[J Tokyo Wom Med Univ
70 (12) 687～692 (2000)]

Surgical Treatment for Ruptured Abdominal Aortic Aneurysm

Hideyuki TOMIOKA

Department of Cardiovascular Surgery (Director: Prof. Hitoshi KOYANAGI),
Tokyo Women's Medical University, School of Medicine

(Received Aug. 2, 2000)

To investigate the surgical results and the preoperative states of patients with ruptured abdominal aortic aneurysm, we carried out a retrospective review of ruptured infrarenal atherosclerotic aortic aneurysms at our institution. Forty-eight cases of ruptured abdominal aortic aneurysm were treated between January 1980 and December 1997. We classified the cases into two groups: group I (26 cases), 1980～1989; group II (22 cases), 1990～1997 and evaluated the surgical results and the preoperative states. The average interval between rupture and operation was 12.7 ± 13.4 hours in group I compared to 6.9 ± 4.1 hours in group II ($p<0.05$). The overall mortality rate was 23%. The surgical results have improved every year and the mortality rate was zero in group II. Most of the causes of previous surgical deaths were DIC (4 cases) and renal failure (3 cases). The patients in group I received transfusion of 5,736 ± 2,809 ml of blood, while those in group II received 3,257 ± 1,440 ml ($p<0.05$). The surgical treatment for ruptured abdominal aortic aneurysm have improved significantly due to the decrease of blood loss under the rapid control of bleeding, that means rapid proximal clamping and the autotransfusion of shed blood.

Introduction

Until the early 1950's, rupture of abdominal aortic aneurysm (AAA) was always fatal. The first successful surgical management of abdominal aneurysms was by Dubost and associates[1]. Since then, a dramatic improvement has been reported in survival rate.

Many factors have played an important role in reducing the 100 percent mortality. These include improvements in surgical and anesthetic techniques, new dependable prosthetic material for restoring vascular continuity and prompt surgical intervention.

Nevertheless, ruptured infrarenal AAAs are still associated with a high mortality[2)～6)]. To investigate the surgical results and the preoperative state of patients with ruptured AAA, we carried out a retrospective review of ruptured infrarenal atherosclerotic aortic aneurysms at our institution.

Patients and Methods

Forty-eight cases of ruptured AAA were treated between January 1980 and December 1997. They ranged in age from 34 to 91 years, and there were 42 male and 6 female patients. We have introduced the autotransfusion system since 1990. We classified the cases into two groups. Patients in group I were treated between 1980 and

Table 1 Patient characteristics

	group I (1980 ~ 1989)	group II (1990 ~ 1997)	p-value
Age (years)	67 ± 13	72 ± 10	NS
Gender (male/female)	23/3	19/3	NS
Blood pressure systolic pressure (mmHg)	74 ± 34	72 ± 38	NS
pH	7.34 ± 0.13	7.37 ± 0.1	NS
Base excess (mmol/*l*)	− 5.6 ± 6.3	− 4.3 ± 4.7	NS
Hb (g/dl)	9.8 ± 2.4	10.0 ± 2.1	NS
Interval rupture → op. (hrs)	12.7 ± 13.4	6.9 ± 4.1	$p < 0.05$
op. → proximal clamp (min)	51 ± 67	31 ± 21	NS
Blood loss (ml)	5,467 ± 3,229	1,465 ± 1,827	$p < 0.05$
Blood transfusion (ml)	5,736 ± 2,809	3,257 ± 1,440	$p < 0.05$
Urine output (ml/kg/hr)	4.7 ± 4.7	3.2 ± 2.0	NS
Left thoracotomy (n)	3 (11.5%)	6 (27.3%)	NS

Values are expressed as the mean ± SD, NS: not significant.

1989. Those in group II were treated between 1990 and 1997. Of the 48 patients, 26 were in group I and 22 in group II. Those in group II received autotransfusion of shed blood. The average interval between rupture and operation was 12.7 ± 13.4 hours in group I compared to 6.9 ± 4.1 hours in group II ($p<0.05$). All patients had acidosis, anemia and hypovolemic shock on admission. However, no significant differences existed between the two groups for the following variables; age, gender, blood pressure, pH and base excess (Table 1).

Of the 48 patients, 9 with massive ruptures underwent left thoracotomy for cross clamping of the descending aorta, and the remaining 39 underwent midline laparotomy. The clamp position was at the infrarenal aorta in 30 patients and at the suprarenal aorta in 9 patients.

Perioperative data was evaluated retrospectively by reviewing patient's hospital records. The data were analyzed using a statistical software (Stat View, Abacus Concepts Inc., USA). Values at each study point were presented as mean ± standard deviation. Univariate analysis was conducted using Student's t test, chi-square test, or the 2-tailed Fisher's exact test with the proportions in categorical variables. Significant differences between measurements is defined as $p<0.05$.

Results

The overall mortality rate was 23%. The mortality in group I was 42%, including surgical death (≦POD 30) in 23% and hospital death (> POD 30) in 12%, while that in group II was zero. The surgical results have improved every year (Figure.).

The causes of surgical death were renal failure (3 patients), hypovolemic shock due to bleeding (2 patients), DIC (2 patients) and multiple organ system failure (1 patient), while the causes of hospital death were DIC (2 patients) and pneumonia (1 patient).

Significant postoperative complications occurred in many patients (Table 2). In group I, renal failure developed in 8 patients (31%), DIC in 5 patients (19%) and sepsis in 2 patients (8%), while in group II, renal failure developed in 2 patients (9%), and pancreatitis requiring medication in 3 patients (14%). The two groups did not differ significantly in terms of renal failure, sepsis, pneumonia, ischemic colitis, pancreatitis, and multiple organ system failure. However, patients in

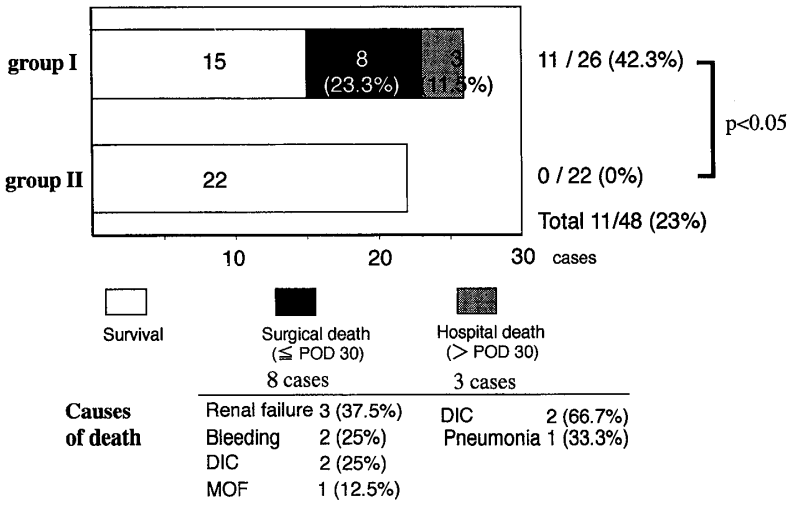

Figure Mortality

Table 2 Complications

	group I	group II	p-value
Renal failure	8(30.7%)	2(9.1%)	NS
DIC	5(19.2%)	0	$p < 0.05$
Sepsis	2(7.7%)	0	NS
Pneumonia	1(3.8%)	1(4.5%)	NS
Ischemic colitis	1(3.8%)	2(9.1%)	NS
Pancreatitis	1(3.8%)	3(13.6%)	NS
MOF	1(3.8%)	0	NS
Others	2(7.7%)	2(9.1%)	NS

NS: not significant.

group I were significantly more likely than those in group II to have DIC.

The volume of intraoperative bleeding was 5,467 ± 3,229 ml in group I and 1,465 ± 1,827 ml in group II. The patients in group I received transfusion of 5,736 ± 2,809 ml of blood, while those in group II received 3,257 ml ($p<0.05$). It was possible to decrease the volume of intraoperative blood transfusion significantly in group II by the rapid control of bleeding, that means rapid proximal clamping, and the use of autotransfusion technique of shed blood. Those patients who required greater blood transfusion had a tendency for higher mortality. No significant differences existed between the two groups in urine output, interval between start of operation and proximal clamping, and the number of patients with left thoracotomy.

Examining all 48 patients together, the degree of acidosis on admission was the most powerful univariate predictor of death (Table 3). Age, gender, blood pressure, urine output, and left thoracotomy failed to attain univariate significance. In addition, the greater the transfusion required and blood loss, the higher the mortality.

Discussion

The overwhelming majority of elective abdominal aortic aneurysm (AAA) repairs are done to prevent rupture[7)8)]. If one could accurately predict which aneurysm was going to rupture and when, the clinical problem of patient selection and timing of operation would have a straightforward solution. Unfortunately, aneurysms are unpredictable and treacherous. In most reports of surgical series of AAAs, ruptured aneurysms account for approximately 18% to 20% of repairs. In the Canadian experience[9)], 17.7% of AAAs had ruptured, and in the Michigan experience the figure was 18.3%[10)]. Surgical mortality associated with ruptured AAA was a approximately 50% in the Michigan study, and did not change significantly from 1980 through 1990. The Canadian study also reported an in-hospital mortality rate

Table 3 Comparison of clinical features

	Status at discharge		p-value
	Alive n = 37	Dead n = 11	
Age (years)	72 ± 10	66 ± 15	NS
Gender (male/female)	32/5	10/1	NS
Systolic pressure (mmHg)	72 ± 38	62 ± 23	NS
pH	7.37 ± 0.1	7.28 ± 0.18	NS
BE (mmol/l)	− 4.3 ± 4.8	− 11.0 ± 5.3	$p < 0.05$
Hb (g/dl)	10.0 ± 2.1	9.3 ± 2.9	NS
rupture → op. (hr)	6.9 ± 4.1	15 ± 17	NS
op. → proximal clamp (min)	31 ± 21	57 ± 104	NS
Blood loss (ml)	1,465 ± 1,827	7,691 ± 3,122	$p < 0.05$
Blood transfusion (ml)	3,257 ± 1,440	7,234 ± 2,885	$p < 0.05$
Urine output (ml/kg/hr)	3.2 ± 2.0	1.9 ± 2.5	NS
Left thoracotomy (n)	6 (16%)	3 (27%)	NS

Values are expressed as the mean ± SD, NS: not significant.

of approximately 50% for ruptured AAAs.

A retrospective review of 48 ruptured infrarenal AAA with classification of the patients into clinical groups based upon the preoperative several factors was undertaken. Several factors related to the aneurysm also have an impact on results. For example, mortality is greater among patients who experience a free intraperitoneal rupture, or who have suprarenal extension of the aneurysm[2)11)]. We treated 48 cases of ruptured AAA. Nine patients with Fitzgerald's classification[2)] III and IV, who underwent left thoracotomy for cross clamping of the descending aorta, had a tendency for higher mortality. The hemodynamic status of the patients when first seen is also predictive of outcome. For example, in a report from the University of Michigan[12)], the intraoperative mortality rate was 39%, and the overall mortality rate was 78%, among patients who had a systolic blood pressure less than 80 mmHg. In another recent series[13)], survival was significantly ($p < 0.05$) better among patients whose initial systolic blood pressure was at least 70 mmHg. Low hematocrit when first seen also correlates with an unfavorable outcome[14)]. Preoperative cardiac arrest is an especially ominous clinical sign that has been shown to be independently predictive of mortality in several series[14)15)]. In one report, no patient who experienced a preoperative cardiac arrest ultimately survived. Finally, delay in making the correct diagnosis significantly increases the likelihood of a fatal outcome, and typically occurs in individuals with small aneurysms[15)].

Although outcome is largely dependent upon these patient-related variables, there are some factors under the control of the operating surgeon. Not surprisingly, the duration of the operating repair has an effect on overall results. For example, in one recent series[16)] the overall mortality rate was 47% for operations that exceeded 4 hours, but was only 33% when the procedure took less than 4 hours. In another study[12)], the mortality rate was 100% when the operation was longer than 400 minutes, but was only 27% when the procedure was 150 to 250 minutes in duration ($p<0.01$). Overall blood loss and volume replacement are also predictive of outcome. In a series from the University of Michigan, estimated intraoperative blood loss >11,000 ml and blood transfusion requirement >3,400 ml correlated with overall mortality. In a recent series from the Mayo Clinic[14)], the overall mortality rate was 55%

among patients who received >3,000 ml of blood, compared to a mortality rate of 40% ($p<0.04$) among those who had a lower transfusion requirement. Finally, persistent hypotension and low urine output at the complication of the operative procedure are also predictive of a fatal outcome[12)15)].

We assume that clinical grouping of these patients permits the severity of the rupture to be assessed and the prognosis to be predicted. It's clear that the rapid control of bleeding and the autotransfusion technique of shed blood are important. The most important factor in preoperative states was the base excess, the degree of acidosis on admission. It is associated with the interval between rupture and operation, and the expansion of rupture. Minimizing preoperative shock interval is the key points for improving operative outcome of ruptured abdominal aortic aneurysms.

Conclusion

It is concluded that the rapid control of bleeding and the use of autotransfusion technique of shed blood significantly improved the results of surgical treatment in cases of ruptured AAA at our institution. The most important factor for survival of these patients was the degree of acidosis on admission, while efforts should be made to shorten the interval between rupture and operation.

Acknowledgments

I acknowledge the helpful comments of Professor Hitoshi KOYANAGI, MD. I also thank Assistant Professor Shigeyuki AOMI, MD for his useful advice.

References

1) **Dubost C, Alloy M, Oeconemeros N**: Resection of an aneurysm of the abdominal aorta. Arch Surg **64**: 405, 1952
2) **Fitzgerald JF, Stillman RM, Powers JC**: A suggested classification and reappraisal of mortality statistics for ruptured atherosclerotic infrarenal aortic aneurysms. Surg Gynecol Obstet **146**: 344–346, 1978
3) **Hoffman M, Avellone JC, Plecha FR et al**: Operation for ruptured abdominal aortic aneurysms: A community-wide experience. Surgery **91**: 597–602, 1982
4) **Meyer AA, Ahlquist RE Jr, Trunkey DD**: Mortality from ruptured abdominal aortic aneurysms: A comparison of two series. Am J Surg **152**: 27–33, 1986
5) **Crawford ES**: Ruptured abdominal aortic aneurysm: An editorial. J Vasc Surg **13**: 348–350, 1991
6) **Perler BA**: The management of patients with ruptured abdominal aortic aneurysms. Adv Surg **30**: 21–38, 1996
7) **Ernst C**: Abdominal aortic aneurysm. N Engl J Med **328**: 1167–1172, 1993
8) **Sampson LN, Cronenwett JL**: Abdominal aortic aneurysms. Probl Gen Surg **11**: 385–417, 1994
9) **Johnston KW, The Canadian Society for Vascular Surgery Aneurysm Study Group**: Ruptured abdominal aortic aneurysm: Six-year follow-up results of a multicenter prospective study. J Vasc Surg **19**: 888–900, 1994
10) **Katz DJ, Stanley JC, Zelenock GB**: Operative mortality rates for intact and ruptured abdominal aortic aneurysms in Michigan: An eleven-year statewide experience. J Vasc Surg **19**: 804–817, 1994
11) **Donaldson MC, Rosenberg JM, Bucknam CA**: Factors affecting survival after ruptured abdominal aortic aneurysm. J Vasc Surg **2**: 564–570, 1985
12) **Wakefield TW, Witehouse WM Jr, Shu-Chen W et al**: Abdominal aortic aneurysm rupture: Statistical analysis of factors affecting outcome of surgical treatment. Surgery **91**: 586–596, 1982
13) **Ouriel K, Green RM, Donayre C et al**: An evaluation of new methods of expressing aortic aneurysm size: Relationship to rupture. J Vasc Surg **15**: 12–20, 1992
14) **Gloviczki PG, Pairolero PG, Mucha P Jr et al**: Ruptured abdominal aortic aneurysms: Repair should not be denied. J Vasc Surg **15**: 851–859, 1992
15) **Murphy JL, Barber GG, McPhail NV et al**: Factors affecting survival after rupture of abdominal aortic aneurysm: Effect of size on management and outcome. Can J Surg **33**: 201–205, 1990
16) **Fielding JWL, Black J, Ashton F et al**: Ruptured aortic aneurysms: Postoperative complications and their etiology. Br J Surg **71**: 487–491, 1984

破裂性腹部大動脈瘤に対する外科治療成績の検討

東京女子医科大学　医学部　循環器外科学（主任：小柳　仁教授）

冨岡（トミオカ）　秀行（ヒデユキ）

破裂性腹部大動脈瘤に対する，術前・術中背景因子と治療手順の変遷に伴う臨床成績の向上について検討した．対象は1980年1月から1997年12月までに東京女子医科大学病院循環器外科で人工血管置換術を施行した破裂性腹部大動脈瘤48例であり，切迫破裂は対象から除外した．年齢は平均69±12歳で，男女比は42対6であった．1980～1989年までの前期26症例をgroup I，1990～1997年までの後期22症例をgroup IIとし，臨床成績を比較検討した．group IIにおいて，破裂から手術開始までの時間は有意に短縮（group I：group II=12.7±13.4：6.9±4.1時間，$p<0.05$）し，自己血返血による血行動態の維持と，術中迅速な大動脈中枢側遮断に努力した．早期死亡は全体で23%（group I：group II=42：0%），死因はDIC4例，腎不全3例，失血死2例，他2例であった．早期死亡の背景因子の検討では，年齢，性別，入院時血圧，Hb，術中尿量，開胸等に有意差を認めなかった．破裂から手術までの時間，手術から大動脈遮断までの時間は生存退院例で短い傾向にあった．また統計学上の有意差は，術中出血量（生存退院：早期死亡＝1,465±1,827：7,691±3,122ml），輸血量（生存退院：早期死亡＝3,257±1,440：7,234±2,885ml）およびbase excess（生存退院：早期死亡＝－4.3±4.8：－11±5.3mmol/*l*）で認め，いずれも生存退院例で良好であった．迅速な出血のコントロールと自己血返血による血行動態の維持が手術成績に反映された．