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Operation for Descending Thoracic Aortic Aneurysm without Blood Transfusion

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Summary: The purpose of this study was to aim at no-blood transfusion in the operation of descending thoracic aortic aneurysm. This policy was supported by means of the assist devices and techniques as follows; 1. Heparin-coated left heart bypass or inter-arterial shunt sets with pump (5 cases) and without pump (5 cases). 2. Autotransfusion of the blood (Average 867 ml). 3. Geratin pre-coated artificial prosthesis. 4. One-lung ventilation cannula. 5. Hypothermic anesthesia (Average of the body temperature 33.3 °C) and 6. Use of Erythropoietin after operation.

Ten patients with true descending thoracic aortic aneurysms were electively operated. The average age was 61 years, and seven of them were male. The aorta was cross-clamped (mean 101 min.) and graft replacement was performed. The average blood loss during operation was 948 ml. No blood transfusion was done in 3 cases. All the patients were discharged after uneventful courses

This disease would be operated without blood transfusion in future.

Aneurysm of the descending thoracic aorta still presents a surgical challenge despite recent progress of operative techniques.

Purpose of this study was to aim at no-blood transfusion for the operation of descending thoracic aortic aneurysm. It was supported by means of the assist devices and techniques as follows;

1. left heart bypass/inter-arterial shunt with Centrifugal pump¹ Heparin-coated tubes and cannulas.
2. Autotransfusion of the blood with Cell-saver²
3. Geratin pre-coated artificial prosthesis¹⁾³
4. One-lung ventilation cannula²⁾⁴
5. Fogarty balloon catheters into the orifices of intercostal arteries.
6. Hypothermic anesthesia
7. post-operative use of Erythropoietin

Patients and Methods

Ten patients with true descending thoracic aortic aneurysm were found and electively operated upon between January, 1989 and December, 1991. Seven of them were male and

the age was an average of 61 years (range 45-70).

Six of the aneurysm were fusiform type and three of them were sacciform type. (Table 1)

Table 1.

| No. | Sex | Age | Aneurysm (Size) | Bypass/Shunt |
|-----|-----|-----|-----------------|--------------|
| 1. | F | 65 | S (79 × 45 mm) | d. AO-r. FA |
| 2. | F | 68 | F (106 × 70) | LA -1. FA |
| 3. | M | 63 | S (68 × 53) | 1. SC-1. FA |
| 4. | M | 45 | F (133 × 79) | 1. SC-1. FA |
| 5. | M | 70 | S (40 × 40) | LA -1. FA |
| 6. | M | 54 | F (95 × 44) | d. AO-1. FA |
| 7. | M | 57 | F (55 × 40) | d. AO-1. FA |
| 8. | M | 57 | F (170 × 60) | d. AO-1. FA |
| 9. | F | 66 | F (80 × 63) | LA -1. FA |
| 10. | M | 69 | S (52 × 52) | LA -d. AO |

Legend: S, Sacciform. F, Fusiform. d. AO: descending aorta. r. FA: right femoral a. LA, left atrium. 1. FA: left femoral a. 1. SC, left subclavian a.

Operative technique

Using the endotracheal tube with movable blocker, general anesthesia was administered. Patient was placed in the right lateral decubitus position. The surface cooling was performed and the body temperature was lowered to the average of 33.3 °C. The generous posterolateral thoracotomy was made. The left lung was collapsed and one-lung ventilation was done., Heparin was given.

The initial dosage of Heparin was 100 units/kg. and then, it was determined by ACT (Activating Clotting Time) which was checked every one hour during aortic cross-clamp time. The last three cases of this series, for whom centrifugal pump were utilized, were given 50 units/kg. of Heparin. Temporary left heart bypass or arterial shunt was administered (Table 1), proximal and distal portion of the aortic aneurysm were cross-clamped, aneurysmectomy was performed and the bleeding from the intercostal arteries were controlled by insertion of Fogarty balloon catheters (Fr. No. 2), and geratin pre-coated prosthesis was implanted. Bleeding during operation was sucked and sent to

the Cell-saver, and autotransfusion of the patient's blood was preformed. After completion of the operation, the temporary shunt was removed. The thoracotomy incision was closed in the usual fashion and a chest tube was left in place. (Table 2)

Table 2.

| No. | lowest temperature | Operation time | Ao-clamp time | Outcome |
|------|--------------------|----------------|---------------|---------|
| 1. | 34.0 | 5 : 25 | 0 : 50 | well |
| 2. | 34.2 | 7 : 20 | 1 : 34 | well |
| 3. | 34.5 | 7 : 40 | 1 : 40 | well |
| 4. | 32.2 | 11 : 25 | 2 : 56 | well |
| 5. | 32.4 | 14 : 30 | 1 : 10 | well |
| 6. | 32.4 | 6 : 40 | 2 : 17 | well |
| 7. | 33.1 | 5 : 35 | 1 : 34 | well |
| 8. | 33.1 | 9 : 30 | 2 : 00 | well |
| 9. | 33.0 | 5 : 25 | 1 : 29 | well |
| 10. | 33.6 | 6 : 55 | 1 : 18 | well |
| Mean | 33.3 | 8 : 03 | 1 : 41 | |

Results

Bleeding during operation was an average of 948 ml. Autotransfusion was an average of 867 ml. except Case 5 who had no-autotransfusion. Blood transfusion was done for seven cases on an average of 1,843 ml. but not in three cases who had no-blood transfusion.

The highest value of ACT was kept on an average of 339 sec. and the last three cases were kept on an average of 223 sec. The dosage of Protamin had no rule for utilization, and it was given in six cases, and the dosage was from 25 to 100 mg.

Erythropoietin was given in one patient (Case 8) whose hemoglobin value was less than 10.0 mg/dl at the first post-operative day.

All of the patients had uneventful courses and was finally discharged. (Table 3)

Discussion

It was widely known that blood transfusion should be avoided because of many disadvantages to patients.

Operation of the descending thoracic aortic aneurysm was performed without blood transfusion in this series.

The aim of using the assist devices and techniques was as follows; left heart bypass or inter-arterial shunt with centrifugal pump. Heparin-coated tubes and cannulas helped to save the dosage of Heparin, and decreased bleeding, and simultaneously worked to keep the circulation properly and protect the erythrocytes from hemolysis.

Cardio-pulmonary bypass with heparin-coated equipment with low (ACT > 180 sec.) versus full (ACT > 480 sec.) systemic heparinization was prospectively analyzed.³⁾ The dosage of the low ACT of this study was 223 sec. and this was relatively high to compare with the standard of the low (ACT > 180 sec.) heparinization. The reason was that the attitude of the gelatin pre-coated prosthesis without Heparin was not yet studied. Autotransfusion of the patient's blood with Cell-Saver saved patient's blood and avoided the blood transfusion.

Geratin pre-coated artificial prosthesis which imparted zero porosity at implantation allowed time saving and minimized blood loss.

One-lung ventilation by using endotracheal tube with movable blocker made the left lung collapsed and kept the broad view of the operation field.

Fogarty balloon catheters which was inserted into the orifice of intercostal arteries during aneurysmectomy avoided bleeding from the vessels and kept proper blood pressure of the intercostal arteries. This method and hypothermic anesthesia protected the spinal cord and the other organs from ischemia.^{4,5)}

Erythropoietin was given when anemia was seen after operation.

Blood loss during operation of six cases was less than 500 ml, and no-blood transfusion was performed in three cases during and after operation.

Table 3.

| No. | Bleeding | Auto-transfusion | Blood transfusion | Heparin ($\times 10^2$ U) | Protamin |
|------|----------|------------------|-------------------|----------------------------|----------|
| 1. | 636 ml. | 860 ml. | 1800 ml. | 40 + 40 U | 0 mg |
| 2. | 411 | 1300 | 1200 | 50 + 50 | 100 |
| 3. | 797 | 1285 | 0 | 50 + 50 | 0 |
| 4. | 1943 | 1450 | 3840 | 50 + 80 | 0 |
| 5. | 4238 | 0 | 3980 | 50 + 50 | 80 |
| 6. | 454 | 460 | 840 | 50 | 70 |
| 7. | 357 | 540 | 1200 | 60 + 25 | 60 |
| 8. | 425 | 940 | 0 | 25 + 25 | 50 |
| 9. | 148 | 640 | 390 | 20 | 0 |
| 10. | 325 | 325 | 0 | 35 | 25 |
| Mean | 948 | 867 | 1843 | 74.5 | 39 |

The instruments and techniques which were used on this series worked effectively for the operation without blood transfusion, and it was also very important for the operator to have the clear intension of his aim.

Conclusion

1. Thoracic aortic aneurysms were operated upon with the assist devices and techniques, such as Heparin-coated prosthesis, Autotransfusion system, zero-polarity artificial vessel, one-lung ventilation cannula, hypothermic anesthesia and use of Erythropoietin.
2. Stable hemodynamic conditions of the patients were kept during operation by combination of controlling the bleeding, autotransfusion and other assist techniques.
3. Operations of the thoracic aortic aneurysm were able to performed without blood transfusion by using this method.

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*1 Bio-Pump System, Bio Medicus

*2 Hemonetics

*3 Gelseal Triaxial

*4 Fuji System Co.