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Preoperative Endoleak Type and Intraoperative Blood Loss in Aneurysmorrhaphy: A Case Series of 18 Patients

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Abstract

Endovascular aneurysm repair (EVAR) has become possible treatment option of abdominal aortic aneurysms, and endoleak was the most common complication after EVAR. Comparing to conventional open surgical treatment including open graft replacement,aneurysmorrhaphy is considered as a less invasive treatment for cases failed with transarterial coil or other interventions against aneurysm enlargement due to endoleakafter EVAR. In our institution a total of 18 patients underwent aneurysmorrhaphy for aneurysmal sac expansion after EVAR from 2010 to 2017.We report 18 cases who experienced aneurysmorrhaphy for endoleak after EVAR. Among these 18 cases, we describe two cases (typical case and massive bleeding case) of type II endoleak and two cases of endotension.In our cases, aneurysmorrhaphy often caused massive bleeding in the cases of type II endoleak, but not in endotension cases.For anesthesiologist, preoperative information of endoleak type by CTA provides an effective indication of intraoperative anesthetic management including preoperative blood preparation in aneurysmorrhaphy.

Keywords: Aneurysmorraphy; Endovascular aneurysm repair; Endoleak; Intraoperative blood loss

Introduction

Aortic aneurysm has been treated mainly by open surgical repair. Since the aortic stent graft was approved in Japan in 2006, endovascular aneurysm repair (EVAR) has become the main choice in the treatment of abdominal aortic aneurysms, especially in elderly patients and patients with high risk complications, because of its low invasiveness and rapid postoperative recovery. Device-related complications of EVAR include endoleaks and endoleak type was defined as follows; type I : blood flow entering through the end of the stent graft, type II : caused by a backflow through collateral vessels include lumbar artery or inferior mesenteric artery, type III : blood flow entering the aneurysm through the stent graft connection, type IV : blood flow through the stent graft membrane into the aneurysm, type V (also called endotension): increment in aneurysm diameter without identifiable blood flow. The simple type from one branch of type II is classified as type IIa and the complex type involving two or more branches as type IIb.

Type II endoleak that caused by a backflow through collateral vessels is most problematic in the chronic phase. Current guidelines recommend treatment of type IIendoleaks associated with aneurysm enlargement to prevent rupture and aorto-enteric fistula, and transarterial coil or embolization is the choice of intervention[1,2]. Conventional open surgical treatment, including open graft replacement and aortobiliac bypass grafting is a secondary choice in type IIendoleak or endotensioncases if previously transarterial coil or embolization failed[3]. Recently, aneurysmorrhaphy is considered as a less invasive treatment for patients failed with transarterial coil or other interventions against aneurysm expansion due to endoleak after EVAR. This proce-

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dure is a modified technique that can avoid aortic cross clamp, graft explantation, and systemic heparinization[4,5]. In our institution, aneurysmorrhaphy is standard surgical treatment in type II or endotension cases of aneurysm enlargement after EVAR. It is recognized among vascular surgeons that there is a large difference in the amount of intraoperative blood loss depending on the type of endoleak in aneurysmorrhaphy. However there has been no discussion in the literature.

In our institution a total of 18 patients underwent aneurysmorrhaphy for aneurysmal sac expansion after EVAR from 2010 to 2017.Clinical characteristics of patients and pre- and post-operative diagnosis of endoleak type were described in Table 1. In 18 patients, 13 patients were diagnosed type II endoleak, and five patients were diagnosed endotension postoperatively. Patient demographic characteristics and medical comorbidities were described in Table 2. Clinical outcomes such as operation time, postoperative diagnosis, intraoperative blood loss, and red blood cell transfusion were described in Table 3. Among these 18 cases, we describe two cases (typical case and massive bleeding case) of type II endoleak and two cases of endotension in which the patients experienced aneurysmorrhaphy for endoleak after EVAR.

Table 1: Clinical characteristics and summary of the diagnosis

Case	Age	Sex	Comorbidities	Diameter of aneurysm (mm)	Preoperative hemoglobin (g/dl)	Preoperative diagnosis	Postoperative diagnosis
1	77	M	HT, CKD	75	12.7	EL2b	EL2b
2	66	M	HT, DM	88	15.1	EL2b	EL2b
3	74	M	HT, CKD, Anticoaglation	94	12.2	EL2a	EL2a
4	84	M	HT, CKD, CAD, Anticoaglation	88	8.3	EL2a	EL2a
5	85	M	HT, DM, CKD	135	8.9	EL2b	EL2b
6	81	M	HT, CKD	132	11.0	EL2b	EL2b
7	67	M	CAD, Anticoaglation	90	14.0	EL2b	EL2b
8	86	F	HT, CKD, Anticoaglation	82	10.9	EL2b	EL2b
9	71	M	HT, Anticoaglation	88	13.2	EL2a	EL2a
10	81	M	HT, Anticoaglation	90	10.7	EL2b	EL2b
11	73	M	Anticoaglation	70	13.3	EL2a	EL2a
12	91	M	HT, CKD	100	9.6	EL2b	EL2b
13	64	M	HT	111	15.1	EL2b	EL2b
14	87	M	HT, CKD, CAD, Anticoaglation	100	10.3	ET	ET
15	79	M	HT, CKD, CAD, Anticoaglation	96	10.2	ET	ET
16	75	M	HT, CAD	76	11.9	ET	ET
17	81	M	HT, CKD	65	14.2	ET	ET
18	86	M	HT, CKD, Anticoaglation	74	11.1	ET	ET

EL, endoleak; ET, endotension
HT, hypertension; CKD, chronic kidney disease;DM, diabetes mellitus; CAD,coronary artery disease

Table 2: Group characteristics and preoperative data in 18 patients.

Characteristics	Type II Endoleak (n=13)	Endotension (n=5)
Age	76.9 ± 8.2	80.2 ± 4.5
Male, n (%)	13 (100)	4 (80)
BMI (kg/m^2)	23.7 ± 3.8	22.8 ± 1.2
Hypertension, n (%)	11 (85.6)	5 (100)
Diabetes mellitus, n (%)	2 (15.3)	0
Chronic kidney disease, n (%)	7 (53.8)	4 (80)
History of CAD, n (%)	2 (15.4)	3 (60)
Anticoagulation, n (%)	7 (53.8)	3 (60)
Diameter of aneurysm (mm)	96 ± 19	82 ± 14
EVAR to aneurysmorrhaphy Duration (month)	68 ± 25	87 ± 19
Preoperative hemoglobin (g/dl)	11.9 ± 2.2	11.5 ± 1.6
Preoperative hematocrit (%)	35.7 ± 6.5	35.3 ± 4.9

Values are expressed as mean ± SD. BMI, body mass index; ACS, acute coronary syndrome; EVAR, endovascular aneurysm repair

Table 3: Clinical outcomes of perioperative period

Case	Operation time (minutes)	Postoperative diagnosis	Intraoperative blood loss (mL)	RBC transfusion (ml)
1	231	EL2b	1,570	240
2	236	EL2b	1,610	630
3	161	EL2a	620	560
4	254	EL2a	1,300	1680
5	361	EL2b	9,170	5690
6	280	EL2b	2,940	1960
7	272	EL2b	3,830	1270
8	602	EL2b	8,130	6300
9	320	EL2a	2,280	440
10	378	EL2b	6,420	4620
11	161	EL2a	310	0
12	460	EL2b	12,500	7480
13	320	EL2b	1,437	0
14	235	ET	80	0
15	268	ET	30	0
16	198	ET	285	0
17	128	ET	30	0
18	197	ET	100	560

Case presentation

Type II endleak

A 71-year-old man (case 9 in tables) underwent EVAR for abdominal aortic aneurysm in 2013. Postoperative Computed Tomography Angiography (CTA) revealed a type 2 endoleakand enlargement of the aneurysm. In 2014, transarterial coiling was performed, however further enlargement of the aneurysm was observed. Therefore, in 2017 aneurysmorrhaphy was performed. He was 167 cm in height and weighed 73 kg. His past history was hypertension.

The operation was performed with general anesthesia combined with epidural anesthesia. After the thrombus in the aneurysm was removed, an inflow vessel from lumber artery was recognized and ligated. Since patient's hemoglobin level was lowered to 7.6 g/dl, red blood cell taransfision was performed.

The duration of the operation was 5 h 20 min. The blood loss was 2280 mL. Red blood cell(RBC) transfusion was 440 mL. He was transferred to the intensive care unit(ICU) after the operation. The patient left the ICU after 20 hours and was discharged after 20 days.

A 91-year-old man (case 12 in tables) underwent EVAR for abdominal aortic aneurysm in 2011. After 6 years of later from the operation of EVAR, aneurysmorrhaphy was performed in 2017 because type IIb endoleak (several inflow vessels) and expansion of the aneurysm were observed by CTA (Figure 1). He was 158 cm in height and weighed 64 kg. His past history was hypertension and chronic kidney disease (CKD).

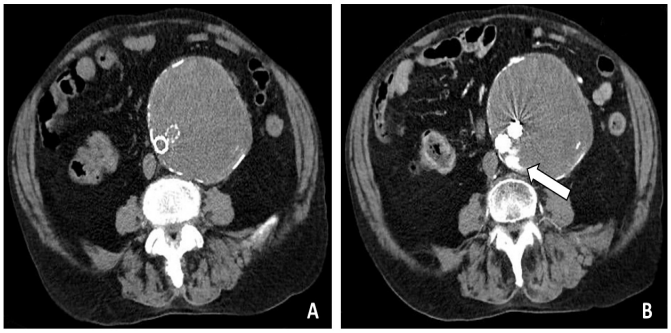

Figure 1: Preoperative plain and contrast-enhanced CT on type II endoleak after EVAR (case 12). (A) A plain CT image shows the high intensity prosthetic stent graft inside enlarged abdominal aortic aneurysm. (B) On contrast-enhanced CT, a contrast agent inflow outside of endoprosthesis lumen and within the aneurysm sac is seen developing from lumber artery (arrow). CT, computed tomography; EVAR, endovascular aneurysm repair.

The operation was performed with general anesthesia combined with epidural anesthesia. Because surgeons and anesthesiologist concerned intraoperative massive bleeding, intraoperative autologous transfusion (cell-saver system) was used in this operation. The preoperative CTA identified inferior mesenteric artery (IMA) as one of the causative vessels of endoleak. Therefore, the IMA was ligated first and then the aneurysm was incised. Blood flow into aneurysm from lumbar artery and median sacral artery was recognized after removal of thrombus. During surgeons identified and ligated these inflow vessels, the blood loss was increasedover 10000 ml.Because patient's intraoperative hemoglobin was as low as 8.1 and sustaining bleeding was expected, the anesthesiologist performed red blood cell transfusion.

The duration of the operation was 7 h 40 min. The blood loss was 12500 mL. Transfusion of 3080 mL of RBC, 3840 mL of fresh frozen plasma, 400 mL of platelet concentrate, and 4400 mL of autologous red blood cell transfusion wasperformed. He was transferred to the ICUafter the operation. The patient left the ICU after 74 hours and was discharged after 23 days.

Endotension

A 79-year-old man (case 15 in tables) underwent EVAR for abdominal aortic aneurysm in 2010. Although no endoleak was found in the postoperative CTA (Figure 2), the aneurysm gradually enlarged. In 2017 aneurysmorrhaphy was performed. He was 170 cm in height and weighed 68 kg. His past history were hypertension and CKD.

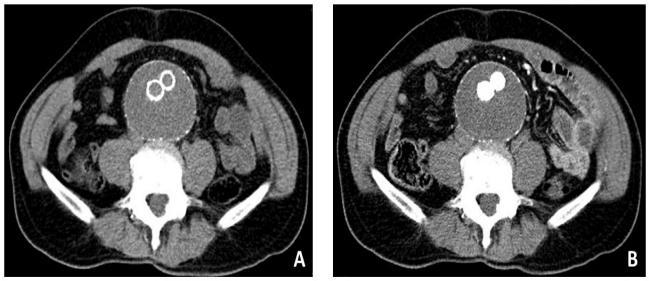

Figure 2: Preoperative plain and contrast-enhanced CT on endotension after EVAR (case 15). (A) On plain CT, high intensity prosthetic stent graft is seen inside enlarged abdominal aortic aneurysm. (B) On contrast-enhanced CT, stent graft lumen is well visualized with contrast agent, however no contrast agent is seen in the aortic aneurysm, suggesting no inflow vessels. CT, computed tomography; EVAR, endovascular aneurysm repair.

The operation was performed with general anesthesia combined with epidural anesthesia, and intraoperative angiography showed no endoleaks. When the wall of the aneurysm was incised, massive hard clots were revealed. Surgeons removed these hard clots and no inflow vessels from the aneurysmal wall were identified.

The duration of the operation was 2 h 8 min. The blood loss was 30 mL, and no blood transfusion was performed. He was transferred to the ICU after the operation. The patient left the ICU after 21 hours and was discharged after 21 days.

A 86 year-old man (case 18 in tables) underwent EVAR for abdominal aortic aneurysm in 2012. Since the expansion of the aneurysm was gradually observedafter EVAR, in 2017 aneurysmorrhaphy was performed. She was 142 cm in height and weighed 42 kg. Her past history was hypertension and CKD.

The operation was performed with general anesthesia combined with epidural anesthesia, and intraoperative angiography showed no endoleaks. After incision of the aneurysm wall and thrombus was removed, no inflow vessels from the aneurysm wall were identified.

The duration of the operation was 3 h 17 min. The blood loss was 100 mL.Althoughthe patients was not preoperative anemia, the anesthesiologist considered a possibility of intraoperative massive bleeding and 560 mL of RBC transfusion was performed. She was transferred to the ICU after the operation. The patient left the ICU after 19 hours and was discharged after 41 days.

Discussion

Endoleak is a major complication of EVAR, and management of end leaks has been a major issue for more than 20 years. The largest published series was from European Collaborators on Stent/graft Techniques for aortic Aneurysm Repair (EUROSTAR) registry (3595 patients), with a 9 % of type II endoleak cases diagnosed during follow-up[6]. It was also reported that 2.4 ~ 6 % of patients were required secondary treatment due to endotension after EVAR[7,8]. Type II endoleak has leakage through retrograde collateral blood flow such as lumbar, inferior mesenteric or internal iliac arteries. Type II endoleaks are generally benign and have little adverse effect on the outcome of EVAR. However, Van Marrewijk[6] found that type II endoleak were significantly associated with dilatation of the aneurysm sac over time and it was widely recognized that such patients should be treated with endovascular therapy or conversion to open repair. On the other hand, the mechanism of endotension is not clear. It has been hypothesized that if the leak is small, the small hole in the stent graft may be blocked with a thrombus, resulting in an undetectable leak on imaging studies[9]. Some investigators have suggested that endotension results from direct pressure transfer from the adjacent aortic lumen to the aneurysm[10]. In endotension, fibrinolysis in the aneurysm sac was also observed[11]. This hyperfibrinolysis may be a risk for bleeding. The difference in the mechanism of these 2 types of endoleaks and the existence of inflow blood vessel may be related to the difference in the bleeding risk.

In type II endoleaks, the number of vessels entering the aneurysm varies. Previous studies have reported that risk factors for persistent type II endoleaks are large, patent IMA, and more than two lumbar arteries on preoperative CTA[12]. Therefore, it has been shown to be reasonable to evaluate the inflow vessels preoperatively. Computed Tomography (CT), Magnetic Resonance Imaging (MRI), and Ultrasonography are commonly used to diagnose endoleak types, although guidelines recommend CTA after 6 months[13].

To the best of our knowledge, we found no literature concerning about preoperative type of endoleak and intraoperative blood loss in aneurysmorrhaphy. In our cases, aneurysmorrhaphy often caused massive bleeding in the cases of type II endoleak. Comparing in type IIa and IIb, intraoperative blood loss ranges 310 – 2280 ml in type IIa, and 1437 – 12500 ml in type IIb.These data indicates that the greater the number of inflow vessels, the greater the intraoperative blood loss. Otherwise, intraoperative blood loss in endotension cases was much less comparingto type II endoleak. Case 12 is a typical case of endotension in aneurysmorrhaphy, namely, a little blood loss and no need for blood transfusion. In case 18, the patient received 560 ml of RBC transfusionin spite of the fact that intraoperative blood loss was 100 ml. The anesthesiologist of case 18 concerned about a possibility of intraoperative massive bleeding and trans used RBC. In view of the blood loss of these endotension and type II EL cases, we modified the protocol of preoperative blood preparation in aneurysmorrhaphy. Specifically, no preoperative blood preparation is necessary in endotension cases and 4 – 8 units of preoperative RBCs must be prepared in type II EL cases along with patient's condition (e.g.; hemoglobin level, number of inflow vessels). For anesthesiologist, preoperative information of endoleak type by CTA provides an effective indication of intraoperative anesthetic management including preoperative blood preparation in aneurysmorrhaphy.

Conclusion

We report 18 cases of aneurysmorrhaphy for endoleak after EVAR. These cases suggested that the type of endoleak after EVAR may be associated with the amount of intraoperative blood loss in aneurysmorrhaphy. Especially blood loss in endotension cases was much less than in other type of endoleak cases. Preoperative estimation of intraoperative blood loss depending on endoleak type will be helpful for the decision making of anesthetic management in aneurysmorrhaphy.

Footnote: The findings of this study were presented in part at the Annual Meeting of the Japanese Society of Anesthesiologists in Yokohama, Japan, May 18, 2018.

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