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Early experience in reconstruction of long ureteral strictures with allogenic amniotic membrane

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Objective: To present our experience with the application of human amniotic membrane for the reconstruction of extensive ureteral wall defects.

Methods: Between 2003 and 2006, 11 patients underwent reconstructive surgery of the ureter. A human amniotic membrane allograft was used to supplement ureteral wall defects. Indications for the procedure included ureteral strictures of a 5.5 cm average (range, 3–8 cm) localized in different parts of the ureter: upper (5), middle (5) and lower (3). The etiology of ureteral loss was: postinflammatory after a complicated stone disease (5), iatrogenic (4) and idiopathic (2). Diagnosis of ureteral stricture was based on antegrade pyelography and excretory urography. Two patients had synchronous treatment for upper and middle ureteral stenosis. Treatment efficacy was assessed by excretory urography and ultrasound.

Results: The mean hospitalization time was 11.9 days, mean operation time 128 min and with an average follow up of 25.2 months. Complications included: stricture recurrence (1) and symptomatic urinary tract infections (2). Excretory urography showed lack of obstruction and normal width of ureters. In one patient, residual hydronephrosis was present on ultrasound.

Conclusions: The described method seems to be a promising tool in the reconstruction of extensive ureteral strictures.

Key words: amniotic membrane, graft, reconstruction, stricture, ureter.

Introduction

Minimally invasive management may represent a solution for short ureteral strictures of up to 2 cm.[1] Extensive ureteral strictures are not frequent but are difficult to manage and constitute a challenge to urologists. In most cases, the reconstruction and the supplementation of the damaged wall is necessary to achieve a satisfactory result. Ureteral replacement is usually performed when less invasive methods are not feasible or have failed. Ureteral stricture may have a varied etiology, including: iatrogenically-induced ureteral injuries (after gynecological and urological procedures in the pelvic area or radiotherapy), retroperitoneal fibrosis, complicated stone disease, or ureteral necrosis following kidney transplantation. Different procedures have been introduced to bridge ureteral defects including ureteral substitutions with intestinal segments, transuretero-ureterostomy, bladder flaps and even renal autotransplantation.[2] These interventions are complex, time-consuming and have a significant potential for complications.[3] The application of artificial biomaterials for ureteral replacement has also been reported; nevertheless, the results were sometimes far from those expected.[4] Furthermore, it was demonstrated that synthetic material might lead to encrustation on the artificially replaced ureter and could provoke foreign body reaction and subsequent rejection of the graft. This has brought about an increasing interest in the search for natural tissue with ureteral regenerative ability which could be used in reconstructive surgery. The material for the graft should be inexpensive, easily available and resistant to infection and rejection. Amniotic membrane, which has been recently used widely and successfully in ophthalmology for corneal and conjunctival reconstructions,[5,6] promised to be a valuable biomaterial. Amnion constitutes the inner part of the placental membrane. Amniotic membrane is composed of the connective tissue with a significant collagen and extracellular matrix composition. Its internal surface is covered with a single-layer cubical epithelium. It is avascular and has anti-scarring, anti-inflammatory and anti-angiogenetic properties. Moreover, it has been reported to possess the exclusive quality of preventing graft-versus-host disease[7] and to facilitate wound healing. Our aim was to assess the efficacy and suitability of human amniotic membrane as a scaffold for new tissue growth in the reconstruction of the extensive ureteral defects.

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Methods

A human amniotic allograft patch (10 cm × 16 cm) was prepared by the Transplantation Institute and Central Tissue Bank, Center of Biostructure, Institute of the Medical University of Warsaw. It was deeply frozen for preservation and radiation-sterilized with a dose of 35 kGy.

Written informed consent for the procedure was obtained from all of the study participants.

Eleven patients (four males and seven females) with a mean age of 51 years (range, 26–74) underwent reconstructive surgery of a ureteral obstruction between 19 February 2003 and 20 February 2006 (Table 1). The indications included extensive ureteral strictures of a 5.5 cm average (range, 3–8 cm) localized in various parts of the ureter: upper (5), middle (5) and lower (3). Two patients had synchronous treatment for upper and middle ureteral strictures. The etiology of ureteral loss was: postinflammatory after a complicated stone disease (5), iatrogenic (4) and idiopathic (2). Diagnosis of ureteral stricture was based on antegrade pyelography and excretory urography. Varied degrees of hydronephrosis and lack of contrast passage, or only a thin trace of this in the stenosed segment, were observed. Surgical action was performed under general anesthesia. A retroperitoneal approach to the ureter was

Table 1 Patients undergoing ureteral reconstruction

Patient age (years)	Follow up (months)	Stricture length (centimeters)	Etiology	Complications	Stricture location (part of the ureter)
51	5.1	8	Iatrogenic	–	Middle
26	19.4	6	Iatrogenic	–	Middle
26	20.3	4	Idiopathic	–	Lower
39	18.9	8 (3 + 5)	Iatrogenic	Stricture recurrence	Upper and middle
70	35.2	5	Postinflammatory/stone disease	Urinary tract infection	Lower
74	35.4	6.5 (3 + 3.5)	Postinflammatory/stone disease	–	Upper and middle
59	32.6	3	Postinflammatory/stone disease	–	Lower
49	28.5	5	Iatrogenic	–	Upper
64	25.5	5	Postinflammatory/stone disease	–	Upper
56	24.6	4	Idiopathic	–	Upper
48	32.2	6	Post inflammatory/stone disease	Urinary tract infection	Middle

Mean patient age, 51 years; mean follow up, 25.2 months; mean stricture length, 5.5 cm.

adopted in all cases. The approach in the upper and middle ureteral strictures was lumbar and, in the lower part of the ureter, ventral. A percutaneous nephrostomy was inserted before each procedure in order to derivate urine from hydronephrosis and to reduce the urine leak from the operated area. In all cases, human amniotic membrane was used to supplement the ureteral wall defect. Before implantation, the amniotic membrane was folded in order to obtain its carrier surface, and covered with cubical epithelium on both sides. Hence, there was no possibility of implanting the membrane improperly. The whole length of the stenosed part of the ureter was prepared and cleaned of adjacent tissues. Afterwards it was incised longitudinally without intersecting. The ureteral wall defect was then covered with human amniotic membrane in an on-lay fashion. The implant was sewed in without tension with interrupted suturing. Two pairs of proximal and distal single Dexon 5.0 sutures on each side were placed to fix the graft patch to the ureteral wall. Sutures were placed 1–2 mm from the ureteral edge with a minimum 3 mm of free margin left. A JJ-catheter was used as a ureteral stent to bridge the reconstructed segment for 3 weeks following the procedure. An excretory urography was done before removing the JJ. Suction was not used because of the danger of aspiration and damaging the implant. The wound was drained with a latex 1 cm diameter catheter with 3–4 holes and sawed with Dexon 1.0 sutures. A Foley catheter was put into the bladder. On the third to fourth day the drain was removed. Sutures were taken away on the seventh to eighth day. The Foley catheter was removed 5 days postoperatively. Nephrostomy was clamped on the seventh day and removed on the ninth. Follow up included excretory urography and ultrasound at 3, 9 and 24 months following intervention. A renal isotope scan was not routinely performed before and after the procedure.

Fig. 1 Preoperative intravenous urography (IVU; 15 min after contrast injection) demonstrates extensive stricture of the upper part of the right ureter.

Results

The procedure had a successful outcome in all patients. There was no intraoperative bleeding. The mean hospitalization time was 11.9 days (range, 6–26 days), the mean operation time was 128 min (range, 70–270 min) and the average follow up was 25.2 months (range, 5–35 months). Complications included (Table 1): one stricture recurrence (in a patient harboring a double graft), and two cases of an isolated, symptomatic urinary tract infection. Excretory urography showed the unobstructed state and normal width of the operated ureter (Figs 1–3). In one patient, residual hydronephrosis was present on ultrasound, despite being non-obstructed. Up to now, we have not observed any significant alteration of patients' general condition.

Discussion

The most common use of an intestine or colon for ureteral reconstruction remains an invasive and complex procedure with a serious, up to 10.5%, potential for major complications including stricture of

Fig. 2 Postoperative IVU (15 min after contrast injection). Passage of contrast appears to have improved (a piece of the upper part of the ureter begins to be visible).

Fig. 3 Postoperative IVU (45 min after contrast injection). Lack of obstruction and regular width of the operated ureter.

anastomosis, graft obstruction, metabolic derangements and even chronic renal failure.[3] Because of the presence of the bowel in the urinary tract the risk of fistula formation, infection, stone disease or even cancer is elevated.[8] Moreover, the procedure is technically demanding, time-consuming and cannot be performed in patients with inflammatory bowel disease, azotemia or in those who lack enough small intestine.[3]

The Boari flap is considered to be a reasonable and safe option for treating extensive strictures of the lower part of the ureter.[9] However, the procedure might be complicated in patients with detrusor hypertrophy. Additionally, the intervention can restrict bladder capacity because it takes up a substantial proportion of bladder surface. Renal autotransplantation has been also reported in the management of ureteral strictures.[10] However, it is a complicated surgical procedure and tends to be accompanied by major and minor complications.

Some authors described the usefulness of small intestine submucosa (SIS) to supplement the ureteral loss in pigs.[11,12] Liatsikos *et al*. demonstrated the ability to bridge extensive ureteral strictures up to 7 cm.[11] SIS ability to stimulate the connective and the epithelial tissue growth allowed the regeneration of the ureteral defects. Greca *et al*. confirmed that the SIS graft behaves as a scaffold for ureteral reconstruction. Conversely, the study performed by El-Assmy[13] does not support the opinion that SIS is a suitable material for replacing extensive ureteral strictures above 4 cm. Obstruction of ureteral lumen and massive fibrosis were observed in all cases.

The application of the acellular matrix (AMX) for ureteral replacement has been reported in different studies, including our own work.[14,15] The results differed for each study. Those obtained by Osman *et al*. in a canine model were discouraging. Our results with AMX were, however, very promising, even though we had to stop performing this procedure because of the lack of material. In our opinion, the implantation method plays a key role in procedure efficiency. Our technique of AMX implantation was similar to that described with amniotic membrane. Osman *et al*. excised the ureteral stricture and afterwards replaced it with an AMX tube.

In our department, we obtained very promising early and late results in reconstructing the extensive ureteral strictures with human dura mater allograft.[16] However, because of the risk of Creutzfeldt–Jakob disease, dura mater was excluded from reconstructive surgery. This obliged us to search for another natural biomaterial with similar properties to continue our work with the reconstruction of the ureteral wall. Fishman *et al*. demonstrated that placental membrane is an acceptable biomaterial for bladder reconstruction. Moreover, they suggest its utility as a graft material for the urinary tract.[17] Amniotic membrane, as far as we know, has never been used for ureteral reconstruction. We used it as a scaffold for ureteral regeneration. Its potential for promoting the migration of host cells, attachment and spreading, as well as the absence of adverse immunological reaction, which is probably due to its anti-inflammatory properties and almost acellular composition, are the main advantages of amniotic membrane.[18] Furthermore, the graft is resistant to rejection and can be left in place if infection occurs. Avoiding the inclusion of intestinal segments, our technique can be used in all patients who have no contraindications to open surgery. It is a versatile, technically undemanding procedure for reconstructing all parts of the ureter. The ureteral stricture is only incised but not cut off. Its fragility is the major disadvantage of amniotic membrane. As it is easily damaged, it has to be carefully treated during the whole procedure and the use of suction is inadvisable. For the same reason, intraoperative bleeding should be controlled.

The treatment evaluation before and after procedure was based upon urography, ultrasound findings and the relief of symptoms.

Unfortunately, renal isotope scanning was not systematically performed and this did not allow us to compare kidney function.

Conclusions

Application of human amniotic membrane appears to be an encouraging method for managing extensive ureteral defects. The procedure is technically easy and short-term results are promising. Nevertheless, long-term follow up and analysis of more cases with precise renal function evaluation remains necessary. The cost-effectiveness of procedure and its durability should be assessed in consideration of this method as an alternative treatment option for ureteral reconstruction.

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