

Is Balloon Angioplasty of Peri-Anastomotic Stenoses of Failing Peripheral Arterial Bypasses Worthwhile?

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Introduction: Surgical revision of failing peripheral arterial bypass grafts has generally been shown to provide superior patency rates compared to balloon angioplasty. We analyzed whether balloon angioplasty, specifically of peri-anastomotic stenoses (PAS), provided acceptable patency rates, because surgery for these lesions is more difficult and is likely associated with higher complication rates compared to surgical revision of stenoses in the body of a graft. **Methods:** This is a retrospective review of PAS balloon angioplasties performed at a single institution between January 1, 1999, and September 1, 2005. We report "primary site patency" as a stenosis treated by balloon angioplasty, "revised primary site patency" as a stenosis treated by repeat balloon angioplasty, and "secondary site patency" as an angioplastied stenosis treated surgically or when the graft thrombosed and was revised surgically. All procedures were performed in an endovascular operating room based on duplex scan findings suggesting a significant stenosis. **Results:** 48 PAS in 33 autologous vein and 15 prosthetic grafts were treated by balloon angioplasty

in 42 patients. Mean follow-up was 12 months (range, 1-49 months). Interventions were performed on 22 femoropopliteal grafts (11 proximal, 11 distal), 20 femorotibial grafts (5 proximal, 15 distal), 2 axillofemoral grafts (2 proximal anastomoses), 2 popliteal-pedal grafts (1 proximal, 1 distal), and 1 common iliac-femoral graft (proximal). Life-table analysis revealed 2-year primary, assisted primary, and secondary patency rates of 38%, 58%, and 84%, respectively. No major complications occurred with any endovascular intervention. **Conclusion:** Balloon angioplasty of PAS resulted in acceptable 2-year assisted primary patency rate of almost 60%. Endovascular intervention avoided repeat incisions in scarred groins, higher rates of nerve injury and infection, significant blood loss, and longer length of hospital stays. We recommend that balloon angioplasty of PAS be attempted before resorting to surgical intervention, especially in cases of hostile anastomotic wounds.

Keywords: balloon angioplasty; failing graft; arterial bypass revision

Introduction

Lower extremity arterial bypass grafts occlude for a variety of reasons, including intimal hyperplasia,

technical errors, and progression of atherosclerosis.¹ Surgical revision of stenoses has been accepted as the gold standard and provides superior patency when compared to endovascular treatment of recurrent stenoses.²⁻⁴ Although surgical revision provides higher patency rates, it is also associated with higher rates of nerve injury, wound and graft infection, bleeding, longer operative times, increased pain, and longer length of hospital stay compared to

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endovascular revision.^{5,6} We specifically analyzed whether balloon angioplasty of peri-anastomotic stenoses (PAS) was worthwhile because surgical revision is considerably more difficult than angioplasty for PAS in reoperative scarred fields. During the time period of this study, only simple balloon angioplasty procedures were included, and other endovascular techniques such as cutting balloon, cryoplasty, stenting, and atherectomy were not performed. This study of PAS lesions can therefore provide "gold-standard" endovascular results with which other techniques can be compared.

Methods

Between January 1, 1999, and September 30, 2005, we conducted a retrospective review of peri-anastomotic balloon angioplasties performed by vascular surgeons at Pennsylvania Hospital in Philadelphia. Patients were identified through our computerized vascular registry. Duplex ultrasound (DU) was part of a routine surveillance protocol to identify stenotic lesions in failing peripheral artery bypass grafts. Ultrasound criteria that suggested a significant stenosis were monophasic signals throughout the graft, uniform peak systolic velocity (PSV), PSV <45 cm/s, PSV >300 cm/s at the site of stenosis, and adjacent PSV ratio >3.5.^{7,8} Patients identified as having significant stenosis were brought to an endovascular operating room where they underwent arteriography to confirm the stenosis and concomitant treatment of the lesion. All lesions were confirmed to be $\geq 75\%$ diameter-reducing stenoses by intraoperative angiography prior to any intervention.

Peri-anastomotic stenosis was defined as a graft stenosis within 2 cm of the proximal or distal anastomosis of the graft and within the previous surgical field.

Life-table analysis was used to evaluate primary patency, assisted primary patency, and secondary patency rates.⁹ For the purpose of this study, we have modified the standard definitions used to describe graft patency following balloon angioplasty of PAS. Primary site patency was defined as a peri-anastomotic stenosis treated with a single balloon angioplasty procedure that remained patent by routine duplex surveillance. Assisted primary site patency was defined as graft angioplasty site patency that required repeat balloon angioplasty based on DU findings. Secondary site patency was defined as graft

Table 1. Type of Graft and Anastomotic Location of Peripheral Arterial Bypass Peri-Anastomotic Stenoses

	Proximal Anastomosis	Distal Anastomosis
Femoral-popliteal	11	11
Femoral-tibial	6	15
Axillary-femoral	2	0
Popliteal-pedal	1	1
Iliac-femoral	1	0

Table 2. Type of Graft and Conduit Associated With Peri-Anastomotic Stenoses

	Vein	PTFE
Femoral-popliteal	13	9
Femoral-tibial	19	2
Axillary-femoral	0	2
Popliteal-pedal	2	0
Iliac-femoral	0	1

NOTE: PTFE = polytetrafluoroethylene

angioplasty site that required surgical revision or graft thrombectomy to remain patent. The reason that all surgical revisions were included in this definition of secondary site patency, regardless of whether the graft was still patent, was that open surgical revision represented a failure of angioplasty. This definition will lower the patency rates compared to standard definitions. Surgical intervention was performed for failing grafts if balloon angioplasty had resulted in a residual persistent defect, if recurrent stenosis developed after relatively short follow-up (less than 3-6 months, based on the discretion of the surgeon), or if the graft had thrombosed.

Results

A total of 48 PAS underwent balloon angioplasty in 42 patients, therefore 6 patients underwent angioplasty at 2 different sites simultaneously. Of them, 20 patients were male and 22 patients were female. The mean age of the patients was 70 years (range, 53-90). Risk factors included diabetes mellitus (33%), smoking (81%), hypercholesterolemia (52%), hypertension (92%), and renal insufficiency (15%) defined as serum creatinine ≥ 2.0 mg/dL. Table 1 demonstrates the site of the stenosis and the proximal and distal anastomosis of the bypass originally performed. Table 2 lists the original conduits used for the bypasses.

Table 3. Primary Patency Rates of Balloon Angioplasty of Peri-Anastomotic Stenosis of Peripheral Arterial Bypasses

Interval (Months)	Sites Angioplastied	Failed Grafts	No. Withdraw patent due to			Interval Patency Rate	Cumulative Primary Patency	Standard Error
			Duration	Loss to Follow Up	Death			
0-1	48	0	0	0	0	1.00	100.00	0.00
1-3	48	10	1	0	0	0.79	78.95	5.23
3-6	37	7	2	3	0	0.80	62.93	6.30
6-9	25	2	2	2	0	0.91	57.46	7.50
9-12	19	1	1	2	0	0.94	54.17	8.41
12-15	15	0	1	0	0	1.00	54.17	9.47
15-18	14	1	0	0	0	0.93	50.30	9.48
18-21	13	3	0	0	0	0.77	38.70	8.40
21-24	10	0	0	0	0	1.00	38.70	9.58
24-27	10	0	1	2	0	1.00	38.70	9.58
27-30	7	0	1	0	0	1.00	38.70	11.45
30-33	6	1	0	0	0	0.83	32.25	10.84
33-36	5	0	1	1	0	1.00	32.25	11.87
36-39	3	0	1	0	0	1.00	32.25	15.32
39-42	2	0	0	0	0	1.00	32.25	18.77
42-45	2	0	0	0	0	1.00	32.25	18.77
45-48	2	0	0	1	0	1.00	32.25	18.77
48-51	1	0	0	1	0	1.00	32.25	26.54

Two-year primary, assisted primary, and secondary patency rates for balloon angioplasty of PAS were 38%, 58%, and 84%, respectively, based on our definition of angioplasty site patency (Tables 3-5, Chart 1). We reemphasize that any graft that underwent surgical revision was counted as a failure, even if the graft was patent at the time of surgical revision, and thus artificially lowered the primary assisted patency rates. Complications of our endovascular interventions included 1 postprocedure hematoma at the puncture site and 1 hematoma at the site of angioplasty. Neither of these required surgical intervention and both patients were discharged the same day as the procedure. No infections, nerve injuries, wound breakdown, or cardiac or pulmonary complications were noted within 30 days of the procedures in any patient.

Discussion

The treatment of stenosis of infrainguinal bypasses grafts has changed over the last decade with the introduction and increasing use of minimally invasive techniques. Several authors have reported treatment of failing grafts with balloon angioplasty but none have focused on the treatment of stenosis, which occur within the peri-anastomotic area.^{10,11}

These stenoses are more difficult to treat surgically and are associated with a higher incidence of complications than stenosis elsewhere in the graft because of associated scarring and the depth of the graft. As these tend to be fibrotic rather than atherosclerotic lesions, angioplasty may be less effective and less durable than surgical repair. However, the higher morbidity of surgery in this setting might balance a relatively lower long-term success rate for balloon angioplasty.

We used DU to monitor our infrainguinal bypasses based on a strict protocol.⁷ Duplex ultrasound examinations were performed every 3 months for the first year, every 6 months for the second year, and yearly after that if no problems were found. Duplex surveillance has been demonstrated in several studies to improve graft patency and limb salvage rates.¹¹⁻¹⁴ Our DU studies examined the inflow and outflow arteries, the peri-anastomotic sites, and every 10 cm along the graft. Duplex ultrasound has also shown to be cost effective to prevent graft occlusion. Visser found that the cost per patient of DU in a graft surveillance protocol was US\$2823 and resulted in 17 amputations per 1000 patients compared to clinical follow-up and lower extremity segmental pressures, which resulted in a cost of about US\$5000 per limb and resulted in 77 amputations per 1000 patients.¹⁵

Table 4. Assisted Primary Patency Rates of Balloon Angioplasty of Peri-Anastomotic Stenosis of Peripheral Arterial Bypasses

Interval (Months)	Sites Angioplastied	Failed Grafts	No. Withdraw Patent Due to			Interval Patency Rate	Cumulative Assisted Primary Patency	Standard Error
			Duration	Loss to Follow Up	Death			
0-1	48	0	0	0	0	1.00	100.00	0.00
1-3	48	9	1	0	0	0.81	81.05	5.09
3-6	38	6	2	3	0	0.83	67.35	6.24
6-9	27	1	2	2	0	0.96	64.66	7.40
9-12	22	2	1	2	0	0.90	58.35	8.03
12-15	17	0	1	0	0	1.00	58.35	9.13
15-18	16	0	0	0	0	1.00	58.35	9.41
18-21	16	0	1	1	0	1.00	58.35	9.41
21-24	14	0	1	0	0	1.00	58.35	10.06
24-27	13	1	1	2	0	0.91	53.28	10.10
27-30	9	0	1	0	0	1.00	53.28	12.14
30-33	8	1	0	0	0	0.88	46.62	12.04
33-36	7	0	2	1	0	1.00	46.62	12.87
36-39	4	0	1	0	0	1.00	46.62	17.03
39-42	3	0	1	0	0	1.00	46.62	19.66
42-45	2	0	0	0	0	1.00	46.62	24.08
45-48	2	0	0	1	0	1.00	46.62	24.08
48-51	1	0	0	1	0	1.00	46.62	34.06

Table 5. Secondary Patency Rates of Balloon Angioplasty of Peri-Anastomotic Stenosis of Peripheral Arterial Bypasses

Interval (months)	Sites Angioplastied	Failed Grafts	No. Withdraw Patent Due to			Interval Patency Rate	Secondary Patency	Standard Error
			Duration	Loss to Follow Up	Death			
0-1	48	0	0	0	0	1.00	100.00	0.00
1-3	48	3	1	0	0	0.94	93.68	3.40
3-6	44	4	2	3	0	0.90	84.65	5.00
6-9	35	0	2	3	0	1.00	84.65	5.61
9-12	30	0	3	2	0	1.00	84.65	6.05
12-15	25	0	1	0	0	1.00	84.65	6.63
15-18	24	0	0	0	0	1.00	84.65	6.77
18-21	24	0	1	1	0	1.00	84.65	6.77
21-24	22	0	1	1	0	1.00	84.65	7.07
24-27	20	0	3	2	0	1.00	84.65	7.42
27-30	15	0	1	0	0	1.00	84.65	8.56
30-33	14	1	0	0	0	0.93	78.61	9.72
33-36	13	0	2	1	0	1.00	78.61	10.08
36-39	10	1	1	0	0	0.89	70.33	12.11
39-42	8	0	1	0	0	1.00	70.33	13.54
42-45	7	0	1	0	0	1.00	70.33	14.48
45-48	6	1	1	1	0	0.80	56.27	15.19
48-51	3	0	2	1	0	1.00	56.27	21.48

Once a peripheral graft stenosis is detected, there are several treatment options available. A minimally invasive approach with percutaneous balloon angioplasty can be performed. This procedure can be done

at the same time as an arteriogram that most interventionalists perform to confirm the DU findings. Generally, balloon angioplasty of a peripheral graft does not require extensive cardiac evaluation due to the

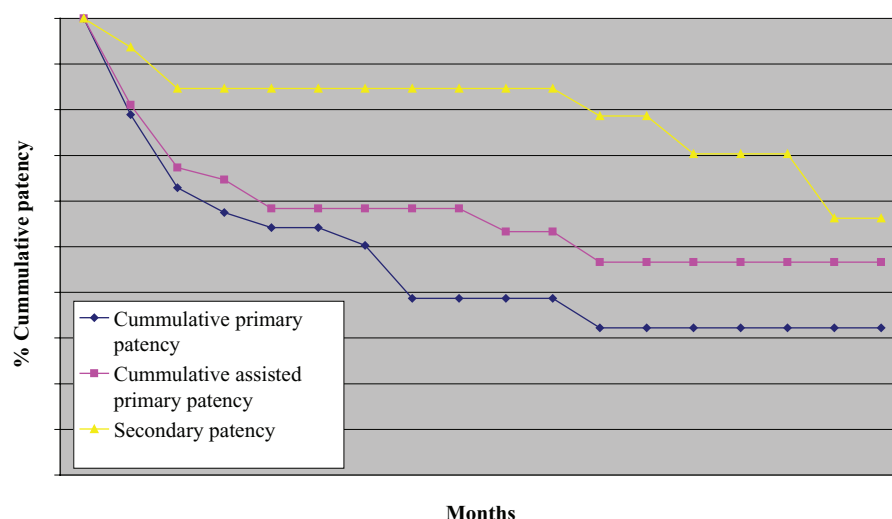


Chart 1. Life-table analysis of graft patency.

minimally invasive nature of this intervention and the fact that it can be performed under local anesthesia. This strategy also permits patients to be discharged the day of the procedure unless complications occur or hydration is required for renal dysfunction.

Alternatively, there are several surgical approaches to treat peripheral bypass stenoses. A patch angioplasty, an interposition graft, or a jump graft can be performed, depending on the severity and length of the lesion. However, operative repair may require an incision in a previously operated field and often requires a venous conduit, which may not be available. Surgical revision of failing peripheral bypasses is associated with a higher incidence of complications including nerve injury, wound and graft infection, prolonged hospital stay, increased bleeding complications, and longer operative times compared to percutaneous endovascular interventions. These complications are even greater when working in previously operated fields such as those associated with stenoses in peri-anastomotic regions.^{16,17}

Surgical revision has shown to provide superior patency rates compared to balloon angioplasty of lower extremity bypass grafts.¹⁸ Assisted primary patency rates of 60% to 82% at 5 years for surgical revision of failing lower extremity arterial bypasses have been reported.¹³ In our study, the assisted primary site patency rate was 58% at 2 years. Therefore, although patency rates in our series of balloon angioplasty of PAS appear lower compared to other series

with open surgery, endovascular intervention was quicker and associated with a lower incidence of reported complications associated with surgery. We decided to intervene surgically if the graft had thrombosed or if balloon angioplasty had resulted in a residual persistent defect or if recurrent stenosis developed after relatively short follow-up, which generally meant less than 3 to 6 months, based on the discretion of the surgeon.

Conclusion

Balloon angioplasty of PAS produced an acceptable 2-year assisted primary patency rate of almost 60%. Endovascular intervention avoids repeat incisions in scarred groins and distal sites where morbidity may be significant. We recommend that balloon angioplasty of PAS be attempted before resorting to surgical intervention. Indeed, even repeat balloon angioplasty for recurrent lesions may be appropriate for many patients. Results of balloon angioplasty and other minimally invasive interventions may continue to improve with new technologies including cutting balloons, cryoplasty, and atherectomy. Our results of balloon angioplasty of PAS can serve as a benchmark for endovascular results with which these other techniques can be compared. In addition, improved antiplatelet drugs may help improve patency rates of these endovascular interventions.

References

- Whittemore AD, Clowes AW, Couch NP, Mannick JA. Secondary femoropopliteal reconstruction. *Ann Surg*. 1981;193(1):35-42.
- Whittemore AD, Donaldson MC, Polak JF, Mannick JA. Limitations of balloon angioplasty for vein graft stenosis. *J Vasc Surg*. 1991;14(3):340-345.
- Bandyk DF, Bergamini TM, Towne JB, Schmitt DD, Seabrook GR. Durability of vein graft revision: the outcome of secondary procedures. *J Vasc Surg*. 1991;13(2):200-208.
- Perler BA, Osterman FA, Mitchell SE, Burdick JF, Williams GM. Balloon dilatation versus surgical revision of infra-inguinal autogenous vein graft stenoses: long-term follow-up. *J Cardiovasc Surg*. 1990;31(5):656-661.
- Landry GJ, Moneta GL, Taylor LM Jr, Edwards JM, Yeager RA, Porter JM. Long-term outcome of revised lower-extremity bypass grafts. *J Vasc Surg*. 2002; 35(1):56-62.
- Sullivan TR Jr, Welch HJ, Iafrati MD, Mackey WC, O'Donnell TF Jr. Clinical results of common strategies used to revise infrainguinal vein grafts. *J Vasc Surg*. 1996;24(6):909-917.
- Calligaro KD, Musser DJ, Chen AY, et al. Duplex ultrasound to diagnose failing arterial prosthetic grafts. *Surgery*. 1996;120(3):455-459.
- Westerband A, Mills JL, Kistler S, Berman SS, Hunter GC, Marek JM. Prospective validation of threshold criteria for intervention in infrainguinal vein grafts undergoing duplex surveillance. *Ann Vasc Surg*. 1997;11(1):44-48.
- Rutherford RB, Flanigan DP, Gupta SK, et al. Suggested standards for reports dealing with lower extremity ischemia. Prepared by the Ad Hoc Committee on Reporting Standards, Society for Vascular Surgery/North American Chapter, International Society for Cardiovascular Surgery. *J Vasc Surg*. 1986;4(1):80-94. Erratum in *J Vasc Surg*. 1986; 4(4):350.
- Rua I, Calligaro KD, Dougherty MJ, et al. Is balloon angioplasty indicated for "short" stenoses of failing vein grafts? *Ann Vasc Surg*. 1998;12(2):134-137.
- Avino AJ, Bandyk DF, Gonsalves AJ, et al. Surgical and endovascular intervention for infrainguinal vein graft stenosis. *J Vasc Surg*. 1999;29(1):60-70.
- Lundell A, Lindblad B, Bergqvist D, Hansen F. Femoropopliteal-crural graft patency is improved by an intensive surveillance program: a prospective randomized study. *J Vasc Surg*. 1995;21(1):26-33.
- Bergamini TM, George SM Jr, Massey HT, et al. Intensive surveillance of femoropopliteal-tibial autogenous vein bypasses improves long-term graft patency and limb salvage. *Ann Surg*. 1995;221(5):507-515.
- Mattos MA, van Bemmelen PS, Hodgson KJ, Ramsey DE, Barkmeier LD, Sumner DS. Does correction of stenoses identified with color duplex scanning improve infrainguinal graft patency? *J Vasc Surg*. 1993;17(1):54-64.
- Visser K, Idu MM, Buth J, Engel GL, Hunink MG. Duplex scan surveillance during the first year after infrainguinal autologous vein bypass grafting surgery: costs and clinical outcomes compared with other surveillance programs. *J Vasc Surg*. 2001;33(1): 123-130.
- Calligaro KD, Veith FJ, Gutpa SK, et al. A modified method for management of prosthetic graft infection involving an anastomoses to the common femoral artery. *J Vasc Surg*. 1990;11(4):484-492.
- Calligaro KD, Veith FJ, Dougherty MJ, et al. Prosthetic patch remnants to treat infected arterial grafts. *J Vasc Surg*. 2000;31(2):253-259.
- Sanchez LA, Suggs WD, Marin ML, Panetta TF, Wengerter KR, Veith FJ. Is percutaneous balloon angioplasty appropriate in the treatment of graft and anastomotic lesions responsible for failing vein bypasses? *Am J Surg*. 1994;168(2):97-101.

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