Early Outcomes of Aorto-Uniiliac Stent Graft with Femorofemoral Bypass for Abdominal Aortic Aneurysm

Khamin Chinsakchai MD*, Tossapol Prapassaro MD*, Pramook Mutirangura MD*,
Chanean Ruansetakit MD*, Chumpol Wongwanit MD*, Nuttawut Sermsathanasawadi MD*,
Suteekhanit Hahtapornsawan MD*, Supaporn Tunpornpituk MSc*, Kiattisak Hongku MD*

* Division of Vascular Surgery, Department of Surgery, Siriraj Hospital, Mahidol University, Bangkok, Thailand

Background: Endovascular repair for abdominal aortic aneurysm (AAA) was developed to provide a less invasive method than the standard open procedure and has been reported to reduce perioperative mortality, hospital stays, and intensive care unit (ICU) stays. However, an unfavorable anatomy precludes the use of a standard bifurcated stent graft, especially in cases with narrow aortic bifurcation. The aorto-uni-iliac (AUI) configuration with a femorofemoral bypass graft appears to be a good alternative in these patients.

Objective: To present the results of the AUI stent graft with femorofemoral bypass graft for AAA during perioperative periods.

Material and Method: The data from 362 patients with AAA from January 2010 to December 2013 at a single institution were retrospectively analyzed. Patients undergoing open repair or endovascular repair with bifurcated graft were excluded. Sixty-two patients underwent AUI with femorofemoral bypass graft for treatment of AAA over the four-year period. Primary endpoint was perioperative mortality. Secondary endpoints included procedural details, intra-operative adverse events, postoperative complication, hospital stays, and perioperative re-intervention.

Results: Mean age was 75±8 years (range, 49 to 92 years). Thirty-two patients (61.3%) underwent AUI with femorofemoral bypass graft for non-ruptured AAA and twenty-four patients (38.7%) were performed in ruptured AAA. The perioperative mortality rate was 5.1%, all of which were ruptured AAA. Mean procedural blood loss was 514 mL (range 50 to 7,000 mL), and 51.61% required intraoperative blood transfusion. Mean length of postoperative stays was 16.3 days (range, 2 to 59 days). There were eleven (18.6%), seventeen (28.8%) and twenty-four (37.3%) developed local, organ and infective complications, respectively. In addition, seven patients (11.9%) needed perioperative re-intervention.

Conclusion: AUI stent graft and femorofemoral bypass graft for AAA is feasible in both elective and emergency situations with a low perioperative mortality rate. This procedure is associated with an acceptable rate of perioperative complications and early re-intervention.

Keywords: Abdominal aortic aneurysm, Aorto-uniiliac stent graft, Endovascular aneurysm repair

Abdominal aortic aneurysm (AAA) accounts for 5 to 10% of the elderly male population[1]. For more than 50 years, AAA has been treated with open surgical repair, which is associated with a 30-day mortality rate of 4 to 12%[1,2]. In the early 1990s, Parodi JC et al introduced a less invasive endovascular method for AAA repair[3]. Recently, three randomized controlled trial studies have well established the efficacy and short-term outcomes of elective endovascular aortic aneurysm repair (EVAR). EVAR is widely considered more effective than open repair, especially in perioperative periods[4-6]. In general, most AAA patients require treatment with EVAR due to open surgical repair posing an unacceptable high rate of risk. However, the unfavorable anatomy usually precludes the use of the standard bifurcated stent graft, especially in cases with narrow aortic bifurcation[7]. The aorto-uni-iliac (AUI) configuration with a femorofemoral bypass graft proved to be an acceptable alternative in these cases[8,9].

Therefore, the purpose of this study was to present the early outcomes of the AUI with femorofemoral bypass graft for AAA during perioperative period.

Material and Method

Between January 2010 and December 2013, a total of 362 patients with AAA were retrospectively

Correspondence to:
Hongku K, Division of Vascular Surgery, Department of Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand.
Phone: +66-2-4198021, Fax: +66-2+4129160
E-mail: kiattisak.hongku@gmail.com

analyzed. The Siriraj ethical committee for research in humans approved this study. Patients undergoing open repair or endovascular repair with bifurcated tube graft were excluded. Sixty-two patients diagnosed with non-ruptured and ruptured AAA undergoing AUI with femorofemoral bypass graft were included in the study. The technique of implantation procedure is described in the previous article[10]. The criteria for operation of AAA was transverse diameter of more than 5 cm or a rapidly increase of AAA sac if less than 5 cm. The any size of saccular AAA was also included in this study.

The indications for AUI with femorofemoral bypass graft in this study were as follows:

1) Narrow aortic bifurcation was defined as a transverse diameter <15 mm.

2) Contralateral common iliac artery (CIA) angle >90 degree from the longitudinal axis of AAA.

3) Heavily calcified contralateral external iliac artery (EIA).

4) Narrow contralateral CIA defined as a transverse diameter <5 mm or obstructed contralateral CIA.

5) Conversion of a bifurcated endograft to AUI.

6) Ruptured AAA either unstable vital sign or unsuitable anatomy for bifucated graft.

The primary outcome assessment was perioperative mortality. The secondary outcomes included procedural details, intra-operative adverse events, post-operative complication, hospital stays, and perioperative re-intervention.

Statistical analysis

Means (±SD) together with medians were used to describe continuous variables. Frequencies were calculated for categorical variables. Chi-square test was used for the comparison between non-ruptured and ruptured groups.

Results

During January 2010 and December 2013, the data of sixty-two patients who have undergone AUI with femorofemoral bypass graft for both non-ruptured and ruptured AAA were analyzed. The mean age was 75.2±8.6 years (range, 49 to 92 years). Most common comorbidity was hypertension (Table 1), which accounted for 75.8%.

As shown in Table 2, the mean diameter of AAA was 68.2±2.1 mm. Most of these instances were abdominal aortic level with fusiform type. It is apparent from Table 3 that the most common indication for AUI

was ruptured AAA (38.7%) followed by narrow aortic bifurcation (16.1%).

Table 4 showed data during intraoperative periods. The mean operative time was 228±90 minutes (range, 75 to 510 minutes), with a mean fluoroscopy time at 35.25±27 minutes (range, 9.2 to 142 minutes). The estimated blood loss was 514±920 ml (range, 50 to 7,000 ml) and blood transfusion was needed in 32 (51.61%) patients. The length of hospital stay was 16.3±14.5 days (range, 2 to 59 days).

As one can see in Table 5, the most common intraoperative complication was proximal type I endoleak 10. This accounted for 16.1% of complications overall. In addition, the most common intraoperative adjunct procedure was Palmaz stent and was performed in nine patients (14.5%).

It can be seen from Table 6 that the perioperative mortality rate was 5.1%, of which all patients were ruptured AAA. There were eleven (18.6%) patients developing local complications, seventeen (28.8%) patients developing organ complications and twenty-two (37.3%) patients developing infective complications. Most of these complications developed in patients with group of ruptured AAA.

Table 7 showed that the most common local complications were groin wound complication accounting for totally 13.6%. However, the most common organ and infective complications were cardiac and pneumonia, respectively. Furthermore, most

Table 1. Demographic data of 62 patients underwent AUI with femorofemoral bypass graft

Demographic data	Number (%)
Age, year	
Mean ± SD	75.2±8.6
Median (min, max)	76 (49, 92)
Gender	
Male	45 (72.6)
Female	17 (27.4)
Coronary artery disease	18 (29.0)
COPD	5 (8.1)
Current smoking	12 (19.4)
Hypertension	47 (75.8)
Diabetes mellitus	15 (24.2)
Chronic kidney disease	9 (14.5)
Cerebrovascular disease	3 (4.8)
Clinical presentation	
Elective asymptomatic	27 (43.6)
Acute non-ruptured	11 (17.7)
Acute ruptured	24 (38.7)

Table 2. Morphology of AAA in this study

Morphology	Total number (%) (n = 62)	Non-ruptured number (%) (n = 38)	Ruptured number (%) (n = 24)
Aneurysm diameter (mm)			
Mean ± SD	68.2±21	64.7±23.5	74.9±16.7
Median (min, max)	70 (20, 113)	59.1 (20, 113)	80 (41, 100)
Type of aneurysm			
Abdominal aortic aneurysm	37 (59.7)	24 (68.5)	13 (54.1)
Aortoiliac	21 (33.9)	12 (34.2)	9 (37.5)
Common iliac	4 (6.7)	2 (5.7)	2 (8.3)
Morphology of aneurysm			
Fusiform	50 (80.6)	31 (88.6)	19 (79.1)

Table 3. The percentage of indications for AUI with femorofemoral bypass graft

Indications	Number (%)
Narrow distal aorta (diameter <15 mm)	10 (16.1)
Contralateral CIA angle >90	3 (4.8)
Heavily calcified contralateral EIA	7 (11.3)
Narrow contralateral CIA (diameter <5 mm)	3 (4.8)
Obstructed contralateral CIA	6 (9.7)
Conversion of a bifurcated endograft to AUI	5 (8.1)
Ruptured AAA	22 (35.5)

complications developed in group of ruptured AAA.

To assess the rate of re-intervention in Table 8, the authors found that most complications developed in group of ruptured AAA associated with abdominal compartment syndrome in two cases and endovascular graft related in two cases. Furthermore, one case developed groin wound hematoma in non-ruptured AAA group.

Discussion

Endovascular repair has been used in patients for whom open repair posed a high risk. A randomized controlled trial study such as EVAR 1, DREAM and OVER trials have well established the efficacy and short-term outcomes of EVAR over open repair, especially in perioperative periods[4-6]. However, unfavorable anatomy precludes the use of a standard bifurcated stent graft. The AUI with femorofemoral bypass graft proved to be an acceptable alternative in these cases[9,11]. In addition, the AUI is most indicated in ruptured AAA due to the placement of AUI stent graft being technically less demanding and rapidly occludes aneurysmal sac. This is especially in early experience of endovascular stent graft placement and unsuitable anatomy for bifurcated graft[12,13].

The overall thirty-day mortality in this series is three patients accounting for 5.1%. However, all three patients were diagnosed with ruptured AAA. This result is consistent with previous study reports with 6.6% of perioperative mortality[11]. This result differs from a previous study that reported perioperative mortality at only 2.83%. However, all 106 patients were performed with elective EVAR[9].

The results of operative time, fluoroscopy time, perioperative blood transfusion and hospital stay in the current study are higher than in previous reports[9,11]. The explanation may possibly be due to the early experience of EVAR during the period of study and the authors included ruptured AAA in this article. Surprisingly, proximal type 1 endoleak was found as a total rate of 16.1% in this present study. Most adjunct procedures within this condition were solved with Palmaz stent. In contrast to earlier findings however, type 1 endoleak was evident in only 6.6% and 0.94% of cases respectively[9,11]. This rather contradictory result may be due to the condensed neck anatomy combined with ruptured AAA in this series.

The result of complications in this study indicates that the group of ruptured AAA had a higher rate of complication than non-ruptured group. The most common of local, organ and infective complications were groin wound, cardiovascular and pneumonia, respectively. It is possible that these results were due to the emergency situation in endovascular repair with AUI and femorofemoral bypass graft of ruptured group. In addition, the hemodynamic instability in ruptured

Table 4. The intraoperative details for AUI with femorofemoral bypass graft

Intraoperative	Total number (%) (n = 62)	Non-ruptured number (%) (n = 38)	Ruptured number (%) (n = 24)
Operative time (minutes)			
Mean ± SD	228±90	241.6±98.7	199.4±73.7
Median (min, max)	205 (75, 510)	205 (115, 510)	202 (75, 338)
Fluoroscopic time (minutes)			
Mean ± SD	35.25±27	26.9±15	40±31.3
Median (min, max)	26 (9.16, 142)	22 (9.16, 58)	27.3 (14, 142)
Estimate blood loss (millilitre)			
Mean ± SD	514±920	588.9±1,100	363.9±313.6
Median (min, max)	300 (50, 7,000)	350 (50, 7,000)	300 (50, 1,500)
Blood transfusion	32 (51.61)	15 (42.8)	17 (70.8)
Length of hospital stay			
Mean ± SD	16.3±14.5	12.4±11.3	22.5±17
Median (min, max)	12 (2, 59)	9 (3, 59)	19 (2, 57)

Table 5. The number of intraoperative complications and additional procedures

Intraoperative complications and additional procedures	Total number (%) (n = 62)	Non-ruptured number (%) (n = 38)	Ruptured number (%) (n = 24)
Intraoperative complication			
Proximal type I endoleak	10 (16.1)	7 (20)	3 (12.5)
Graft migration	2 (3.2)	1 (2.8)	1 (4.1)
Graft limb occlusion/stenosis/kinking	2 (8.1)	2 (5.7)	0
Intraoperative adjunct procedures			
Palmaz stent	9 (14.5)	6 (17.1)	3 (12.5)
Aortic extension cuff	2 (3.2)	1 (2.8)	1 (4.1)
Ligation IIA, EIA, CFA	2 (3.2)	0	2 (8.3)
Embolectomy at SFA	1 (1.6)	0	1 (4.1)

Table 6. Comparing the rate of perioperative outcomes for AUI with femorofemoral bypass graft

Perioperative outcomes	Total number (%) (n = 62)	Non-ruptured number (%) (n = 38)	Ruptured number (%) (n = 24)	*p*-value
30 days mortality	3 (5.1)	0 (0.0)	3 (12.5)	0.062
Re-intervention within 30 days	7 (11.8)	1 (2.8)	6 (25.0)	0.050
Local complications	11 (18.6)	4 (11.4)	7 (29.1)	0.102
Organ complications	17 (28.8)	5 (14.2)	12 (50.0)	0.007
Infectious complications	22 (37.2)	8 (22.8)	14 (58.3)	0.013

group may develop more complications than non-ruptured group.

Another important finding was that thirty-day re-intervention in ruptured group was higher than that of non-ruptured group. It might have resulted from retroperitoneal blood loss and hypotension leading to

Table 7. Local, organ and infective complications

Complications	Total number (%) (n = 62)	Non-ruptured number (%) (n = 38)	Ruptured number (%) (n = 24)
Local complication			
Groin wound	8 (13.6)	3 (8.5)	5 (20.8)
Graft failure	1 (1.7)	0	1 (4.1)
Thromboembolic	1 (1.7)	0	1 (4.1)
Abdominal wound dehiscence	1 (1.7)	0	1 (4.1)
Limb ischemia	1 (1.7)	1 (2.8)	0
Organ complication			
Cardiovascular	11 (18.6)	4 (11.4)	7 (28)
Renal	7 (11.9)	0	7 (28)
Gastrointestinal	3 (5.1)	1 (2.8)	2 (8.3)
Pulmonary	1 (1.7)	0	1 (4.1)
Infectious complication			
Pneumonia	15 (25.4)	3 (8.5)	12 (50)
Septicemia	12 (20.3)	5 (14.2)	7 (28)
Urinary tract infection	3 (5.1)	2 (5.7)	1 (4.1)

Table 8. Details of 30-day re-intervention procedure

Complication	Re-intervention procedure
Non ruptured AAA	
Hematoma both groin	Explore groin hematoma + evacuate blood clot
Ruptured AAA	
Type Ic endoleak	Ligation both left EIA/IIA
Ischemic colitis	Left side colectomy
Graft limb occlusion	Axillo to right femoral graft bypass with graft thrombectomy
Abdominal compartment syndrome	Decompressive laparotomy
Abdominal compartment syndrome	Decompressive laparotomy evacuate retroperitoneal hematoma

abdominal compartment syndrome and ischemic colitis, respectively[14].

The limitation of this study was small sample size and retrospective review. Therefore, the results were not adequate to compare between non-ruptured and ruptured AAA with statistical methods in all parameters. In addition, this present study focuses only on early outcome analysis. More research is required in order to determine the mid and long-term outcomes of this endovascular method. However, the present study reveals that AUI with femorofemoral bypass graft may be beneficial in patients with AAA, compounded by the anatomical unsuitability of standard bifurcated graft.

Conclusion

AUI with femorofemoral bypass graft for AAA is feasible in both elective and emergency situations with low perioperative mortality rate. It allows for effective treatment of patients for whom open surgery poses an unacceptable high risk. Although the ruptured group has a greater rate of perioperative complications and re-intervention than those with non-ruptured group, the early outcomes for this AUI with femorofemoral bypass graft are safe and effective for this group of patients.

What is already known on this topic?

Although EVAR has been increasingly performed for two decades, not every anatomy of AAAs is suitable for bifurcated EVAR graft. Narrowing of distal aorta is a common condition which precludes the bifurcated graft as a suitable treatment. Another common factor in using AUI in ruptured AAA is to

rapidly control bleeding at the ruptured point. In addition, some reports encouraged performing AUI in ruptured AAA, especially in cases where surgeons are with early experience[13].

What this study adds?

The current study was designed to analyze the early outcomes of AUI with femorofemoral bypass graft in both non-ruptured and ruptured AAA. From previous reports, most articles favored the AUI in only asymptomatic AAA. The present study's objective was to analyze in both asymptomatic and symptomatic AAA. Regarding the outcomes of this study, it showed that group of ruptured AAA had a tendency to develop more adverse perioperative outcomes than non-ruptured group in terms of thirty-day mortality, perioperative complications as well as early re-intervention.

Potential conflicts of interest

None.

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ผลลัพธ์เบื้องต้นของการรักษาโรคหลอดเลือดแดงส่วนช่องท้องโป่งพองด้วยการสอดใส่หลอดเลือดเทียมชนิดขาเดียว ผ่านทางสายสวนร่วมกับการผ่าตัดเชื่อมต่อหลอดเลือดแดงบริเวณขาหนีบทั้งสองข้าง

คามิน ชินศักดิ์ชัย, ทศพล ประภัสโร, ประมุข มุทิรางกูร, เฉนียน เรืองเศรษฐกิจ, ชุมพล ว่องวานิช, ณัฐวุฒิ เสริมสาธนสวัสดิ์,
สุธีคณิต หัฌพรสวรรค์, สุภาภรณ์ ต้นพรพิทักษ์, เกียรติศักดิ์ หงษ์คู

ภูมิหลัง: การรักษาโรคหลอดเลือดแดงใหญ่ช่องท้องโป่งพองโดยการผ่าตัดสอดใส่หลอดเลือดเทียมถือเป็นวิธีการผ่าตัดที่มีการพัฒนาขึ้นเป็นอย่างมาก และมีงานวิจัยที่สนับสนุนผลการผ่าตัดรักษาด้วยวิธีสอดใส่หลอดเลือดเทียมเปรียบเทียบกับผ่าตัดแบบเปิด ซึ่งพบว่าอัตราการเสียชีวิตใน 30 วันแรก ระยะเวลาการนอนโรงพยาบาลและระยะเวลาในการอยู่หออภิบาลผู้ป่วยวิกฤตสั้นกว่าการผ่าตัดแบบผ่าเปิด แต่อย่างไรก็ตามการผ่าตัดรักษาด้วยวิธีการสอดใส่ หลอดเลือดเทียมนั้นมีข้อจำกัดในเรื่องของกายวิภาคที่ต้องเหมาะสม สำหรับโรคหลอดเลือดแดงส่วนช่องท้องที่โป่งพอง ซึ่งการผ่าตัดสอดใส่ หลอดเลือดเทียมชนิดขาเดียวผ่านทางสายสวนร่วมกับการผ่าตัดเชื่อมต่อหลอดเลือดแดงบริเวณขาหนีบทั้งสองข้างอาจเป็นทางเลือกสำหรับการรักษา ด้วยวิธีสอดใส่หลอดเลือดเทียมในกรณีที่กายวิภาคบางส่วน ไม่เหมาะสมต่อการผ่าตัดรักษาโดยการผ่าตัดสอดใส่หลอดเลือดเทียมแบบมาตรฐาน

วัตถุประสงค์: เพื่อศึกษาผลลัพธ์ของการรักษาโรคหลอดเลือดแดงใหญ่ช่องท้องโป่งพองโดยการผ่าตัดสอดใส่หลอดเลือดเทียมชนิดขาเดียว ผ่านทาง สายสวนร่วมกับการผ่าตัดเชื่อมต่อหลอดเลือดแดงบริเวณขาหนีบทั้งสองข้าง

วัสดุและวิธีการ: การศึกษาย้อนหลังของภาวะโรคหลอดเลือดแดงในช่องท้องโป่งพองโดยการผ่าตัดสอดใส่หลอดเลือดเทียมชนิดขาเดียวผ่านทางสายสวน ร่วมกับการผ่าตัดเชื่อมต่อหลอดเลือดแดงบริเวณขาหนีบทั้งสองข้างจำนวน 62 คน ตั้งแต่เดือนมกราคม พ.ศ. 2553 ถึงเดือนธันวาคม พ.ศ. 2556 โดยศึกษาถึงอัตราการเสียชีวิตภายใน 30 วัน, ภาวะแทรกซ้อนหลังผ่าตัด, อัตราการเสียเลือดและความจำเป็นในการให้เลือดระหว่างผ่าตัด, ระยะเวลาผ่าตัด, ระยะเวลาการนอนโรงพยาบาลและการรักษาโดยการผ่าตัดเพิ่มเติมภายใน 30 วันเป็นต้น

ผลการศึกษา: พบว่าอายุโดยเฉลี่ยอยู่ที่ 75±8 ปี (49 ถึง 92 ปี) จำนวน 24 รายจาก 62 ราย (38.7%) เป็นการรักษา ในภาวะฉุกเฉินที่มีการแตกของ หลอดเลือดแดงใหญ่ในช่องท้องส่วนที่เหลือ 38 รายเป็นการรักษาในภาวะไม่ฉุกเฉินโดยพบอัตราการเสียชีวิตภายใน 30 วันหลังผ่าตัดพบได้ใน 3 รายจากทั้งหมด 62 รายคิดเป็น 5.1% อัตราการเสียเลือดโดยเฉลี่ยอยู่ที่ 514 มิลลิลิตร (50 ถึง 7,000) และความต้องการให้เลือดระหว่างผ่าตัดพบในผู้ป่วย 32 ราย (51.61%) ระยะเวลาการนอนโรงพยาบาลเฉลี่ยอยู่ที่ 16 วัน (2 ถึง 59 วัน) ภาวะแทรกซ้อนเฉพาะที่พบได้ 11 ราย (18.6%) ภาวะแทรกซ้อน ตามระบบ 17 ราย (28.8%) และภาวะแทรกซ้อนจากการติดเชื้อ 22 ราย (37.3%) นอกจากนั้นยังพบว่าผู้ป่วย 7 ราย (11.9%) จำเป็นต้องได้รับการรักษาโดยการผ่าตัดเพิ่มเติมจากภาวะต่างๆ เช่น การใช้เครื่องช่วยหายใจเป็นระยะเวลา

สรุป: การรักษาโรคหลอดเลือดแดงใหญ่ช่องท้องโป่งพองโดยการผ่าตัดสอดใส่หลอดเลือดเทียม ชนิดขาเดียว ผ่านทางสายสวนร่วมกับการผ่าตัดเชื่อมต่อ หลอดเลือดแดงบริเวณขาหนีบทั้งสองข้าง เป็นการผ่าตัดที่สามารถทำได้ทั้งในภาวะที่ไม่ฉุกเฉินและในภาวะฉุกเฉินที่มีการแตกของหลอดเลือดแดงใหญ่ ในช่องท้องโดยมีอัตราการเสียชีวิตภายใน 30 วัน อยู่ในเกณฑ์ต่ำ ภาวะแทรกซ้อนที่เกิดขึ้นและการรักษาเสริมหลังการผ่าตัดยังอยู่ในเกณฑ์ที่ไม่สูงมากนัก