Patency of Stenotic Arteriovenous Fistula (AVF) after Percutaneous Balloon Angioplasty (PTA)

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Background: *Despite its high long-term patency rate and low incidence of infection and thrombosis, native AVF is frequently interfered by stenosis. This troubleshooting can be managed by PTA for prolonging survival function of AVF and enhancing primary-assisted patency of AVF stenoses.*

Objective: *To evaluate the primary-assisted patency of AVF stenoses after treated by PTA.*

Material and Method: *A retrospective study enrolled all hemodialysis patients who had undergone PTA for arm AVF stenoses at Siriraj Vascular Unit from 1 January 2008 to 31 May 2012. The follow-up period was 12 months. Primary-assisted patency was taken into account during an interval from the time of PTA until any intervention to maintain the access patency or access abandonment. Kaplan-Meier test was applied for analyzing primary-assisted patency of the treated AVF stenoses.*

Results: *Of all 76 patients with symptomatic or troubleshooting AVF stenoses underwent PTA, forty-one patients (53.9%) were male. Mean age of the patients was 60.4 years. Thirty-seven patients (48.7%) were on hemodialysis via brachio-cephalic AVF. Regarding underlying diseases, 92.1% were hypertension, 47.4% diabetes mellitus, 40.8% dyslipidemia, and 18.4% coronary arterial disease. Technical success rate was 83%. The primary-assisted patency rates of the treated AVF stenoses at 3, 6, and 12 months were 86.75%, 77.34%, and 68.74%, respectively. Minor complications occurred in 6 patients (7.9%). Postoperative hematoma was presented in 3 patients (3.9%) whereas 3 developed extravasation. All minor complications required no surgical correction. According to Kaplan-Meier test, the mean survival function of the treated AVFs was 53.4 months. Chi-square allowed for a subgroup analysis in those underwent pre-emptive PTA.*

Conclusion: *Since PTA is an effective and a safe procedure to treat autologous arteriovenous fistula stenosis with a 1-year primary-assisted patency rate at 68.74% and minor complication rate (requires no surgical correction) at 7.9%, it should be adopted as a first-line management of the trouble shooting AVF stenosis.*

Keywords: *Percutaneous balloon angioplasty, Arteriovenous fistula stenosis, Hemodialysis access*

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Native AVF has become a vascular access of choice for hemodialysis (HD) owing to its high long-term patency rate and low incidence of infection and thrombosis. Accordingly, it requires lower maintenance cost and less adjunctive intervention[1-9]. As being issued by the National Kidney Foundation (NKF), the Kidney Disease Outcomes Quality Initiative (KDOQI) Clinical Practice Guidelines (CPGs) for Vascular Access suggested fistula creation as the best long-term vascular access for HD[10].

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To prolong the AVF function is a vascular challenge. A crucial AVF dysfunction includes AVF stenoses which can be initially corrected with PTA[3,10-12]. PTA is an effective method for treatment to prolong function of stenotic AVF. Some studies suggested preemptive PTA of AVF dysfunction before AVF thrombosis. A prospective controlled trial study reported PTA of stenotic functioning AVF significantly improved fistula survival and increased access flow. However, PTA may be also associated with a significant reduction in access-related morbidity, risk of hospitalization, central venous catheterization, and thrombectomy[5,8,11-15,18-23]. Although PTA has been adopted as an initial treatment of patients with AVF dysfunction in our unit since 2006, no data were analyzed in terms of its survival function after treatment.

Therefore, the purpose of this study was to evaluate primary-assisted patency of AVF stenoses after PTA treatment.

Material and Method

The present study has been approved by the Ethics Committee of the Faculty of Medicine Siriraj Hospital, Mahidol University. Its approval number was 733/2556.

All hemodialysis patients at the age of 18 to 80 years who underwent PTA for stenotic arm AVF remedy in the Division of Vascular Surgery, Department of Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University from January 2008 to May 2012 were reviewed retrospectively. The follow-up periods were at 3 months, 6 months and 1 year after the endovascular therapy. The patient's demographic data, perioperative course, complications, and functional outcome after PTA were collected and analyzed.

Stenotic AVF implied a greater than 50% narrowing in luminal diameter based upon comparison with its adjacent normal vessel. Dysfunction of AVF was taken into consideration if at least one of the following clinical/functional criteria incorporated with anatomical stenosis criteria (Table 1).

Primary outcome of the study was 3-month, 6-month and 1-year primary-assisted patency rate after the endovascular therapy of stenotic AVF dysfunction. Secondary outcome was technical success and complications. Technical success was defined as an increase in AVF flow sufficiency for hemodialysis and alleviation of venous hypertension symptoms. Major complications consisted of an event requiring in unexpected surgical correction, amputation or death. Ethics consideration: 773/2556 (EC1).

Statistical analysis

The collected data were assessed by SPSS software version 11.5 and Kaplan-Meier curves were adopted for analyzing the primary-assisted patency of AVF.

Results

Of all 76 patients with symptomatic or troubleshooting AVF stenoses underwent PTA, 41 (53.9%) were male. The mean age was 60.4 years. Most patients were non-smokers (94.7%). The underlying disease of the patients comprised of hypertension (92.1%), diabetes mellitus (47.4%), dyslipidemia (40.8%) and coronary artery disease (18.4%). Others diseases were polycystic kidney disease, COPD, and SLE. Majority (88.1%) of the AVFs were performed on the non-dominant arm. Regarding the reconstructed AVF sites, 61.9% was at the elbow and the rest (38.1%) was at the forearm (Table 2). The clinical manifestations of the patients indicated for PTA embraced upper extremity swelling, absent thrill, upper extremity pain and no audible bruit, were 24 (31.5%), 12 (15.8%), 6 (7.9%) and 1 (1.3%), respectively (Table 3). During hemodialysis, AVF troubleshooting occurred in 42 patients (55.2%) owing to reduced blood flow, 8 (10.5%) of prolonged puncture site hemorrhage requiring longer than 15 minutes of local compression, 7 (9.2%) of venous hypertension, 1 (1.3%) of blood clot and 1 (1.3%) of recirculation (Table 3).

Of all PTA treated patients, 20 (26.3%) required additional procedures such as cutting balloon angioplasty and stent placement. Intra-operative finding revealed various stenotic sites: 14 (18.4%) at AVF anastomosis; 56 (73.7%) at AVF outflow (juxta-anastomosis); 2 (2.6%) at AVF inflow; and 15 (19.7%)

Table 1. Criteria of AVF dysfunction and stenosis

Clinical/functional criteria (at least one)	Persistent arm swelling >1 week (without hematoma, infection or venous hypertension)
	Palpable pulsatile flow
	Absent palpable thrill
	High-frequency audible bruit
	Decreased access blood flow during HD
	Elevated venous pressure during HD
	Clot aspiration during HD
	Decreased dialysis flow during HD
	Prolonged bleeding from puncture site >15 minutes after HD is completed.
Anatomical stenosis criteria	Duplex Doppler ultrasound measurement by a surgeon of the vascular unit confirmed a significant AVF stenosis (>50% reduction in vessel diameter compare to its adjacent normal vessel)[24].

Table 2. Demographic characteristics of the treated patients

Demographic data	Number	Percent
Sex		
Male: female	41:35	54:46
Age (years)		
Mean (SD)	60.4 (10.1)	
Range	36 to 79	
Associated diseases		
Hypertension	70	92.1
Diabetes mellitus	36	47.4
Dyslipidemia	31	40.8
Coronary artery disease	14	18.4
Smoking		
Smoker	72	94.7
Non-smoker	4	5.3
AVF access sites		
Non-dominant arm	67	88.1
Dominant arm	9	11.9
AVF anastomosis sites		
Elbow	47	61.9
Forearm	29	38.1

Table 3. Clinical/functional criteria for PTA of troubleshooting AVF stenoses

Criteria	Number	Percent
Clinical criteria		
Persistent arm swelling	24	31.5
Palpable pulsatile flow	0	0
Absent palpable thrill	12	15.8
Absent audible bruit	1	1.3
Arm pain	6	7.9
Functional criteria		
Decreased access blood flow	42	55.2
Elevated venous pressure	7	9.2
Clot aspiration	1	1.3
Decrease dialysis dose	1	1.3
Prolonged access site bleeding	8	10.5

at central vein. Immediate technical success rate was 83%. The primary-assisted patency rates of the treated AVF stenoses were 86.75%, 77.34%, and 68.74% at 3, 6, and 12 months, respectively (Fig. 1). Complication occurred in 6 patients (7.9%). Postoperative hematoma was noted in 3 patients (3.9%) whereas 3 (3.9%) developed extravasation. Fortunately, no one required surgical correction.

Discussion

As an effective and a safe vascular access,

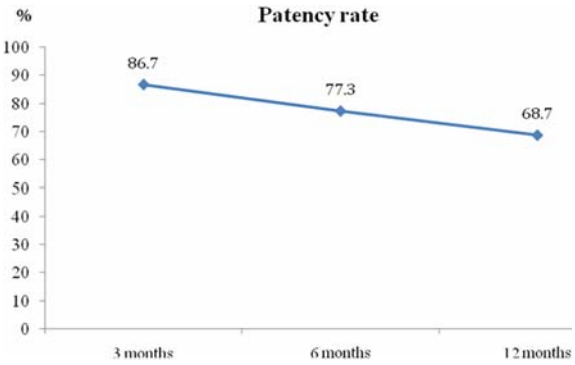

Fig. 1 The primary-assisted patency rates of the treated AVF stenoses.

the AVF has been applied in hemodialysis patients for nearly 50 years. The "autologous AV fistula first" has been proposed by the United States 2006 National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF-K/DOQI) Clinical Practice Guidelines for Vascular Access[10]. However, an extended survival of hemodialysis patients is a great concern for dialysis patients. The development of venous stenosis is likely a result of uremia itself, operative technique, hemodynamic and pathophysiologic factors.

Main therapeutic approaches for stenotic AVFs include PTA using endovascular therapy, AV re-anastomosis proximal to the narrowed site, and vascular graft placement. Among these techniques, PTA is the primary choice recommended by the NKF-K/DOQI guidelines[10]. Gmelin et al[25] first introduced PTA to treat fistula stenosis in 1989. Its advantages include safety and efficacy, less vascular injury, easy surgical operation, and repeatable fistulous vasodilation at multiple times and locations. Forty-six patients with malfunctioning hemodialysis access fistulas were treated with balloon angioplasty. The initial PTA procedure was successful in 16 (89%) of 18 patients with stenoses. In 10 of the 16 patients with initial success PTA, repeated PTA dilation was required after the first intervention. In the 16 patients with stenoses, the patency rate after 6 months was 93%; after 1 year, 91%, and after 2 years, 57%, respectively. This study concluded that dilation of stenoses in malfunctioning hemodialysis AVF was the procedure of choice. When hemodialysis shunts trend to be malfunction, immediate dilation of stenotic lesions should be performed to prevent occlusion. Tapping et al[26] demonstrated the patency after endovascular treatment in malfunctioning autologous hemodialysis fistulas consisting 25 patients underwent percutaneous intervention by angioplasty,

thrombolysis or stent alone or combined techniques. Technical success and initial clinical success rates were 88% and 76%, respectively. Primary patency rates at 6, 12, 18 and 24 months were 68%, 68%, 60% and 52%, respectively. There was no major complication following interventional procedures. The authors suggested that the excellent clinical results could be achieved by percutaneous endovascular treatment in malfunctioning autologous fistulas, justifying its continuous use as first line treatment.

Majority (73.7%) of vascular access stenotic site of the patients in our study was at juxta-anastomotic stenosis while only one-fifth (19.7%) was at central vein. Mortamais et al reported 1-year primary-assisted patency rate was 81.3% after the endovascular therapy of juxta-anastomotic stenosis of forearm radio-cephalic fistulas[27].

The results of our study were comparable to the previously mentioned studies. Technical success rate was 83%. Primary patency rates at 3, 6 and 12 months were 86.75%, 77.34%, and 68.74%, respectively. There were only 6 minor complications (7.9%) following interventional procedures that could be resolved without any surgical correction required. Kaplan-Meier test disclosed the mean survival function of the treated AVFs at 53±4 months.

Limitations

This study is a retrospective review study that includes a small number of patients and a short follow-up period of one year. Our single-center results rely on various interventional techniques of different operators. Further prospective studies with more number of enrolled patients and long-term follow-up period are required. However, variable techniques from different operators can hardly be avoidable and may influence the outcome of patency rates of the treated AVFs.

Conclusion

Since PTA is an effective and a safe procedure to treat autologous AVF stenosis with an initial technical success rate at 83%, a 1-year primary-assisted patency rate at 68.74% and a minor complication rate (requires no surgical correction) at 7.9%, it should be adopted as a first-line management of the troubleshooting AVF stenosis.

What is already known on this topic?

PTA is an effective and a safe procedure to treat autologous AVF stenosis with high initial, technical success rate, 1-year primary-assisted patency rate and low complication rate.

What this study adds?

The outcome of PTA in patients with native AVF stenosis in this study is comparable to those of other studies in terms of initial technical success rate, 1-year primary-assisted patency rate and complication rate.

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Potential conflicts of interest

None.

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อายุการใช้งานของหลอดเลือดที่ใช้ฟอกเลือดไตเทียมที่แขนภายหลังการผ่าตัดรักษาหลอดเลือดที่ใช้ฟอกเลือดไตเทียมที่แขนตีบแคบโดยการถ่างขยายด้วยสายสวนหลอดเลือดที่มีบอลลูน

ชุมพล วองวานิช, ทัตติญา สีมะสิงห์, ประมุข มุทิรางกูร, เฉนียน เรืองเศรษฐกิจ, คามิน ชินศักดิ์ชัย, ณัฐวุฒิ เสริมสาธนสวัสดิ์, สุธีคณิต หัลพรสวรรค์, เกียรติศักดิ์ หงษ์คู

ภูมิหลัง: การตีบแคบเป็นปัญหาที่พบบ่อยของหลอดเลือดที่ใช้ฟอกเลือดไตเทียมที่แขน ทั้งที่การสร้างหลอดเลือดดังกล่าวมีอัตราการคงสภาพการใช้งานค่อนข้างสูง และมีอัตราการเกิดภาวะแทรกซ้อนค่อนข้างต่ำภาวะหลอดเลือดที่ใช้ฟอกเลือดไตเทียมที่แขนตีบแคบสามารถรักษาโดยการถ่างขยายด้วยสายสวนที่มีบอลลูนเพื่อช่วยยืดอายุ การใช้งานและช่วยเพิ่มอัตราการคงสภาพของหลอดเลือดดังกล่าว ตั้งแต่ระยะเริ่มสร้างหลอดเลือดไปจนถึงระยะสิ้นสุดสภาพการใช้งานของหลอดเลือดนั้น

วัตถุประสงค์: เพื่อประเมินผลลัพธ์ของการรักษาในแง่ของอายุการใช้งานผลสำเร็จและภาวะแทรกซ้อนภายหลัง การรักษาผู้ป่วยที่มีปัญหาหลอดเลือดที่ใช้ฟอกเลือดไตเทียมที่แขนตีบแคบโดยการถ่างขยายด้วยสายสวนที่มีบอลลูน

วัสดุและวิธีการ: การศึกษาย้อนหลังในผู้ป่วยที่มีปัญหาหลอดเลือดที่ใช้ฟอกเลือดไตเทียมที่แขนตีบแคบที่ได้รับการรักษาโดยการผ่าตัดถ่างขยายด้วยสายสวนที่มีบอลลูนโดยการเก็บข้อมูลผู้ป่วยที่ได้รับการรักษาดังกล่าว ภายในหน่วยศัลยศาสตร์หลอดเลือด ภาควิชาศัลยศาสตร์ คณะแพทยศาสตร์ศิริราชพยาบาล มหาวิทยาลัยมหิดล ตั้งแต่เดือนมกราคม พ.ศ. 2551 จนถึง เดือนพฤษภาคม พ.ศ. 2555 เพื่อนำไปวิเคราะห์หาผลลัพธ์ปฐมภูมิโดยการประเมินจากอายุการใช้งานของหลอดเลือดที่ใช้ฟอกเลือดไตเทียมที่แขนภายหลังจากได้รับการแก้ไขด้วยการผ่าตัดถ่างขยายหลอดเลือดส่วนที่ตีบแคบด้วยสายสวนที่มีบอลลูนที่ระยะเวลา 3 เดือน 6 เดือน และ 12 เดือน และวิเคราะห์หาผลลัพธ์ทุติยภูมิ โดยการประเมินอัตราความสำเร็จทางเทคนิคและอัตราการเกิดภาวะแทรกซ้อนของการผ่าตัดรักษา

ผลการศึกษา: ผู้ป่วย 76 ราย (ชาย: หญิง = 41:35) อายุเฉลี่ยอยู่ระหว่าง 60.4 ปี (ช่วงอายุ 36 ปี ถึง 79 ปี) ผลลัพธ์ปฐมภูมิ คืออายุการใช้งานของหลอดเลือดที่ใช้ฟอกเลือดไตเทียมที่แขนตีบแคบภายหลังที่ได้รับการรักษาด้วยการผ่าตัดถ่างขยายโดยสายสวนที่มีบอลลูนในช่วงระยะเวลา 3 เดือน 6 เดือนและ 12 เดือน อยู่ที่ร้อยละ 86.8, 77.3 และ 68.7 ตามลำดับ ผลลัพธ์ทุติยภูมิอันได้แก่ (1) ผลสำเร็จทางเทคนิคอยู่ร้อยละ 83 ภาวะแทรกซ้อนหลังการผ่าตัดมีเพียงก้อนเลือดคั่งใต้ผิวหนังเพียง 3 ราย (ร้อยละ 3.9) และมีเลือดรั่วออกจากแผลบริเวณรู ทางเข้าหลอดเลือดเพียง 3 ราย (ร้อยละ 3.9) โดยที่ภาวะแทรกซ้อนที่เกิดขึ้นทั้งหมดสามารถแก้ไขได้โดย ไม่ต้องพึ่งการรักษาด้วยการผ่าตัดโดยอายุการใช้งานเฉลี่ยของหลอดเลือดที่ใช้ฟอกเลือดไตเทียมที่แขนตีบแคบ ภายหลังที่ได้รับการรักษาด้วยการผ่าตัดถ่างขยายโดยสายสวนที่มีบอลลูนอยู่ที่ 53±4 เดือน

สรุป: การรักษาหลอดเลือดที่ใช้ฟอกเลือดไตเทียมที่แขนตีบแคบด้วยสายสวนที่มีบอลลูนเป็นวิธีการรักษาที่มีประสิทธิภาพในการยืดอายุการใช้งานหลอดเลือดดังกล่าวได้อย่างปลอดภัย