Outcomes of Abdominal Aortic Aneurysm with Aortic Neck Thrombus after Endovascular Abdominal Aortic Aneurysm Repair

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Background: *Endovascular abdominal aortic aneurysm repair (EVAR) has increasingly been performed for the last two decades. One of the anatomical exclusion criterion of EVAR is the presence of thrombus within the infrarenal neck of an aneurysm.*
Objective: *To investigate the influence of proximal aortic neck thrombus morphology on clinical outcomes after EVAR.*
Material and Method: *The subjects were retrospectively recruited from all the patients whom undergone EVAR in our institution between January 2010 and December 2012. The patients with apparent thrombus of more than 40% at proximal aortic neck were included. Primary endpoints consisted of technical success and perioperative mortality. Secondary endpoints included adjuvant procedures at neck, procedural details, perioperative adverse events, ICU, and hospital stay. The late outcomes of stent grafts related complications were the presence of endoleak, aneurysm expansion, stent graft migration, stent graft thrombosis, AAA rupture, secondary intervention rate, and conversion to open repair.*
Results: *Twenty-one out of 145 patients having thrombus of more than 40% of circumferential aortic neck underwent EVAR. The mean follow-up was 15.4 months (range, 2-36 months). There was 100% technical success with no perioperative death. Adjuvant of aortic neck procedure was required in three patients. One patient developed graft limb occlusion. In addition, one patient developed renal infarction requiring long-term hemodialysis and two patients presented with blue toe syndrome and trash feet. During late follow-up, three, five, and two patients had a type II endoleak at one, six, and 12 months, respectively without AAA sac expansion. There was no stent graft migration, stent graft thrombosis, or ruptured AAA. Three patients expired during the late follow-up. In addition, there was neither conversion to opened repair nor secondary intervention.*
Conclusion: *The presence of aortic neck thrombus may not be a contraindication for EVAR in selected patients. However, it seems to negatively influence the outcomes in the aspect of renal and peripheral embolization, which could be prevented during EVAR procedure. There was no adverse graft-related complication, secondary intervention, or aneurysm-related mortality during mid-term follow-up period.*

Keywords: *Abdominal aortic aneurysm, Aortic neck thrombus, Outcome*

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Endovascular abdominal aortic aneurysm repair (EVAR) has been increasingly used since its introduction in 1991[1]. Many benefits of EVAR over traditional open surgical repair had been reported, such as an increased perioperative survival rate, fewer postoperative complications, and a shorter hospital stay[2,3]. However, not all abdominal aortic aneurysm (AAA) patients are suitable for the EVAR procedure. Exclusion criteria for EVAR are mainly based on the limits laid by the anatomical configuration of the aneurysm. It is especially important that a patient have a proper proximal aneurysm neck to allow for adequate proximal fixation and sealing[4]. Proximal aortic neck thrombus is suggested to influence EVAR results negatively[5] and has therefore been an exclusion criterion in the clinical trials studying EVAR. However, some reports suggest that aortic neck thrombus might not influence the clinical outcome after EVAR[6,7].

The purpose of the present study is to investigate the influence of proximal aortic neck thrombus morphology on clinical outcomes after EVAR.

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Material and Method

Patients

The subjects of the present study were retrospectively recruited from all the patients who had

undergone EVAR in our institution between January 2010 and December 2012. The patients were included if they met the following criteria, a preoperative proximal aortic neck length of ≥15mm, with thrombus of >2 mm thick in the first 10 mm of aortic neck[8], lining more than 40% of the aortic neck wall, as judged by a single observer (KC) on axial computed tomographic angiography (CTA) slices. All of the patients must have at least one CTA, one-month post EVAR procedure. The Siriraj ethical committee for research in humans approved this retrospective study.

Pre-operative measurements

The acquired datasets were transferred to a workstation (OsiriX Imaging Software, vs. 4.0, 64-bit) for a center lumen line (CLL), multiplanar reconstruction, and 3D volume rendering method[9]. The following morphologic characteristics were measured on all preoperative CTAs: (1) proximal aortic neck length, (2) maximum AAA diameter, (3) proximal neck diameter, (4) percentage of thrombus-lined neck wall.

The aortic neck length was measured from the most distal renal artery to the first discernible level where the aortic diameter increased by 10%. All diameter measurements were performed perpendicularly to the CLL. The percentage of thrombus lining the aortic neck wall was measured at the aortic neck, more than 40% of which were included in the present study, Fig. 1. The patients with ruptured AAA were excluded.

Study end-points

Primary endpoints consisted of the early outcomes with technical success and perioperative mortality. Secondary endpoints included adjuvant aortic neck procedures, procedural details, perioperative adverse events, ICU and hospital stays, and the late outcomes of stent-graft-related complications: presence of endoleak, aneurysm expansion, stent graft migration, stent graft thrombosis, AAA rupture, secondary intervention rate, and conversion to open repair.

Technical success was defined as successful intravascular access to the aneurysm site, deployment of the stent graft with secured fixation and patency, and absence of type I and III endoleak or graft limb occlusion within the first 24 hours after the procedure[8]. Adjuvant aortic neck procedures were defined as the uses of a proximal aortic cuff or balloon expandable bare stent (Palmaz 4010 or 5010 stent, Cordis Corp., Miami Lakes, Fla) during the procedure[10]. Aneurysm sac growth was defined as an increase in diameter of aneurysm by ≥5 mm. Migration was defined as downward movement of device by ≥10 mm or any migration causing symptoms or requiring therapy[8].

Descriptive statistics are reported as mean ± standard deviation for continuous data and categorical data are presented as number and percentage. Statistical analysis was conducted with SPSS software version 20 (SPSS Inc., Chicago, III).

Results

Between January 2010 and December 2012, 21 out of 145 patients having thrombi of more than 40% of circumferential aortic neck underwent EVAR. Three different stent-graft devices were implanted, 11 Zenith (Cook, Bloomington, IN), nine Endurant (Medtronic, Minneapolis, MN), and one Excluder (Gore, Flagstaff, AZ). The preoperative characteristics of the included patients were shown in Table 1.

Early outcomes (<30 days)

There was 100% technical success without perioperative death in the present study. Adjuvant of aortic neck procedure was found in three cases, of

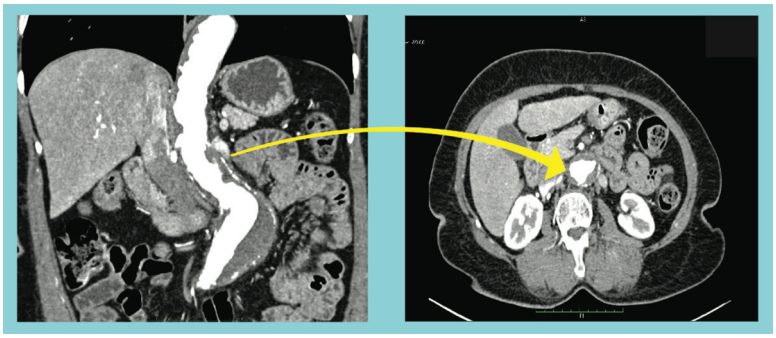

Fig. 1 The aortic neck thrombus of infrarenal abdominal aortic aneurysm.

Table 1. Preoperative characteristics

Characteristics	n = 21
Demographics	
Age, mean ± SD, years	76.1±7.0
Male gender, %	66.7
Risks, %	
Coronary artery disease	38.1
COPD	19.0
Hypertension	71.4
Dyslipidemia	47.6
Renal insufficiency (Cr >2 mg/dl)	14.3
Diabetic mellitus	19.0
Current smoking (<8 weeks)	9.5

COPD = chronic obstructive pulmonary disease

Table 2. Adjuvant procedures during operation

Complications	Number (%)	Adjuvant procedures
Type 1A endoleak	1 (4.8)	Palmaz stent
Type 3 endoleak	1 (4.8)	Iliac extension
Graft migration	2 (9.5)	Aortic extension cuff
Graft limb kinking	2 (9.5)	Palmaz stent

Table 3. Procedural details

Variables	n = 21
Aneurysm diameter, mm (mean ± SD)	60.9±12.4
Duration of procedure, min (mean ± SD)	173.0±61.9
Regional anesthesia, %	61.9
Intraoperative blood loss, mL (mean (range))	200 (50-2,000)
Volume contrast, mL (mean ± SD)	119.7±39.2
ICU stay, day (mean (range))	0 (0-12)
Hospital stay, day (mean (range))	6 (4-56)

ICU = intensive care unit

Table 4. Perioperative adverse events

Complications	Number (%)
Organ complications	
Congestive heart failure	1 (4.8)
Renal failure, need dialysis	1 (4.8)
Blue toe syndrome	2 (9.5)
Infective complications	
Pneumonia	2 (9.5)
Acute cholecystitis	1 (4.8)
Perioperative mortality	0

which one Palmaz stent for solving the type 1A endoleak and two aortic extension cuffs for managing the graft migration, Table 2. The procedural details were presented in Table 3. Most procedures took approximately three hours and about two-thirds of the patients underwent regional anesthesia with spinal block before the operation. As for perioperative adverse event, one case developed graft limb occlusion. This complication resulted from narrowing of aortic bifurcation that was solved with graft thrombectomy and kissing balloon. In addition, one patient developed renal infarction requiring long-term hemodialysis and two patients presented with blue toe syndrome and trash feet after EVAR procedure, Table 4 and Fig. 2.

Late outcomes (>30 days)

The mean follow-up was 15.4 months (range, 2-36 months), without any patients loss during the follow-up. Three patients expired during the follow-up, at two, four, and five months due to sepsis and multi organ failure. During late follow-up, three, five, and two patients had type II endoleak at one, six, and 12 months, respectively without AAA sac expansion. There was no stent graft migration, stent graft

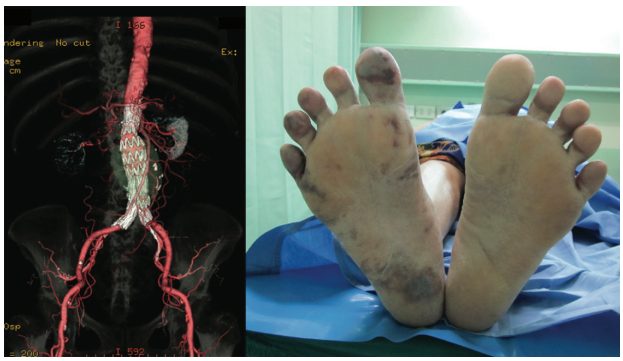

Fig. 2 Post-operative complications: renal infarction and blue toes syndrome after EVAR procedure.

Table 5. Outcomes of late follow-up (>30 days)

Events	1 month (n = 21)	6 months (n = 16)	1 year (n = 9)	2 years (n = 4)
Mortality	0	3	0	0
AAA-related mortality	0	0	0	0
Graft-related complications				
Endoleak type 2	3	5	2	0
Graft migration	0	0	0	0
Graft thrombosis	0	0	0	0
AAA sac size				
Regression	1	5	2	1
Stable	20	11	7	3
Expansion	0	0	0	0
Secondary intervention	0	0	0	0
Open conversion	0	0	0	0

AAA = abdominal aortic aneurysm

thrombosis, ruptured AAA during the follow-ups at one, six, 12, and 24 months, Table 5. In addition, there was neither conversion to opened repair nor secondary intervention in the present study.

Discussion

In the present study, the authors investigated the clinical outcomes after EVAR in the patients with aortic neck thrombus. Thrombus in the proximal AAA neck is currently considered a contraindication for EVAR because it may lead to proximal type I endoleak, graft migration, and proximal and distal embolization[5]. However, some reports showed no negative effect on EVAR durability and complications[6,7]. In the present study, this neck thrombus was found to develop renal infarction and distal embolization during perioperative period. In contrast, there was no adverse graft-related complication during the late follow-up.

It is considered that severe thrombus at the proximal aneurysm neck may influence on sealing and anchoring of the stent grafts, thereby increasing the risk of type IA endoleak. Although the authors routinely oversized the stent grafts according to local protocol (20-30%), one patient developed type IA endoleak during operation and was treated with Palmaz stent.

In our series, the graft migration was seen in two cases intra-operatively. This complication could be managed with aortic extension cuff. Chuter et al[11] studied 52 EVAR cases with follow-up to three years. They reported three cases of endograft migration and all of them had thrombi lining the aortic neck[11]. In contrast to the Chutter's study, no evidence of endograft migration was detected in Gitlitz D et al's[7] study of 19 AAA patients and aortic neck thrombus after a mean follow-up of 23 months[7]. It might be the design of supra-renal fixation of stent graft that was 95% (20 cases) used in this series[7].

Graft limb occlusion was the third most common reason for readmission after EVAR[12] and was usually presented within 90 days after the procedure[13], of which the incidence was approximately 4%[14]. One patient developed this complication on the second post-operative day, which probably resulted from narrowing of distal aorta, and was successfully treated by graft thrombectomy and kissing balloon of both iliac limbs. Both iliac limbs were still patent after 18-month follow-up.

A right renal infarction was seen in one patient on the first postoperative CTA. This complication seemed to be comparable to a renal infarction after EVAR in another study investigating the relationship between proximal aortic neck thrombus and outcome after EVAR[7]. Besides, Walsh et al reviewed the renal function after EVAR and found that embolization was probably one of the reasons to develop deterioration in renal function[15]. An inflatable balloon might force an embolus out of the proximal neck thrombus. Therefore, the authors believe that an inflatable balloon should not be used at the proximal part of aortic neck in patients with severe aortic neck thrombus[6].

Blue toe syndrome from distal embolization developed postoperatively in two patients. Thompson et al mentioned that EVAR had a tendency to develop more distal embolization than open aneurysm repair[16]. Tsunehiro et al reported that distal embolization developed in 20% after EVAR in AAA with neck thrombus, of which two cases presented with blue toe

syndrome and the other two cases developed peripheral artery embolization treated by embolectomy[17].

The authors adapted three techniques to prevent renal and lower extremity embolic complications as follows: distal control of both common femoral arteries before the EVAR procedure, avoidance of positioning the stent graft above the level of renal artery by locating the upper end of the covered-stent graft at the lowest of renal artery, and no inflation of the balloon at aortic neck after the EVAR procedure. In our experience, these techniques could prevent the visceral and lower extremity embolization during the EVAR procedure.

During the late follow-up, the most common complication is type 2 endoleak. However, there was no AAA sac expansion, re-intervention, nor open conversion in this group of patients. The three cases passed away in the first six months after EVAR caused by sepsis and multiple organ failure. There was no aneurysm-related death in the present study.

The limitation of the present study was small sample size so it was unable to analyze the variables with statistical methods. Considerably more work needs to be done to determine the exact outcomes of aortic neck thrombus in clinical practice. Nevertheless, the present study revealed that EVAR might be the treatment of choice in patients with aortic neck thrombus and both complications from renal and lower extremity embolization could be prevented with the three techniques as the authors described in the present study.

Conclusion

The present study was designed to determine the effect of proximal aortic neck thrombus on the outcomes after EVAR. The presence of neck thrombus seems to influence the EVAR outcomes negatively in terms of renal and lower extremity embolization, which could be prevented during EVAR procedure. There was no adverse graft-related complication, secondary intervention, and aneurysm-related mortality during mid-term follow-up period.

What is already known on this topic?

Although EVAR has been increasingly used for 20 years, not all AAA patients are suitable for this procedure, especially the complicated neck of the aneurysm. One of the complicated neck problems is the proximal aortic neck thrombus, which is suggested to influence EVAR results negatively and has therefore been an exclusion criterion in the clinical trials studying EVAR. However, some reports suggest that aortic neck thrombus might not influence the clinical outcome after EVAR.

What is this study adds?

The present study was designed to determine the effect of proximal aortic neck thrombus on the outcomes after EVAR. The presence of neck thrombus seems to influence the early outcomes negatively in terms of renal and lower extremity embolization, which could be prevented with three techniques. Those techniques are the distal control of both common femoral arteries before the EVAR procedure, avoidance of positioning the stent graft above the level of renal artery by locating the upper end of the covered-stent graft at the lowest of renal artery, and no inflation of the balloon at aortic neck during EVAR procedure. Regarding the late outcomes, there was no adverse graft-related complication, secondary intervention, and aneurysm-related mortality during mid-term follow-up period.

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Potential conflicts of interest

None.

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ผลการรักษาของหลอดเลือดแดงเอออร์ตาโป่งพองในช่องท้องที่มีลิ่มเลือดบริเวณคอของหลอดเลือด โดยการผ่าตัดหลอดเลือดเทียมผ่านทางสายสวน

คามิน ชินศักดิ์ชัย, เกียรติศักดิ์ หงษ์คู, สุธีคณิต หัถพรสวรรค์, ชุมพล ว่องวานิช, ณัฐวุฒิ เสริมสาธนสวัสดิ์, เฉนียน เรืองเศรษฐกิจ, ประมุข มุทิรางกูร

ภูมิหลัง: การรักษาหลอดเลือดแดงเอออร์ตาโป่งพองในช่องท้องด้วยวิธีสายสวนทางหลอดเลือดได้รับความนิยมมาก ในช่วง 20 ปีที่ผ่านมา ข้อห้ามข้อหนึ่งของการรักษาด้วยวิธีนี้ คือ ภาวะที่มีลิ่มเลือดเกาะอยู่บริเวณคอของหลอดเลือดแดงเอออร์ตาที่โป่งพองนั้น

วัตถุประสงค์: เพื่อศึกษาผลกระทบของลิ่มเลือดบริเวณคอของหลอดเลือดแดงเอออร์ตาที่โป่งพองในช่องท้อง ที่มีต่อผลลัพธ์ของการรักษาโดยการผ่าตัดหลอดเลือดเทียมผ่านทางสายสวน

วัสดุและวิธีการ: การศึกษาย้อนหลังในผู้ป่วยหลอดเลือดแดงเอออร์ตาโป่งพองในช่องท้องที่มีลิ่มเลือดปกคลุมบริเวณคอของหลอดเลือดมากกว่า 40 เปอร์เซ็นต์ ของเส้นรอบวง ที่ได้รับการผ่าตัดด้วยวิธีหลอดเลือดเทียมผ่านทางสายสวน ตั้งแต่เดือนมกราคม พ.ศ. 2553 ถึง เดือนธันวาคม พ.ศ. 2555 ผลลัพธ์ปฐมภูมิประกอบด้วยความสำเร็จของการผ่าตัด และอัตราการเสียชีวิตภายใน 30 วันหลังการผ่าตัด ผลลัพธ์ทุติยภูมิ ประกอบด้วย การผ่าตัดเสริมบริเวณคอของหลอดเลือด, รายละเอียดการผ่าตัด, ภาวะแทรกซ้อนภายใน 30 วันหลังผ่าตัด, ระยะเวลาการอยู่ในหออภิบาล และระยะเวลาการอยู่โรงพยาบาล รวมถึงภาวะแทรกซ้อนหลังจากออกโรงพยาบาลได้แก่ การรั่วซึมของเลือดกลับเข้ามาในหลอดเลือดที่โป่งพอง, การขยายของหลอดเลือดแดงที่โป่งพองหลังผ่าตัด, การเลื่อนไหลของหลอดเลือดเทียมที่ใส่, การอุดตันของหลอดเลือดเทียมที่ใส่, การผ่าตัดซ้ำ และการผ่าตัดภายหลังด้วยวิธีเปิดช่องท้อง

ผลการศึกษา: ผู้ป่วยหลอดเลือดแดงใหญ่ในช่องท้อง จำนวน 21 ราย จาก 145 ราย มีลิ่มเลือดบริเวณคอของหลอดเลือดที่โป่งพองมากกว่า 40 เปอร์เซ็นต์ ได้รับการรักษาด้วยวิธีหลอดเลือดเทียมผ่านทางสายสวน ระยะเวลาการติดตามการรักษาโดยเฉลี่ย 15.4 เดือน (พิสัย 2-36 เดือน) ได้รับความสำเร็จในการผ่าตัดทุกราย ไม่มีการเสียชีวิตหลังผ่าตัด การผ่าตัดเสริมบริเวณคอของหลอดเลือดพบ 3 ราย ภาวะการอุดตันของขาข้างหนึ่งของหลอดเลือดเทียมมีจำนวน 1 ราย ต้องได้รับการฟอกเลือดถาวร 1 ราย พบลิ่มเลือดกระจายไปบริเวณเท้าทั้ง 2 ข้าง จำนวน 2 ราย การติดตามเดือนที่ 1, 6 และ 12 พบว่ามีลิ่มเลือดซึมเข้ามาในหลอดเลือดแดงโป่งพองชนิดที่ 2 จำนวน 3, 5 และ 2 ราย ตามลำดับ โดยไม่พบการขยายของหลอดเลือดแดงเอออร์ตาโป่งพองนั้น ผู้ป่วย 3 รายเสียชีวิตระหว่างติดตามการรักษา ซึ่งไม่สัมพันธ์กับหลอดเลือดแดงเอออร์ตาโป่งพองในช่องท้อง และไม่มีการผ่าตัดเปิดช่องท้องหรือ การทำผ่าตัดซ้ำระหว่างติดตามการรักษา

สรุป: การผ่าตัดด้วยวิธีใส่หลอดเลือดเทียมที่มีขดลวดค้ำยันผ่านทางสายสวน ในผู้ป่วยหลอดเลือดแดงเอออร์ตาโป่งพองในช่องท้องที่มีลิ่มเลือดบริเวณคอของหลอดเลือด ไม่ควรเป็นข้อห้ามในการผ่าตัด อย่างไรก็ตาม ภาวะแทรกซ้อนของลิ่มเลือดนั้นอาจมีผลต่อการอุดตันของหลอดเลือดแดงที่เลี้ยงไตหรือหลอดเลือดแดงปลายเท้าได้ ซึ่งสามารถป้องกันได้ระหว่างผ่าตัด การติดตามการรักษาหลังจากออกโรงพยาบาลพบว่าไม่มีภาวะแทรกซ้อนในแง่ของการรักษาซ้ำ และการเสียชีวิตจากหลอดเลือดแดงเอออร์ตาที่โป่งพองนั้น