ELSEVIER

Techniques in Vascular and Interventional Radiology

Ureteral Interventions

Allen Herr, MD,* Anuj Malhotra, MD,* Mark White, MD,† and Gary Siskin, MD*

Interventional radiologists are commonly called upon to manage patients with benign and malignant ureteral pathologic conditions. Unfortunately, treatments for both cure and palliation can be fraught with problems causing patients to be undesirably maintained with lifelong catheters. This review describes outcomes for antegrade and retrograde therapeutic options and techniques for patients with most types of ureteral pathologic conditions that the interventional radiologist would encounter in practice.
Tech Vasc Interventional Rad 19:182-193

KEYWORDS Ureteral strictures, Angioplasty, Stents, Treatment outcomes

Introduction

The ureter is affected by a myriad of intrinsic and extrinsic pathologies because of its anatomical location, its proximity to adjacent structures, and its length and narrow caliber, all of which complicate treatment and makes analysis of outcomes difficult. In general, surgery is felt to be the gold standard for treating ureteral pathology with success rates as high as 80%, but surgery is limited by inherently high morbidity and mortality rates.[1] As a result, interventional radiologists are often called upon to manage these patients. Percutaneous management of these conditions can be quite challenging as patients and family members are often surprised when they are informed of the complexity and duration of what is required to treat these conditions. Compound that with the need for multiple and varied procedures, outcomes that are limited at best, and the potential for a chronically indwelling drainage tube when treatments fail, the patience of any patient can be significantly tested. A multidisciplinary approach to treatment that takes advantage of the complementary skill sets of interventional radiology and urology provides the best care with optimal results for patients. This article will review the percutaneous antegrade and retrograde therapeutic options and techniques, both historical and yet to be mainstream, for patients with most types of ureteral pathologic conditions that the interventional radiologist would encounter in practice.

*Department of Radiology, Albany Medical Center, Albany, NY.
†Division of Urology, Albany Medical Center, Albany, NY.
Address reprint requests to Allen Herr, MD, Department of Radiology, Albany Medical Center, 47 New Scotland Ave, MC-113, Albany, NY 12208. E-mail: aherr@communitycare.com

Ureteral Strictures

Balloon Dilatation

Ureteral strictures may result from a wide variety of benign and malignant pathology, each affecting the ureter in different ways. Benign etiologies may occur from intrinsic genitourinary processes or be iatrogenic in nature resulting from trauma, ureteral injury after endoscopic or percutaneous procedures, stone passage, radiation therapy, and open or laparoscopic surgery.[2] Periureteric fibrosis, both idiopathic and secondary, endometriosis, tuberculosis, and other infectious ureteritis are additional, less common causes of benign ureteral strictures.[3] In addition to tumors, an array of pelvic and retroperitoneal malignancies, both primary and metastatic, can result in ureteral strictures by extrinsic compression or direct extension.

Balloon dilatation of the ureter has become a primary treatment modality for ureteral strictures because of its relative simplicity, cost-effectiveness, and generally lower morbidity.[4] This was first reported by Banner et al,[5] who described a success rate of 48% after treating 27 ureteric strictures with balloon dilatation. Since that time, several studies have reported mixed results with success rates of 18%-83%.[6-13] With stratification of the study populations, themes in the data apparent to these authors included the duration, cause, length, and location of the stricture. For example, Beckmann et al[7] found success treating postsurgical anastomotic strictures and strictures of <3 months in duration. However, Richter et al[12] reported only a 10% success rate when dilating malignant strictures and attributed that to presumed compromised vascular supply. Byun et al[14] attributed the poor outcomes after dilatation of malignant strictures to ischemic injury because of mural infiltration or extrinsic ureteral obstruction or both.

 1089-2516/16/$ - see front matter
http://dx.doi.org/10.1053/j.tvir.2016.06.003

These and other studies support the statement that benign, short segment (<2 cm) strictures with a duration <3 months and intact vascular supply are most amenable to curative treatment with balloon dilatation.

The data outlined earlier form the historic cornerstone for the use of balloon dilatation in neoureterovesical strictures encountered after renal transplantation. This is considered the most common urologic complication of renal transplantation and can result in deterioration in renal function.[15-17] As a cohort, this pathology matches a good number of the characteristics most amenable to simple balloon dilation with the most notable exception being the devascularization injury resulting from organ harvest and extended ischemic times. Several series have demonstrated the safety and efficacy of balloon dilatation to treat these strictures, with an overall success rate of 40%-70% when treating short strictures (<3 cm) and when following balloon dilatation with internal ureteral stenting.[18-26] From a technical standpoint, neoureterovesical stricture interventions may be easier to accomplish antegrade because transurethral endoscopy through a ureteral orifice that is often less than optimally positioned, particularly anterior or near the urinary bladder dome, can be challenging. It is for this reason that, in our institution, we prefer to place longer internal ureteral stents in the renal transplant patient (particularly males), despite studies showing increased symptoms and decreased quality-of-life scores. This approach facilitates access to the ureteral orifice and may avert the need for nephrostomy placement to maintain renal function. Consensus from these studies seems to favor balloon dilation as first line therapy for neoureterovesical strictures, reserving surgery for those that fail the more conservative approach.

Patients with anastomotic strictures after ureteral diversion also have much to gain from minimally invasive therapy because of the risk associated with reoperation. As a group, ureteroenteric anastomoses result in anastomotic stricture in 4%-8% of patients and are the commonest cause of deteriorated renal function after urinary diversion with a frequency estimated at 10%-15%.[27-29] Surgical revision is considered the most effective approach for treatment with a patency rate of 76% at 3 years, but it is associated with a high recurrence rate of 24%.[1,27] To date, balloon dilation of these strictures has met with limited success. Several studies have reported success rates of 30%-60% and have surmised that the reduced success was the result of devascularization of the ureter near the anastomosis.[1,7,11,13,30-32]

New Technologies to Treat Ureteral Strictures

A number of new technologies and devices for minimally invasive treatment of ureteral strictures show promise for improving patient outcomes and limiting the need for surgical intervention.

Acucise Balloon Dilation

The Acucise balloon (Applied Medical Technologies, Laguna Hills, CA) employs an electrosurgical cutting wire to incise tissue as it dilates. The device consists of a 6F, 78-cm long catheter with a 2.8-cm long, 150-μm wide cutting wire mounted to an 8-mm balloon. The balloon is inflated for 10 minutes, and energy is applied to the wire to provide a full thickness ureteral incision. Healing occurs around a subsequently placed stent. It has been used most commonly to treat ureteropelvic junction strictures where it has had a 61%-93% success rate.[33-35] Several other small series have reported on the use of this device for other ureteral strictures with success rates of 61%-90%.[36-39] These studies concluded that the Acucise balloon is most effective when treating strictures occurring >6 months after surgery, strictures <1.5 cm in length, and strictures in patients with optimal ipsilateral renal function. Of note, outcomes for ureteroenteric anastomotic strictures treated with the Acucise balloon have been mixed, with several studies reporting success rates <50%.[32,40] The use of the Acucise balloon to treat ureteral strictures has fallen out of favor at present in preference to techniques that provide direct vision avoiding the more difficult to control fluoroscopic transmural incisions.

Cutting Balloon Dilatation

Traditional ureteral stricture dilation is accomplished by using sequentially increased diameter smooth walled, high-pressure balloons, and leaving them inflated for 5-10 minutes. Authors have suggested that the multiple tears in the ureter wall resulting from high-pressure balloon dilation may lead to significant periureteric fibrosis and contribute to recurrence.[41] The cutting balloon uses small microsurgical blades mounted on the outside of a balloon to enhance dilation at lower pressures, potentially decreasing trauma to the ureter wall (Fig. 1). A review of the published literature using this technique to treat ureteral strictures is limited but appear promising in the short term.[23,42-44] Additionally, small series report resolution of patient symptoms up to 12 months after the use of cutting balloons to treat neoureterovesical and ureteroenteric strictures. As most minimally invasive treatment failures occur before this time period,[45] these results are encouraging; however, larger series with longer term follow-up are necessary.

Cryoplasty

The PolarCath balloon (Boston Scientific, Natick, MA) uses nitrous oxide to expand the balloon, which cools the surface to −10°C. The cooling process induces fibroblast apoptosis, but not endothelial cell death.[46] To date, this technique has had extremely limited use for ureteral strictures. In 2007, Orsi et al[47] used the PolarCath to dilate ureteroenteric strictures in 4 patients as a primary treatment modality. All 4 patients were patent at a short follow-up of 2.5 months with 1 patient requiring a repeat procedure. In 2010, Heran et al[48] described using the PolarCath balloon for a postrenal transplant neoureterovesical stricture in a 17-year-old male patient. Of interest, high-pressure dilation with 5 weeks of an indwelling stent failed in this patient whereas the subsequent cryoplasty remained patent at 2-year follow-up with stable renal function and no hydronephrosis on ultrasound imaging.