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Urological Research

Optimization of uretero-intestinal anastomosis in urinary diversion: an experimental study in dogs

I. Evaluation of the Le Duc technique

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Summary. Experimental evaluation of uretero-ileal reimplantation was carried out in 10 adult mongrel dogs. One half of the ureters (10) were implanted into ileal reservoirs using the classic Le Duc technique. In the other half, the implanted ureters were covered by ileal mucous membrane. Following the classic Le Duc technique, 40% of the reimplanted ureters showed evidence of either reflux and/or stenosis resulting from shortening and fibrosis of the tunnel. The remaining 60% were perfect due to spontaneous nipple formation at the implantation sites rather than to creeping of the intestinal mucosa. In contrast, none of the ureters examined was either refluxing or stenotic. This study outlines the critical importance of covering the implanted ureters with mucosa to avoid the ureteric adventitia being exposed to the irritative effects of urine with subsequent scarring.

Key words: Le Duc – Ureter – Implantation – Ileum

In our own experience [6] and that of others [1–3, 5, W. J. Catalona personal communication 1990], 10%–35% of reimplanted ureters showed evidence of stenosis and/or reflux following the classic Le Duc uretero-ileal reimplantation technique. In this study a series of experiments on dogs were carried out to identify the cause(s) of this failure and to characterize the healing patterns of the implanted ureter and ileal mucous membrane when exposed to the urinary stream.

Materials and methods

Experimental animals

Ten mongrel dogs weighing 12–15 kg were used for the experiments. The procedures were carried out with the animals under general anaesthesia. Thiopental sodium (10 mg/kg) was used for induction and maintenance of anaesthesia, with endotracheal intubation and mechanical ventilation.

Operative procedure

A segment of the terminal ileum 25 cm long was isolated and the continuity of the small intestine re-established. The proximal 20 cm of the isolated segment was opened at its antimesenteric border, turned into U-shaped configuration and the two medial borders joined by a continuous suture of 4/0 Vicryl.

In each dog, one ureter was reimplanted using the classic Le Duc technique [5]. The other ureter was inlaid in a mucosal sulcus created by excision of a mucosal strip. The edges of the mucosa were then sutured over the implanted ureter (Fig. 1). In all ureters the length of the implanted segment was 3 cm and the anastomosis was stented for 10 days. The reservoir was then closed. Its distal end was brought out as a cutaneous stoma in the right lower quadrant of the abdomen. Parenteral antibiotics and fluids were given for 5 days followed by a fluid oral diet for 2 days and the solid food as tolerated.

Evaluation

The dogs were evaluated 12 weeks following surgery. The evaluation included a gravity ascending pouchgram (water head 50 cm) and excretory urography. The dogs were then killed for necropsy. The

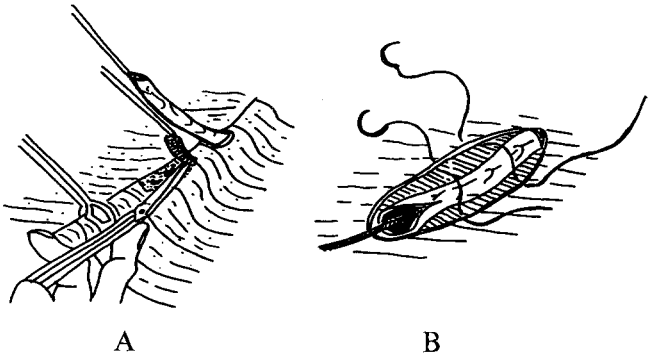

Fig. 1A. Excision of an ileal mucosal strip. **B** The mucosa is resutured over the reimplanted ureter

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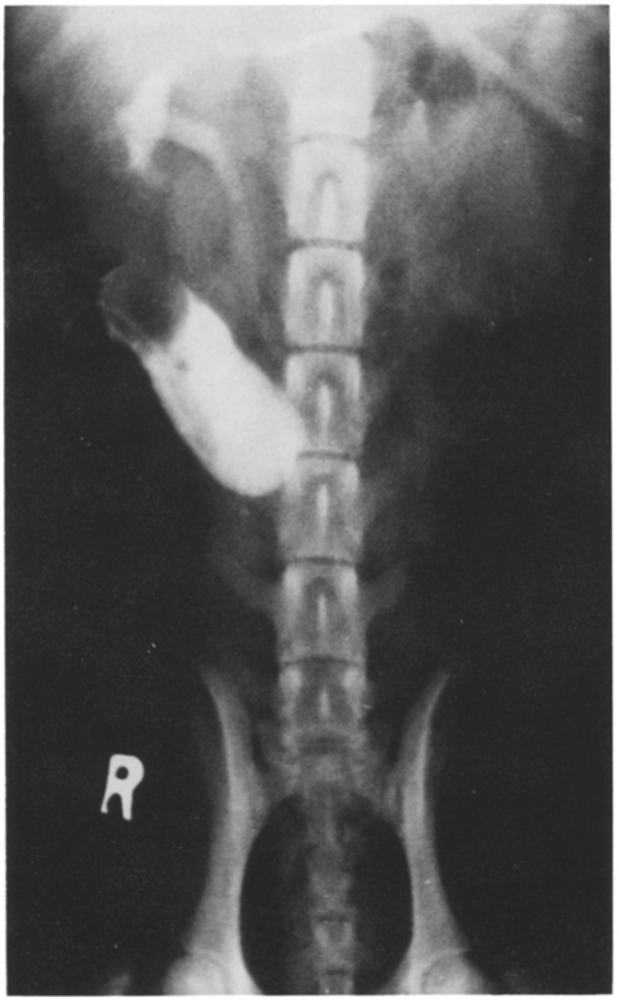

Fig. 2. Ascending pouchgram showing reflux to the right side following the Le Duc technique

Fig. 3. Autopsy specimen showing advanced hydronephrosis of the right kidney following the Le Duc technique due to tunnel fibrosis. Note the perfect configuration of the left renal unit in which the ileal mucosa was resutured in front of the implanted ureter

anastomotic sites were examined grossly and histopathologically. Sections were stained by haemotoxylin and eosin and the Masson trichrome stain.

Results

Ureters implanted by the Le Duc technique

Of 10 ureters, 6 had a perfect configuration without evidence of reflux. Two ureters showed evidence of second-degree reflux but with a normal intravenous urogram (Fig. 2). The remaining 2 ureters showed evidence of advanced hydronephrosis with loss of function (Fig. 3). On gross examination, nipple formation was observed at the reimplantation sites associated with good functional results (Fig. 4).

Histological examination of the nipples revealed that they were composed of ureteral wall lined with transitional epithelium. The submucosa showed a chronic inflammatory reaction, the severity of which was exaggerated at the base of the nipple where the transitional and intestinal epithelia met (Fig. 5). In contrast, no nipples could be observed on gross examination of the reimplantation sites associated with reflux and/or stenosis. Moreover, histological examination showed shortening and/or obliteration of the ureteral tunnels. Fibrosis and inflammatory reaction were dominant features (Fig. 6).

Mucosal sulcus with mucosal suturing over the implanted ureters

All the reimplanted units in this group had a perfect configuration without evidence of reflux. Gross examination of the implantation sites showed perfect submucous tunnels, 2–3 cm in length, without nipple formation. Histological examination revealed intact submucous ureters covered with normal ileal mucosa. The submucosa and the periureteral fascia showed a slight inflammatory reaction (Fig. 7).

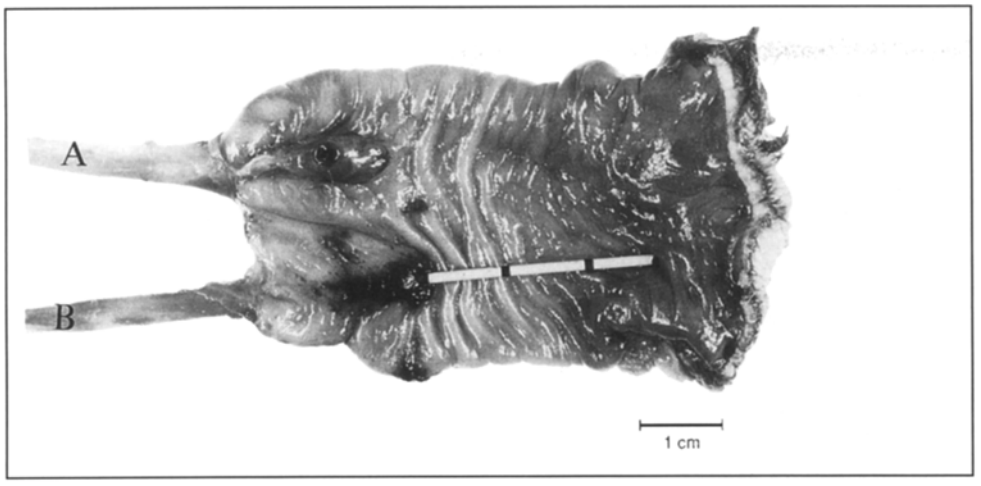

Fig. 4A. Autopsy specimen showing nipple formation at the implantation site following the Le Duc technique. **B** An adequate tunnel is observed when the ileal mucosa was resutured in front of the implanted ureter. The *scale* is in centimeters

Fig. 5. Histopathological picture of the nipple formed at the implantation site following the Le Duc technique. The nipple is formed of granulation tissue covered with normal transitional epithelium. H&E, ×25

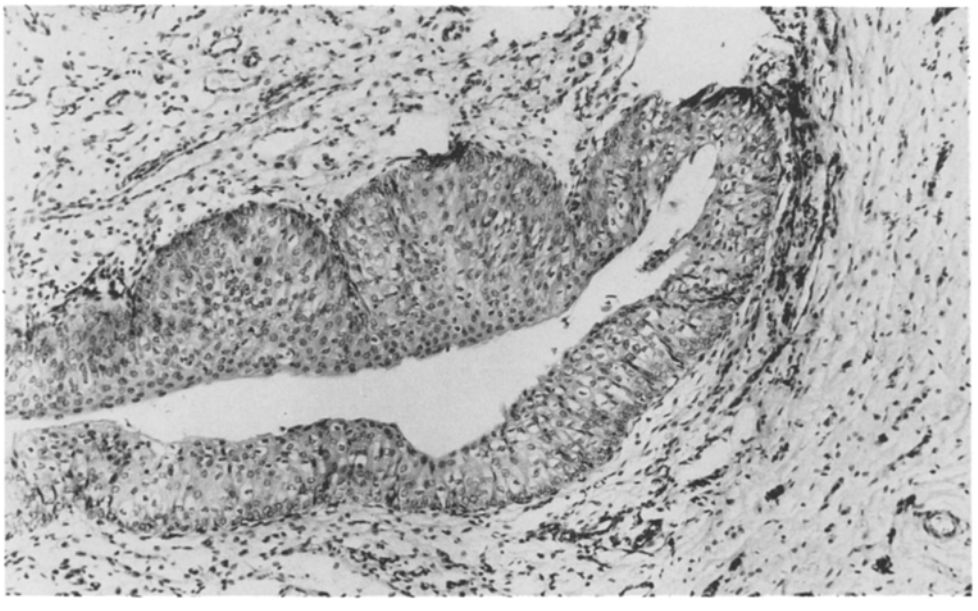

Fig. 6. Micrograph of ureter reimplanted using the Le Duc technique. Note the obstructed distal end of the ureter, bands of fibrosis and the chronic inflammatory cells. H&E, ×100

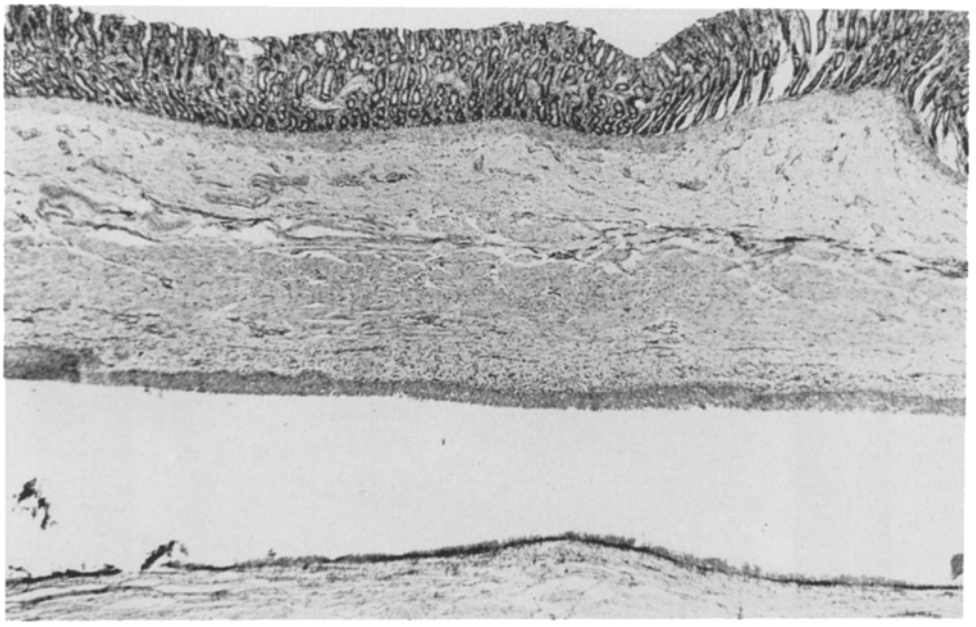

Fig. 7. Micrograph of an implanted ureter over which the ileal mucosa was resutured. Note the healthy ileal mucosa covering an intact patent ureter. H&E, ×25

Table 1. Review of the results of Le Duc uretero-ileal reimplantation

Author [Ref.]	Number	Stenosis	Reflux
Camey 1985 [2]	150 patients	?	(15%)
Allen et al. 1985 [1]	11 patients	–	4/11 (36%)
Le Duc et al. 1987 [5]	71 ureters	8/71 (11.3%)	?
	64 ureters	–	16/64 (19%)
Hautmann et al. 1988 [3]	11 patients	7/11 (63%)	–
W. J. Catalona 1990 (unpubl.)	?	?	15–35%
Shaaban et al. 1992 [6]	38 ureters	11/38 (29%)	1/38 (3%)

Discussion

Uretero-intestinal anastomosis is a critical requirement when segments of intestine are considered for bladder substitution. It should provide a non-obstructive unidirectional flow of urine to maintain the integrity of the upper tract. Two thirds of patients with urinary reservoirs had intermittent or constant bacteriuria [4], which underlines the importance of an antireflux mechanism.

In view of its simplicity and its applicability to small intestines where a submucous tunnel cannot be created, the Le Duc technique was received with enthusiasm. It was maintained that the intestinal mucosa would creep to cover the implanted ureter, forming, in effect, a submucous tunnel. Nevertheless, critical analysis of published data as well as our own experience has shown that the incidence of stenosis varies between 2% and 25% and that of reflux between 4%–20% following this procedure (Table 1). It is of particular interest to note that when Hautmann et al. used the Le Duc technique for 11 patients with ileal orthotopic bladder substitution, 7 showed grade I and II upper tract dilatation [3]. In a later series, the same authors reported their experience in 113 patients in whom a significant modification of the technique was employed. A mucosal strip of intestine was excised, the ureter was inlaid in the sulcus and the mucosa was sutured in front of the implanted ureter. With this variation, upper tract dilatation was seen in 7.5% of cases only [7].

Our experimental findings have provided evidence that initial covering of the implanted ureters is critical for proper healing and is associated with minimal scarring. On the other hand, following the classic Le Duc technique with inevitable exposure of the ureteric adventitia to urine, which may be infected, an intense inflammatory reaction and granuloma formation were observed. Ultimately, fibrosis and calcification may result. Accordingly, 4/10 of the reimplanted ureters showed evidence of stenosis and/or reflux. A tendency for nipple formation was observed at the implantation sites of the remaining ureters. They were covered by transitional rather than intestinal epithelium. In other words, the expected creeping did not occur. Nevertheless, nipple formation was associated with a good functional result since the nipple provides an antireflux mechanism.

In summary, the course of healing by scarring, calcification or nipple formation at the implantation site following the Le Duc technique was unpredictable. These findings stimulated us to study in a second animal model the process of healing of the implanted ureter and ileum when exposed to urine.

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