Ultrasound-guided Fistuloplasty: A Novel Office-based Technique for Arteriovenous Fistula Salvage

Shubhabrata Banerjee, Hiten Mohanbhai Patel, Tapish Sahu, Virender K Sheorain, Tarun Grover, Rajiv Parakh
Division of Peripheral Vascular and Endovascular Sciences, Medanta The Medicity, Gurgaon, Haryana, India

Abstract

Introduction: Along with the increasing awareness of fistula for dialysis, there has been an increasing utilization of endovascular interventions to create and maintain native Arteriovenous fistulas. So far the widely practiced corrective endovascular options are fistulogram and plasty. However with most target segments being superficial veins of the outflow channel with juxta-anastomotic lesions, ultrasound guided fistuloplasty is a promising answer to such a clinical scenario. Methods: All patients with diagnosed outflow vein obstruction with dialysis disturbance and no evidence of central vein stenosis were subjected to the procedure. Results: Satisfactory dilatation was achieved in 84% of patients at the end of one month. Only four patients required additional procedure prior to dialysis. The most common procedure related side effect was hematoma- in 08 (19%) of patients, however they were non expanding and self resolving limited to the area around the plasty site. Conclusion: The procedure can be accomplished in office setting avoiding the exposure of dye and radiation. It also decreases the burden on health care in operating theatres and decreases cost and time of hospitalization. However central vein stenosis and cephalic arch stenosis are definitely limitations of the procedure.

Keywords: Fistuloplasty, office setting, ultrasound guided

INTRODUCTION

Of the many revolutions in the management of end-stage renal disease patients requiring long-term dialysis, the most emphatic has been the awareness of maintaining a functional native arteriovenous fistula as the priority access route. According to the Fistula First Breakthrough Initiative database, the prevalence of arteriovenous fistula use in patients on dialysis increased from 32.2% in July 2003 to 58% in June 2011. Subsequently, there has been an increasing utilization of endovascular interventions to create and maintain native arteriovenous fistulas.

The majority of the fistula dysfunction are picked up by trained dialysis technicians, and the vascular surgeons are challenged to deliver a prompt solution. So far, the widely practiced corrective endovascular options are fistulogram and plasty. However, with most target segments being superficial veins of the outflow channel with juxta-anastomotic lesions, an increasing demand for office setting corrective procedures are on the rise. Ultrasound-guided fistuloplasty is a promising answer to such a clinical scenario.

MATERIALS AND METHODS

Inclusion criteria

All patients with dialysis disturbance who have:
- Dampered thrill or pulsatile flow on clinical examination
- Flow disturbance picked up by dialysis technician
- Outflow vein stenosis (diagnosed on Doppler).

Patients on dialysis by alternate route with failure of fistula maturation. Informed consent was obtained from all patients.

Exclusion criteria

- Thrombosed or completely occluded fistula or outflow vein
- Suspected central vein stenosis - arm edema or Doppler detected suspicion of same.

Access this article online

Quick Response Code:

Website: www.indjvascsurg.org

DOI: 10.4103/ijves.ijves_8_17

Address for correspondence: Dr. Shubhabrata Banerjee, E-mail: banerjee_shubhabrata@rediffmail.com

How to cite this article: Banerjee S, Patel HM, Sahu T, Sheorain VK, Grover T, Parakh R. Ultrasound-guided Fistuloplasty: A Novel Office-based Technique for Arteriovenous Fistula Salvage. Indian J Vasc Endovasc Surg 2017;4:58-62.

Received: February, 2017. Accepted: February, 2017.
The “rule of 6s” was used as a benchmark: fistulas should be 6 mm in diameter, 6 mm or less from the skin, and ready for use in 6 weeks. Inadequate flow was defined as <400 ml/min and was measured on Doppler.

**Technique**

- **Anesthesia:** Local anesthesia (2% xylocaine).
- **Patient position:** Supine with affected arm abducted on a hand rest.

**Equipment**

- Doppler with a sterile probe wrap
- Access needle
- Guidewire
- Balloon (4, 5, and 6 mm angioplasty balloons and high-pressure balloons).

**Procedure**

The fistula and the outflow track are mapped under sterile conditions with access area prepared and under local anesthesia using a micropuncture needle access is taken (either retrograde or antegrade) and a 5F sheath inserted. Using standard Terumo J-tipped, 0.035 glidewire and Slip-Cath Combination (4 Fz), the lesion is crossed and dilated serially with 4, 5, and 6 mm balloon normal pressure angioplasty balloon. Cutting balloon is used for refractory lesions with a nonyielding waist. The balloon inflation time used is for 30 s. The typical giveaway click and simulated with the break of waist visualized on grayscale ultrasound are the initial signs of a successful procedure. On table visualization of a continuous segment of dilated vein to 5–6 mm with a continuous flow rate of >400 ml/min and a palpable thrill signified the end points of the procedure. Often a successful procedure is seen to be associated with a limited hematoma around the plasty site which is self-remitting and nonexpanding, on serial monitoring table and on immediate postprocedure scans. Access site hemostasis is achieved by gentle compression dressing.

Follow-up scan is done next day, after 1 week, and 1 month. If hemodialysis is due, then patient is sent to the dialysis clinic with written and telephonic advice to the technician regarding details of procedure and to revert back in case of any untoward findings.

**Features noted of significance during the procedure**

**Two dot**

Both dots of the balloon should be visible, and the target lesion should ideally be at a symmetric distance from the two dots signifying its central positioning, central waist [Figure 1] while inflation.

Next, the balloon is partially inflated to confirm the central location of the stenosis at the targeted plasty site over the balloon.

**Hourglass**

An hourglass configuration with the constricting stenosis marks the lesion, and the giveaway with the symmetric balloon inflation [Figure 2] is taken as a primary successful technical completion of the procedure.

In few cases, a tributary to the main outflow vein is suitable for access, preserving the major outflow vein but requires intraoperative Doppler guidance to redirect the guidewire into the working region and manual compression combined with ultrasonography-guided redirection is an important adjunct in such a scenario.

**Discussion**

**Epidemiological distribution**

Of the total 43 patients studied over a period of 18 months, 29 (67.4%) were female patients with 14 (32.6%) male patients. The average age of the patient being 63 years [Diagram 1].

**Distribution of fistula**

Majority of the fistulas requiring plasty for maturation were radiocephalic (84%) though few brachiocephalic fistulas also required assisted maturation [Diagram 2].

**Distribution of lesion**

More than one lesion was a usual finding accounting to 47% patients requiring fistuloplasty though the majority had solitary focal correctable lesions [Diagram 3].

Majority of the patients had lesions around the swing point of the fistula corresponding to a distance of 2 cm from the anastomotic site, though distant lesions, probably sequelae to missed thrombophlebitis or noncompliance of the venous wall and surrounding soft tissues were seen in nine patients. Three patients often had multiple lesions [Diagram 4].

**Access**

Usually, retrograde access was used in 31 out of 43 patients, and of them, if a suitable tributary was identified, the same was used as an access rather than the primary outflow vein [Diagram 5].
Diagram 1: Twenty-nine (67.4%) were female patients with 14 (32.6%) male patients

Diagram 2: Majority of the fistulas requiring plasty for maturation were radiocephalic (84%)

Diagram 3: Number of lesions

Diagram 4: Distribution of lesion

Diagram 5: Access site distribution

This branched vessel access was important in preserving the main outflow veins from the effects of postpuncture and sheath traversing the vein.

Wires used: Soft curved tip glide wire was used to cross the lesion.

Balloon inflation
The lesion was dilated serially with 4, 5, and 6 mm balloons with inflation time of 2 min. Conventional angioplasty balloons were used in all cases. However, seven cases required cutting balloons. More than single inflation were required in the majority of cases; however, focal pliable lesions often responded to single dilatations.

Postprocedural venous diameter
The target was to attend an end point venous diameter of 6 mm, which was achieved in 33 of the 43 patients and the rest required serial dilatation.

Duration of surgery was 45 min on an average and this being carried out in the office setting, relieved the patients of the hassle of admission, shifting to the theater, and the burden off the theater.

Patients were seen for follow-up ultrasound next day, 1 week, and 1 month
- Satisfactory dilatation in 36 (84%) patients at the end of 1 month
- Of the seven other patients, three patients underwent ultrasound-guided puncture and dialysis; however, four remaining patients required second intervention [Diagram 6].

Complications
The most common procedure-related side effect was hematoma in 8 (19%) of patients; however, they were nonexpanding and self-resolving limited to the area around the plasty site [Figure 3]. Gentle preoperative compression was successful, and on the postprocedure day, all had resolved. Adjunct intravenous analgesia in the form of tramadol was required in only six (14%) patients, who were subsequently discharged on oral analgesics. Rupture of the plasty site with active leakage was encountered in
three (7%) patients but was controlled by direct pressure; however, one patient required a balloon occlusion for control of rupture site.

Adjunctive fistulogram and stent was required in two cases for significant recoil with thrombosed aneurysmal dilatation of outflow vein hindering smooth outflow [Diagram 7].

**Advantages of ultrasonography-guided fistuloplasty**
The most important aspect of an ultrasound-guided fistuloplasty is avoiding radiation hazard and eliminating contrast-related hazards in already renal compromised patient. The equipment required is readily available and cheap. Most importantly, it can be accomplished in office setting, thus reducing the burden on theaters or cath laboratories. It is instrumental in achieving rapid turnover with decreased in-hospital duration for patients.

**Limitation of procedure**
It is essentially technical dependent, and trained personnel are required. Central vein stenosis cannot be negotiated. Often multiple lesions are cumbersome to tackle solely under ultrasound guidance. In the event of an inadvertent rupture requiring endoluminal recanalization, angiography suite may be the ideal complementary setting.

**Review of literature**
In 2012, Daniel R. Gorin et al. reported a series of 31 arteriovenous fistulas (AVFs) in thirty patients in their study [Table 1]. Fifty-five interventions were performed, 48 for AVFs failing to mature and 7 for stenosis in functioning AVFs. The 90-day patency was 93%. The overall complication rate was 11%. Two patients had proximal stenosis that could not be crossed (one patient required surgical revision, and one patient refused further treatment and thrombosed). There were four perifistular hematomas; three of these resulted in fistula thrombosis. No patients required hospitalization or urgent surgical intervention. Eighty-five percent of patients treated for AVF failing to mature achieved a functional fistula. The average age was 73 years. The fistulas treated were Cimino (17; 55%), upper arm cephalic (9; 29%), and basilica transposition (5; 16%). Forty-eight (87%) of the interventions were performed on fistulas that had failed to mature, and 7 (13%) were done on fistulas that developed hemodynamically significant stenosis while they were being used. The time from fistula creation until the initial intervention ranged from 52 to 3304 days (median, 120 days). Forty-three percent of the patients (13 of 30) were undergoing hemodialysis through a temporary dialysis catheter at the time of their interventions.[2]
Fox et al. presented a series of 223 consecutive office-based duplex-guided AVF angioplasties performed from January 2008 to June 2009. Cutting balloons were required in three cases; one uncovered stent was placed for elastic recoil and four covered stents were placed for fistula rupture or pseudoaneurysm formation.\[3\]

Kim and Cho presented a series of ten selected patients (from September 2006 to February 2007), who underwent ultrasound-guided interventions in the angiography suite. The patients were treated with a single ultrasound-guided angioplasty and then underwent a completion angiogram. Residual stenosis was present in two patients requiring further angioplasty. One of these was not picked up in ultrasound due to the very short nature of the stenosis.\[4\]

In 2007, Marks et al. presented a small series of ten patients treated with ultrasound guidance performed in the operating room. Only one patient required a completion angiogram. Four patients required cutting balloons, and in one patient, a self-expanding stent was placed as well. All fistulas were patent in 30 days. In 2009, the same group published a larger series of 32 interventions on 25 patients done under ultrasound guidance in the office setting. They had one hematoma and one focal dissection, with no periprocedural thrombosis and no serious complications. No adjunct modalities were required.\[5\]

**Conclusion**

USG guided fistuloplasty has satisfactory results, can be performed in office setting and avoids the exposure of dye and radiation. However central vein stenosis and cephalic arch stenosis are definitely limitations of the procedure.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**References**

1. Arteriovenous Fistula First. Fistula First Data. Available from: http://www.fistulafirst.org/AboutFistulaFirst/FFBIData.asp. [Last accessed on 2017 Mar 15].
2. Gorin DR, Perrino L, Potter DM, Ali TZ. Ultrasound-guided angioplasty of autogenous arteriovenous fistulas in the office setting. J Vasc Surg 2012;55:1701-5.
3. Fox D, Amador F, Clarke D, Velez M, Cruz J, Labropoulos N, et al. Duplex guided dialysis access interventions can be performed safely in the office setting: Techniques and early results. Eur J Vasc Endovasc Surg 2011;42:833-41.
4. Kim JC, Cho JS. Ultrasonography-guided balloon angioplasty in an autogenous arteriovenous fistula. J Korean Soc Ultrasound Med 2007;26:129-36.
5. Marks N, Ascher E, Hingorani AP. Duplex-guided repair of failing or nonmaturing arterio-venous access for hemodialysis. Perspect Vasc Surg Endovasc Ther 2007;19:50-5.