the severed ascending aorta was sutured over and over with atraumatic needle. Cerebral blood flow was then maintained by way of the aortic shunt and retrograde way through the aortic arch to the brain (Fig. 2-b).

The reconstituted crimped Tetoron* tube, 19 mm. in an internal diameter, having 2 branches, 9.5 mm. in internal diameters was implanted into lower end of the severed ascending aorta and then one of the branches arising from the graft was anastomosed to the innominate artery (end-to-end) (Fig. 2-c).

The left common carotid artery was occluded and severed and then anasto-

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* Tetoron: polyester fiber made in Japan.
mosed to another branch of the graft (Fig. 2-d). The noncrashing clamp was then moved to the area distal to the base of the left carotid branch of the graft, and thus normal fashion of blood flow in the carotid arteries was obtained. The left subclavian artery was simply ligated and severed.

The descending aorta distal to the bypass shunt was doubly clamped and severed. Then aneurysm was resected.

The anastomosis between the graft and the descending aorta was accomplished (Fig. 2-c), and after removal of the clamps normal blood flow through the aortic arch and its branches was established. The temporary bypass shunt was removed and the defect on the ascending aorta was closed by continuous suture with atraumatic arterial silk (Fig. 2-f, Fig. 3). During all these procedures E. K. G. and E. E. G. showed no remarkable changes (Fig. 4).

Fig. 3. Case 1. Transplantation with crimped Tetoron tube accomplished.

Tetoron graft with two branches was transplanted. End-to-end anastomoses were done between the graft and the ascending aorta, descending aorta, innominate and left common carotid arteries respectively. The left subclavian artery was ligated.

The opened pericardium was approximated roughly with silk suture. The thoracic wall was closed after insertion of Vinyl tubes into bilateral pleural spaces and mediastinum for water-seal drainage. The divided sternum was immobilized with wire sutures, the muscles and fascia were approximated with chromic catgut, and the skin was sutured with silk. A tracheotomy was performed to protect the patient from suffocation. About 8 1/4 hours were consumed for this operation. Blood loss was estimated to be 9,600 ml. and 10,400 ml. of whole blood was transfused.
Fig. 4. Case 1. E.E.G. during operation for aneurysm of the aortic arch.

(left) During occlusion of the innominate artery. (Occluded for 15 minutes.)
(right) During occlusion of the left carotid artery. (Occluded for 20 minutes.)

No significant changes were noted in E.E.G. during occlusion of the innominate and left common carotid arteries.

Fig. 5. Case 1. Specimen of the resected aneurysm.
Resected aneurysm, 17 x 15 x 15 cm. in size. The outlets of the innominate, left common carotid and left subclavian arteries are shown. Copious blood clots filled the lumen.

during the procedure. Resected specimen is shown in Fig. 5.

The patient woke up promptly from anesthesia and there was no evidence of cerebral or spinal cord damages. The patient was mentally alert, and movement and sensation of legs were normal.

Excellent pulses were present in all peripheral arteries and vital signs were well maintained. His temperature was normal during and after the operation. Oliguria was not present after the procedure. Physical examination of the chest revealed both lungs to be well expanded.
On the second postoperative day, the mediastinum drain was removed, and the patient began to take a diet. Condition of the patient improved progressively. On the fifth postoperative day, pleural cavity drains were removed and a roent-

Fig. 6. Case 1. Chest X-ray after resection of the aortic arch.
Abnormal shadow which was seen in the mediastinum preoperatively disappeared and showed relatively normal chest X-ray.

E.K.G.

right carotid artery

left carotid artery

right femoral artery

Fig. 7. Postoperative pressure curves of peripheral arteries.
genogram of the chest appeared satisfactory. The wound healed well and there was no evidence of infection of the wound. On the eighth postoperative day, digitoxin therapy was started because of the tachycardia. On the ninth postoperative day, tracheal cannula was removed. Dyspnea did not occur but his voice was very hoarse. Examination revealed left vocal cord paralysis. Ambulation was then started. On the twelfth postoperative day, the patient began to eat a regular diet without any difficulty. The E.K.G. was unchanged comparing with that of the preoperation. The postoperative chest X-ray revealed relatively normal finding (Fig. 6), and pressure curves in peripheral arteries taken on the twentieth postoperative day were nearly normal (Fig. 7). Laboratory findings revealed: hemoglobin 103% Sahli, hematocrit 50%, serum protein 6.6 Gm./100 ml., serum sodium 146 mEq./L., serum potassium 3.9 mEq./L., serum chloride 103 mEq./L.

The patient was discharged on March 14, 1960, the fourth postoperative week, in good condition physically and mentally. He has been well for about 1 year after the operation.

Case 2. A 68-year-old Japanese male was admitted to Tokyo University Hospital because of a huge pulsating tumor on the anterior chest wall. He had syphilis about 40 years prior to the present admission. He had started to have pressure feeling in the anterior chest in March 1959 and noticed the tumor which had

Fig. 8. Case 2. Transplantation with crimped Tetoron tube accomplished.

Tetoron graft with three branches was transplanted and end-to-end anastomoses were done between the graft and the ascending aorta, innominate, left common carotid, left subclavian arteries and the descending aorta respectively. Circulation restarted and blood flow in each vessel was well maintained.
increased in size with aggravation of pressure feeling and finally he began to have hoarseness. In May 1959, diagnosis of aneurysm of the thoracic aorta was made. Since April 1960, the tumor had showed rapid increase in size and he developed slight dysphagia and neuralgia in the following month.

Aneurysm involving the ascending aorta and the aortic arch was diagnosed by chest X-ray. On May 25, operation was performed under general anesthesia. The aneurysm was resected with the same technique as case 1, and crimped Tetoron tube with 3 branches was transplanted (Fig. 8). Nine and a half hours were consumed for the operation. The patient remained unconscious and expired 12 hours after the operation. Cerebral ischemia or cerebral embolism provoked by clamping the carotid arteries was presumed to be the cause of the death. Autopsy revealed an embolus in right cerebral hemisphere.

**DISCUSSION**

Two cases with aneurysm of the aortic arch have been presented. As stated before, resection of the thoracic aorta is quite difficult and many studies have been performed on this problem.

In case of the descending thoracic aorta, there are few problems

<table>
<thead>
<tr>
<th>Table I. Experimental Results of Aortic Arch Transplantation in Dogs (Bypass Grafting with Crimped Teflon Tube)</th>
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</thead>
<tbody>
<tr>
<td>No.</td>
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<tr>
<td>1</td>
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<td>12</td>
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<td>13</td>
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</table>

*Note:* Out of 13 cases, 8 cases (61%) were alive and 5 cases (39%) died during the operation.

Out of these 8 successful cases, 4 cases (50%) died of insufficiency of suture.

The sites of insufficiency were all at the anastomosis on the ascending aorta.
concerning the cerebral circulation. However, spinal cord damages, and shock due to the ischemia of organs below the diaphragm are serious complications to be provoked by cross clamping.

To resolve these problems hypothermia and extracorporeal circulation have been applied with success so far by us, but from our independent standpoint of view, we have devised a new "Cerebrospinal Fluid Draining

Table II. Cases with Surgical Treatment for Aneurysm of the Ascending Aorta and the Aortic Arch

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Age</th>
<th>Sex</th>
<th>Diseased area</th>
<th>Note</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>S.O.</td>
<td>55</td>
<td>M</td>
<td>Aneurysmorrhaphy</td>
<td>Died about 1 month after operation, because of the rupture of another aneurysm developed just above the site of aneurysmorrhaphy.</td>
<td></td>
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<tr>
<td>2</td>
<td>K.F.</td>
<td>51</td>
<td>F</td>
<td>Only partial resection because of marked adhesion</td>
<td>Died immediately after operation (The left common carotid artery and the innominate artery were occluded.)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>D.N.</td>
<td>55</td>
<td>M</td>
<td>Exploratory thoracotomy because of marked adhesion</td>
<td>Unknown</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>K.T.</td>
<td>44</td>
<td>M</td>
<td>Exploratory thoracotomy because base of the aortic arch was involved</td>
<td>Unknown</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>S.S.</td>
<td>51</td>
<td>F</td>
<td>Died of gross haemorrhage</td>
<td>Died during operation (Haemorrhage)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>T.T.</td>
<td>56</td>
<td>M</td>
<td>Cardiac standstill immediately after starting left cardiac bypass</td>
<td>Died during operation (Cardiac standstill)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>G.K.</td>
<td>62</td>
<td>M</td>
<td>Exploratory thoracotomy because of marked adhesion (Aorto-caval fistula was noticed)</td>
<td>Died on the first post-operative day (Impaired respiratory function)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>T.K.</td>
<td>44</td>
<td>M</td>
<td>After transplantation of bypass graft, died of gross haemorrhage during separating adhesions</td>
<td>Died during operation (Haemorrhage)</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Y.O.</td>
<td>56</td>
<td>F</td>
<td>After reconstruction of the aortic arch was accomplished, wall of the ascending aorta was injured by cross clamping</td>
<td>Died during operation</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>H.M.</td>
<td>49</td>
<td>M</td>
<td>Presented in this report</td>
<td>Cured</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>T.H.</td>
<td>68</td>
<td>M</td>
<td>do.</td>
<td>Died of cerebral embolus 12 hours after operation</td>
<td></td>
</tr>
</tbody>
</table>
Method" and proved this method to be more excellent.4) Serious problems such as cerebral damages and myocardial damages must be considered when surgical treatment of aneurysm of the ascending aorta or the aortic arch is performed. Severing the neck of aneurysm and suturing the aneurysmal wall are one of the simple operative methods because it is unnecessary for this method to perform the aortic occlusion. In 1951, we reported a successfully operated case with this method.5) According to this method, it is very possible that the recurrence of the aneurysm and the rupture may happen when diseased area of the aorta is left out.

It is now widely accepted that resection and transplantation of aneurysm is the best operative method. To perform this kind of radical operation, the helps with extracorporeal circulation or temporary bypass are needed. However, extracorporeal circulation is not thought to be preferable method because anticoagulant which must be used during extracorporeal circulation may aggravate the bleeding during the operation. We experimentally studied on temporary bypass method which was clinically applied by DeBakey et al. The results obtained were presented in Table I which proved the method to be excellent in spite of the difficulties of the technique. Until today operation has been tried on 11 clinical cases with aneurysms of the ascending aorta and the aortic arch including 2 cases reported here (Table II).

The operation of almost all cases in early period had not been accomplished because of the advanced lesions and difficulties of the techniques. Temporary bypass transplantation was applied to the recent cases and made it possible to perform resection and transplantation. However, for this type of the operation it is absolutely necessary that the temporary bypass is able to be placed to lateral wall of the ascending aorta proximal to the aneurysm. Consequently, it has a disadvantage when the whole area of the ascending aorta is involved in the aneurysm. In such a situation, extracorporeal circulation must be applied. Temporary bypass graft from the left ventricle to the descending aorta without using pump and anticoagulant is now being studied in our clinic.

**Summary**

Two cases of aneurysms of the ascending aorta or the aortic arch which were operated upon with resection and transplantation using temporary bypass grafting have been presented and operative methods for this kind of aneurysm have been discussed.

**References**