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TRAUMA AND RECONSTRUCTIVE UROLOGY

Ureterolysis with ureterotomy and omental sleeve wrap in patients with radiation induced pelvic retroperitoneal fibrosis

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Introduction Secondary retroperitoneal fibrosis (RPF) due to pelvic radiation alone or together with pelvic surgery is one of the causes of obstructive renal failure. Ureteral obstruction is caused by ischemic stricture and encasement by fibrotic tissue. Endo-ureterotomy alone, without vascular supply, is not successful in these cases.

Material and methods We present eleven cases of ureteral obstruction due to radiation and surgery induced RPF. Seven patients had radiation therapy with or without radical hysterectomy and three patients had anterior resection of the rectum with pre-emptive radiation and one patient had anal cancer treated with local excision and radiation therapy. Nine of the eleven patients had bilateral ureteral obstruction. Open ('intubated') stented ureterotomy and omental sleeve wrap was performed. In one patient, Boari flap ureteroneocystostomy was necessary.

Results Of the eleven patients (twenty renal units) we succeeded in nine patients (eighteen renal units). In two patients with bilateral ureteral obstruction, we were able to reestablish ureteral patency in only one renal unit each.

Conclusions Ureterolysis with ureterotomy and omental sleeve wrap is a valid surgical approach for alleviation of ureteral ischemic obstruction due to secondary retroperitoneal fibrosis caused by radiation alone or together with pelvic surgery.

Key Words: pelvic radiation ‹› pelvic surgery ‹› retroperitoneal fibrosis ‹› ureteral obstruction

INTRODUCTION

Secondary retroperitoneal fibrosis (RPF) caused by radiation and pelvic surgery [1] is an ischemic ureteral obstruction [2]. The ureter is encased by fibrous tissue caused by radiation and or surgery and the radiation effect also causes ischemia of the ureteral wall encased in the RPF.

This entity differs from idiopathic RPF in which the ureter is encased in retroperitoneal fibrous tissue but the ureter itself does not have ischemic damage; the benign periureteral compression causes the extrinsic ureteral obstruction. Also, the location of the ureteral obstruction is different, mid and upper ureter in idiopathic RPF and mostly the lower third of the ureter in secondary RPF due to radiation and or pelvic surgery [1].

In historic series, the average risk of a radiation induced ureteral stricture was 0.15% per year [3, 6]. Ischemic strictures tend to be associated with fibrosis and scar formation and thus are less likely to respond to endoureterotomy or to only open ureterotomy. Also, it is an accepted fact that endoureterotomy in general has a lesser success rate than open corrective surgery for ureteral stricture, even more so if the ureteral stricture is ischemic (i.e. radiation therapy induced) [2].

Based on these facts, additional measures have to be applied in order to resolve ischemic ureteral strictures. If ureterotomy is contemplated in this situation, it is reasonable to consider additional measures in order to revive the blood supply of the ischemic, incised segment of the ureter. Omentum is an excellent source of neovascularization deployed in numerous surgical fields [4].

MATERIAL AND METHODS

Between 2003 and 2014 we diagnosed and treated 11 patients between the ages of 49 and 73 (median age of 64 years, 10 female and 1 male) who presented with ureteral obstruction (9 bilateral and 2 unilateral) secondary to previous pelvic surgery and or radiotherapy for carcinoma of the cervix, rectum and anus. One patient received brachytherapy for cervical cancer. All patients were former oncological cases followed in the clinic of oncology and free of malignant recurrence. Two cases presented with rapidly progressing obstructive renal failure. The other patients were referred by an oncologist or by the multidisciplinary clinic following the patients for de novo or progressive hydronephrosis. The cases were initially treated with percutaneous nephrostomy and preoperative stent insertion was performed in 7 patients. In 4 patients, the affected renal units were drained by stent insertion only.

These latter cases presented with a lesser hydronephrosis/obstruction compared to the cases who underwent percutaneous nephrostomy insertion. All cases underwent laparotomy, and ureterotomy of the length of the ureter that was found encased in the retropritoneal, mostly pelvic, fibrous tissue. During surgery, biopsies were taken from the fibrotic tissue adjacent to the ureters.

No malignancies were found in these biopsies. After the intubated ureterotomy (all patients had stents in the ureters) the ureters were wrapped in an omental sleeve fixed to the ureteral plate and to the bladder (Figures 1, 2).

In one case very severe degree of ureteral stricture was diagnosed and a right Boari flap uretero-neocystostomy was performed on the side of the dominant kidney and ureterotomy on the non-dominant side (27% DMSA renal scan split renal function). The bladder was also partially encased in fibrous tissue due to radiation and previous pelvic surgery and technically there was no chance for a double Boari flap construction. Adhesions in the abdomen and the already damaged kidney function prevented us from using bowel for ureteral corrective surgery.

After surgery, the patients with nephrostomy had the nephrostomy tubes plugged, after one week and stents removed after 2 months. After satisfactory computed tomography (CT) urography or intravenous pyelography, and depending on the time period the patient was treated, the nephrostomies were removed. Patients with only ureteral stents had their stents removed two months after corrective surgery and only after a satisfactory cystogram revealed reflux alongside the stents. These patients also underwent a functional study after a further four weeks (CT urography). Follow-up period of the patients ranged from 13 to 139 months (median 56 months). Characteristics of the patients are presented in Table 1.

Figure 1. *Picture presenting preparation of the omental plates for the sleeve. The omental apron is divided into two segments with the base at the transverse colon or stomach, depending on the length of omental plate needed.*

RESULTS

One patient, later on during follow-up, underwent laparoscopic nephrectomy for a poorly functioning kidney while a second patient had an indwelling stent exchange every 6 months. This decision was made after balloon dilation of a remnant segmental ureteral stricture after the corrective surgery. The split renal function was 27% in the involved renal unit.

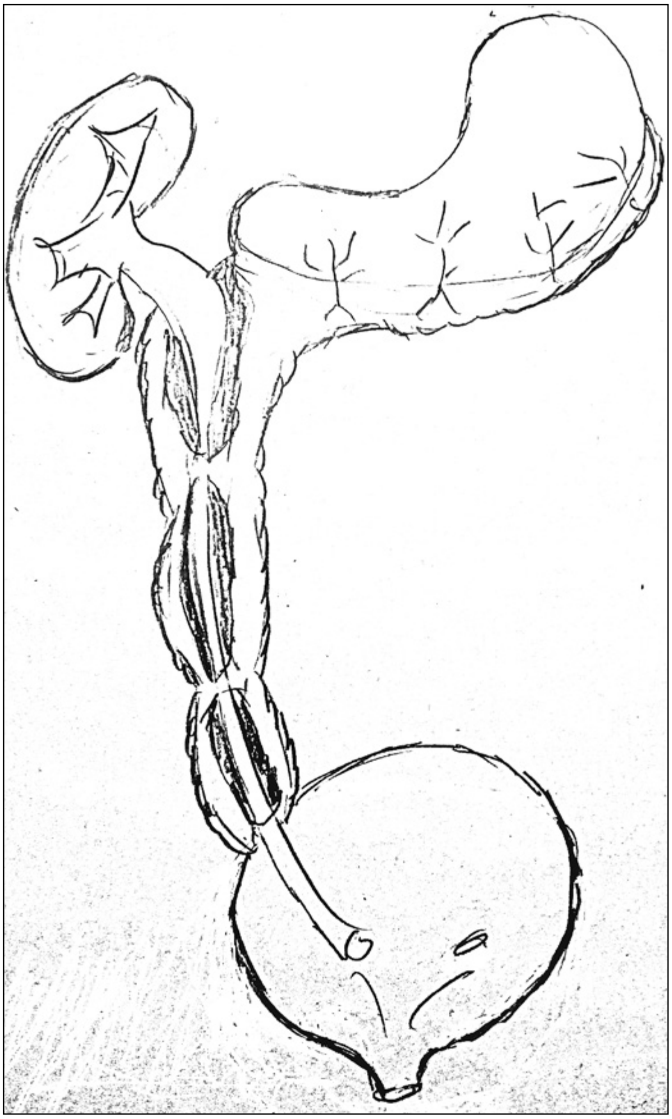

Figure 2. *Drawing that shows right ureter wrapped in omental sleeve. The sleeve is prepared from a plate of omentum, obtained by separating the omental apron into two plates (not necessarily symmetrical) according to the length of the ureter needed to be wrapped.*

One patient died after 30 months of follow-up of a condition related to ischemic heart disease.
All the other patients continue follow-up consisting of ultrasound of the kidneys every 6 months and blood chemistry, in addition to the oncological follow-up program.
There were no major intra- or postoperative complications.

DISCUSSION

Ureteral stricture is a late complication of radiotherapy for carcinoma of the cervix or rectum. Recurrent pelvic tumor must be ruled out before a diagnosis of radiation induced ureteral stenosis can be made. The latency time between radiotherapy and the manifestation of ureteral complications may range from 0.5–41.5 years with an incidence of 1.5% at 10 and 2.5% at 20 years after radiation.
Newer strategies for better defining the target for radiotherapy, conformational radiotherapy and better understanding of the radiobiologic factors, contribute to further reducing the frequency of this complication [5].
Because the occurrence is rare, correlation with factors that increase the frequency of the damage is difficult. Combination of radical surgery, external radiation or brachytherapy which may further compromise the vascular supply of retroperitoneal and ureteral tissue have been implicated as complicating factors responsible for increasing the risk of ureteral stricture [6–10].
The general consensus is that endourologic techniques for managing ureteral strictures do not achieve success rates comparable to those of open surgery, yet these minimally invasive approaches are often preferred because of their lower morbidity, reduced operative time, shorter hospitalization, and decreased cost compared with open reconstruction. Moreover, failure of a minimally invasive technique does not preclude a successful open operative repair. Wolf et al. reported an overall success rate of endoureterotomy of 60% [2, 12]. The degree of ischemia and the length of the stricture are the really important factors that influence the success of the ureterotomy either endourologic or open [14].
Animal studies by Davis in the early 1940s provided the foundation for current endourologic management of ureteral stricture. In his description of the 'intubated ureterotomy', Davis noted that a stented incision of the ureteropelvic junction (UPJ) epithelialized completely in 1 week. Within 6 weeks, muscular regeneration had already occurred. So, Davis et al. were the first to describe the ability of an incised ureteric stricture to regenerate and re-epithelialize if incised and intubated with a ureteric catheter. The principles of successful endoureterotomy are derived from this original work [11, 12, 13].
In order to render an open ureterotomy of an ischemic ureteric segment successful, one has to ensure the revival of the blood supply of the incised ischemic ureteral segment.
The greater omentum, with its immunologic and angiogenic properties can be used to reconstruct a diverse range of extraperitoneal wounds and defects. Infected, irradiated, and ischemic wounds are particularly amenable to reconstruction with the omentum due to its large surface area, pliability,

Table 1. *Patients' data*

No.	Age	Basic pathology	Treatment for basic pathology	Corrective surgery	Result
1	49	Cervical cancer	Radiotherapy	Bilateral ureterolysis, ureterotomy and omental wrap	Good with remnant moderate hydronephrosis
2	55	Cervical cancer	Radiotherapy	Idem	Good with mild bilateral hydronephrosis
3	59	Rectosigmoid cancer	Radiotherapy and anterior resection	Left ureterolysis, ureterotomy and omental wrap	
4	60	Cervical cancer	Radical hysterectomy and radiotherapy	Left ureterolysis and ureterotomy Right Boari uretero neocystostomy; Bilateral omental wrap	Good Right renal unit; Left ureteral balloon dilation and indwelling stent; exchange
5	64	Anal cancer	Local excision and radiotherapy	Bilateral ureterolysis, ureterotomy, omental wrap	Left: Good renal unit Right: Poorly functioning renal unit Right laparoscopic nephrectomy
6	66	Cervical cancer	Hysterectomy, lymph node dissection and radiotherapy	Bilateral ureterolysis, ureterotomy and omental wrap	Good; mild to moderate remnant bilateral hydronephrosis
7♂	67	Rectal cancer	Radiotherapy and anterior resection	Left ureterolysis, ureterotomy and omental wrap	Good
8	67	Cervical cancer	Radiotherapy	Bilateral ureterolysis, ureterotomy and omental wrap	Good, mild bilateral hydronephrosis
9	70	Rectal cancer	Radiation and anterior resection	Idem	Good, with bilateral mild remnant hydronephrosis
10	71	Cervical cancer	Hysterectomy and radiotherapy	Idem	Good with moderate remnant hydronephrosis
11	73	Cervical cancer	Brachytherapy	Idem	Idem

♂ male patient

malleable volume, generous pedicle length and extremely rich blood supply.

The omentum may be used as a primary flap for massive sternotomy wounds and for complex head and neck defects after trauma or oncologic resection [15, 16, 17].

A fundamental characteristic of the omental cells is their ability to synthesize angiogenic growth factors such as fibroblast (FGF) and vascular endothelial growth factors (VEGF). The capacity to produce these factors confers to omental cells the potential to promote angiogenesis when implanted into a tissue by favoring an environment prone to new vessel formation making omentum ideal for use in an ischemic environment such as ischemic ureteral strictures cause by radiation and previous surgery [18, 19].

Combining the basic physiologic principles described, it seemed logical to apply them in the treatment of the ischemic ureteric strictures in our eleven patients (combining: open ureterolysis, ureterotomy and omental sleeve wrap).

The major drawback of this article is its retrospective nature and that we had a hypothesis that we did not verify in a randomized trial.

However, historically, we found a reasonable amount of evidence in the literature to sustain our working hypothesis [20].

We did fail in two renal units. However, in both cases there were factors that made failure foreseeable.

In one case, we could not attempt a double Boari flap uretero-neocystostomy due to not having enough bladder tissue to work with since the ureteric stricture segments were long. Also, due to bowel adhesions from previous surgery we did not attempt using bowel in the ureteral repair. Additionally, the ipsilateral split kidney function was 30% on the DMSA scan at that time. This case was managed by an indwelling stent which is exchanged every 6 months. This was decided on after a seemingly successful balloon dilation of the remnant stricture of the incised and omentum wrapped ureter.

In the second failed case there was a 7 cm ureteral stricture of a poorly functioning kidney with less omental tissue with which to wrap the ureter. We saved the better portion of the omental tissue for the good renal unit. This patient eventually underwent a laparoscopic nephrectomy.

Before surgery, we performed renal unit drainage by percutaneous nephrostomy in the majority of the cases. Ureteric stents were also inserted before surgery. In the remainder of the patients, where we used uretric stents only for initial drainage, we tried to perform the corrective surgery within one month.

We preferred percutaneous kidney drainage, due to its advantage in assuring a controllable good drainage of the affected renal unit. It is documented that there is a reasonably high failure rate with only stent drainage of extrinsically obstructed ureters [21].

Mechanisms of stent occlusion are not fully defined, but it is suspected that impairment of ureteral smooth muscles and occlusion of the space between the stent and the ureteric wall by extrinsic compression are the main contributors to stent malfunction in these cases. Urine has to be able to pass around the stent in order for the ureteric stent to be effective. Previous studies showed that repeated stent replacement for a malfunction did occur, on average, 2.8 times in a 90-day period [21, 22].

CONCLUSIONS

Ureteral obstruction caused by radiation and surgery induced retroperitoneal fibrosis is a type of ischemic stricture. Combining ureterolysis, open intubated [12, 13] – stented ureterotomy with omental wrap [17] of the affected ureteric segment ensured a reasonable success rate of renal unit salvage in our patients

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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