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Ultrasound Guided Angioplasty of Autogenous AV Fistulas in the Office Setting.

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Ultrasound Guided Angioplasty of Autogenous AV Fistulas in the Office Setting.

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Introduction/Objectives

There has been an increasing awareness of the superiority of native arteriovenous fistulas (AVF's) over prosthetic grafts for dialysis access. Many AVF's fail to mature however, and others develop stenosis while in use. There is growing experience in treating these patients in the interventional suite with percutanous balloon angioplasty. These procedures, however, are expensive, uncomfortable, and inconvenient for patients and physicians, involve exposure to radiation and IV contrast in patients who are often not on dialysis. This study reviews our experience with ultrasound-guided angioplasty of AVF’s in the office setting.

Methods

A retrospective review was performed of all patients treated in our practice with ultrasound guided AVF angioplasty, from May '09 to April '11. The need for intervention was determined by exam and duplex ultrasound. All patients referred to the practice with failing or nonmaturing AVF’s were treated in the office under ultrasound guidance unless a central venous stenosis was suspected. All procedures were performed under local anesthesia by a single surgeon, and pre, peri and post procedure ultrasounds were performed in a single vascular laboratory.

Results

There were 31 AVF’s in 30 patients in the study. 55 interventions were performed, 48 for AVF's failing to mature, 7 for stenosis in functioning AVF's. 90-day patency
was 93%. Overall complication rate was 11%. 2 patients had proximal stenosis that could not be crossed, (1 required surgical revision, and 1 refused further treatment and thrombosed). There were 4 peri-fistula hematomas, 3 of these resulted in AVF thrombosis. No patients required hospitalization or urgent surgical intervention.

85% of patients treated for AVF failing to mature achieved a functional fistula.

**Conclusions**

AVF intervention can be performed safely and effectively under ultrasound guidance in the office setting, and is a valuable tool in the management of dialysis access patients.

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Two factors have combined to create a significant change in dialysis access management over the past decade. The first is an increasing awareness of the superiority of native arteriovenous fistulas as the dialysis access of choice. According to the Fistula First Breakthrough Initiative database, the prevalence of AV fistula use in dialysis patients increased from 32.2% in July 2003 to 58% in June 2011. While still short of the Fistula First Breakthrough Initiative's goal of 66%, this represents a marked change in the standard of care in dialysis patients. As part of this change, there has been an increasing utilization of endovascular interventions to create and maintain native AV fistulae.

The second factor has been a move to shift endovascular procedures from the hospital to an ambulatory setting. This has been influenced by a number of factors, most notably by substantial changes in reimbursement by CMS to incentivize physicians to perform interventions in an office setting. Dialysis access intervention is particularly suited to an office environment. The procedures are usually fairly straightforward, equipment needs are modest and predictable, the vessels to be treated are superficial, and most importantly, access site management is much simpler and safer. For patients, procedures performed in the office are almost always more convenient and less stressful, and for the healthcare system they are much less expensive. One impediment to treating these patients in the office, however, has been the need for imaging equipment, which creates issues of space requirements, radiation safety, and expense.

We have found that performing dialysis access interventions under duplex ultrasound guidance can circumvent these concerns. The vascular lesions that require
treatment are readily imaged with ultrasound, and the needed equipment is readily available in most vascular surgeons’ offices. Over the past several years we have adopted duplex guided, office based angioplasty as our primary mode of endovascular intervention in our dialysis access patients. In this series, we present our initial experience with this technique.

Materials and Methods

Starting in May 2009, we began treating all of our patients undergoing percutaneous angioplasty of autogenous arteriovenous fistulas using duplex ultrasound guidance in our office. Patients were only treated in the hospital interventional unit if they were undergoing treatment of a suspected central vein stenosis. From May 2009 to April 2011 we performed a total 55 percutaneous angioplasties on 31 autogenous AV fistulas in 30 patients (14 female, 16 male, average age 73). The fistulas treated were Cimeno 17 (55%), upper arm cephalic 9 (29%), and basilic transposition 5 (16%). 48 (87%) of the interventions were performed on fistulas that had failed to mature, 7 (13%) were done on fistulas that developed hemodynamically significant stenosis while they were being utilized. An average of 1.7 interventions were performed on each fistula during the time of the study. The time from fistula creation until the initial intervention ranged from 52 to 3,304 days. (Median 120 days). 43% (13/30) of the patients were undergoing hemodialysis via a temporary dialysis catheter at the time of their interventions. The decision to intervene on a fistula was based on the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF-KDOQI) guidelines. Clinical and ultrasound evaluation, as well as flow rates for those fistulas currently being used for hemodialysis
were used in the assessments. The "rule of 6's" was used as a benchmark: fistulas should be 6mm in diameter, 6 mm or less from the skin, and ready for use in 6 weeks. Inadequate flow was defined as less that 400-500 ml/min.

**Technique**

A single operating surgeon performed all of the procedures. Patients were treated in a procedure room in a freestanding medical office building. The procedures were done under local anesthesia; no additional sedation was used and patients were not kept NPO. Patients were prepped and draped in the usual sterile manner. Both the surgeon and the vascular ultrasound technologist were gowned and gloved, and the ultrasound keyboard was covered with a clear sterile drape (fig 1). The fistula was then examined by ultrasound and the areas to be treated were identified. Access was obtained using a micropuncture technique under ultrasound guidance. Fistulas were accessed retrograde 34 (62%), antegrade 18(33%) or dual access 3 (5%), depending upon the anatomy and the location of the stenosis. An appropriately sized sheath, 11cm, 4-7fr, was placed over a short J wire. An .035-angled Zipwire (Boston Scientific, Natick MA) was directed through the fistula under ultrasound guidance, using a short Berenstein catheter if needed. Heparin (3000u) was only used early in our experience; the majority of patients were treated without anticoagulation with the exception of heparin flushes of the access sheath. An Ultrathin-Diamond angioplasty balloon (Boston Scientific, Natick MA) was then directed over the guidewire and positioned appropriately (fig 2). Balloons were sized at 1-2 mm larger that the normal vein size, and ranged from 4-12mm in diameter, with lengths of 4-10cm. Our first few patients experienced discomfort with balloon inflation. We then modified our
technique. Under ultrasound guidance, a tumescent anesthetic solution was infiltrated along the length of the fistula using a 21 gauge spinal needle (fig 3). This was tolerated very well, and made the angioplasties essentially painless. Angioplasties were done at fairly high pressures of 20-30mm hg, with balloon inflation times of approximately one minute (fig 4-5). Selective manual inflow occlusion was performed, particularly if longer sclerotic segments were being treated. Once a completion ultrasound demonstrated a satisfactory result, (fig 6-7) the sheath was removed and a figure of eight suture was placed with manual inflow occlusion. A gentle pressure dressing was applied and the patient was discharged after a brief period of observation. Patients were seen for follow up ultrasound and examination in 2 weeks (fig 8).

Results

There were a total of 6 complications (11%). Two patients had proximal stenoses that could not be crossed under ultrasound guidance. One of these patients had an upper arm cephalic fistula, and underwent fistulography in the hospital interventional unit, where the stenosis still could not be crossed. She was successfully treated in the OR with patch angioplasty. The second patient had a Cimeno fistula. She refused further intervention, and represented a month later with a thrombosed fistula. She went on to have successful creation of a transposition fistula.

Small perifistula hematomas were not uncommon and were not counted as complications. There were 4 incidences of significant hematomas (in 3 patients). One patient had a large hematoma after angioplasty that was controlled with pressure and
resolved, resulting in a functioning fistula. One patient developed significant hematomas on 2 different occasions after angioplasty of 2 different fistulas. First he underwent treatment of a long sclerotic segment in a basilic transposition fistula with angioplasty to 6mm, resulting in vein rupture, hematoma, and subsequent fistula thrombosis. He later had a contra lateral upper arm cephalic fistula created, which developed a long proximal sclerotic segment, which was treated with angioplasty to 6mm, also resulting in vein rupture and thrombosis. He went on to have an upper arm prosthetic fistula placed with worked well. The last patient underwent treatment of a proximal stenosis via retrograde access in a basilic transposition fistula. She then developed a perifistula hematoma. A distal stenosis was then identified that had not been appreciated initially. Antegrade access was obtained and the stenosis was treated with manual inflow occlusion, however the patient had developed a fairly large hematoma, and went on to thrombose her fistula.

All patients with the exception of the 4 mentioned above had patent fistulas at 30 and 90 days (93%). All 4 fistulas that thrombosed were small nonfunctioning fistulas that had failed to mature. Of the patients being treated for fistulas that had failed to mature, 22 of 27 developed functional fistulas (81.4%). An additional patient had a patent AV fistula but expired before his last planned intervention. Therefore 85% (22 / 26) of fistulas treated to completion were functional.

All complications were easily managed in the office setting. No patient required transfer to the hospital, blood transfusion, or subsequent hospitalization or emergency room evaluation for complications of their procedure. No patient underwent successful
interventional in the interventional suite after unsuccessful treatment under ultrasound guidance.

One patient complication could be interpreted as occurring because of limits of our imagining; the patient that developed a hematoma in part because of a distal stenosis that was not well appreciated. This occurred early in our experience. The patient was treated on heparin which contributed to the hematoma; we not longer anticoagulate our patients. The distal stenosis was well seen during the initial ultrasound, but its significance was underestimated. Currently we are more facile with manual proximal occlusion techniques, we do not use systemic heparin, and we are more attuned to treating distal stenosis before treating proximal lesions, so this type of complication is much less likely to occur in the future. Treating a patient in the interventional suite under fluoroscopic guidance would realistically have prevented no other complication.

Discussion

There are several small series in the literature of ultrasound-guided angioplasty of dialysis access arteriovenous fistulae. In 2007 Marks, Ascher et al⁹ presented a small series of 10 patients treated with ultrasound guidance performed in the operating room. All of the procedures were successfully completed under ultrasound guidance, although one patient had a completion angiogram confirming the ultrasound findings. 4 patients required cutting balloons and one patient had placement of a self-expanding stent as well. All fistulae 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 1 hematoma and 1 focal dissection, with no periprocedural thrombosis and no serious
complications. No patient required a stent or the use of a cutting balloon or other
adjunctive modalities.

Kim et al\textsuperscript{10} presented a series of 10 selected patients who underwent ultrasound-
guided interventions in the angiography suite from Sept 2006 to Feb 2007. The patients
were treated with a single ultrasound-guided angioplasty and then underwent a completion
angiogram. Two patients were found to have residual stenosis by angiography and
underwent further angioplasty. One of these was also recognized by ultrasound, the
second was not seen due to the very short nature of the stenosis.

Fox et al\textsuperscript{11} presented a series of 223 consecutive office-based duplex-guided
arteriovenous fistula angioplasties performed from January 2008 to June 2009. Cutting
balloons were required in 3 cases, 1 uncovered stent was placed for elastic recoil and 4
covered stents were placed for fistula rupture or pseudoaneurysm formation.

Our series similarly shows office-based ultrasound-guided angioplasty of AV fistulae to be
safe and effective. We did have 3 periprocedural thrombosis related to graft rupture. Two
of these occurred in a single patient with long sclerotic segments in two different small,
non-functional fistulas. It does not seem likely that these outcomes would have been
prevented by the use of fluoroscopic imaging. The stenoses were well visualized, and the
balloons chosen were fairly small (6mm). Perhaps these fistulae could have been salvaged
with placement of covered stents, but it is difficult to see how that would have resulted in a
functional, durable access. That patient had placement of a prosthetic graft that has served him well.

Using ultrasound guidance for intervention on arteriovenous fistulas offers a number of advantages. It utilizes equipment that is relatively inexpensive and readily available. It avoids the problems associated with radiation exposure for both patients and treating clinicians. It also eliminates the need for contrast agents, which is particularly helpful in that many of these patients have severe impairment of renal function, but are not yet on dialysis. With ultrasound guidance, tumescent anesthesia can be infiltrated along the areas of the fistula to be treated, making the procedure very comfortable and eliminating the need for conscious sedation.

The use of ultrasound as the imaging modality also removes a major barrier to performing these procedures in the office setting. Fluoroscopic imaging equipment is expensive, and occupies a great deal of space. Unless one is doing full time dialysis access management, or performing other fluoroscopic guided procedures, such as angiography, arterial intervention or pain management, it is difficult to justify the expense of setting up an office base fluoroscopy suite. Radiation safety and local and regional regulatory issues add even more complexity. Ultrasound equipment is readily available in most vascular surgeons’ offices. It is relatively inexpensive, and used in a variety of other related applications, such as diagnostic vascular imaging, and venous intervention. It is also necessary for complete dialysis access management, both in planning surgical procedures
Moving dialysis access interventions to the office provides a number of advantages to both physician and patient. For patients, the office setting is much more convenient. Those already on dialysis have to devote three days a week to their medical care, and often have other health issues that occupy even more of their time. The complexity of a hospital system invariably means that procedures done there take up most of the day. When these procedures are done in the office, most patients are in and out in less than an hour. Because no conscious sedation is used, the patients do not have to fast, and no IV access or preoperative blood work is needed. For the physician, the office environment is much more efficient, and allows them much greater control of personnel and scheduling issues.

Because the vascular sonographer is involved in the procedures, they become much more adept at pre and post operative diagnostic imaging, and the entire office staff becomes much more knowledgeable regarding management issues in these patients.

Office based dialysis access intervention provides significant financial advantages as well. Because CMS has recognized the cost savings that can be realized by moving these procedures out of the hospital, they have provided significant financial incentives. The CPT codes for angioplasty of and arteriovenous fistula are: 35478 (Repair of a venous blockage), 36147 (access av dialysis graft for eval) and 75978-26 (radiologic supervision and interpretation). In our region the reimbursement is $387.39 when the procedure is done in the hospital. When the procedure is performed in an office setting the
reimbursement is $2375.80, more than a 6-fold increase. Even when the cost of equipment and personnel is taken into account, this still represents a significant financial advantage.

**Conclusion**

Duplex-guided angioplasty of arteriovenous fistulae in the office setting is feasible, safe and effective. It offers a number of advantages over hospital-based, fluoroscopic procedures, and in the future has great potential to play a significant role in the management of these challenging patients.
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Figure 1
Figure 2

Guidewire

Catheter Tip

Balloon
Figure 4

Stenosis
Figure 5

Stenosis
Figure 6
Figure 7

Map B
DynRg 50dB
Persist Med
Fr Rate High
2D Opt:Res
Col 78% Map 1
WF Low
PRF 2500 Hz
Flow Opt:Med V

LT AVF
Figure 8
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Author Contribution Statement

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