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Consequences to the Upper Urinary Tract after Ureteric Torsion

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Summary. The effects of ureteric torsion on the upper urinary tract were studied in 8 pigs. With 5 pigs the distal ureter was mobilised, torted 1 to 5 times and reimplanted into the bladder. With three pigs the proximal ureter was torted 1 to 3 times and re-anastomosed to the renal pelvis. It was shown that a torsion of 1 or 2 times in the distal ureter does not result in ureteral obstruction. However, as little as 360 degrees torsion in the proximal ureter may lead to dysfunction secondary to mechanical obstruction. Histological examination of the ureter showed ischaemic changes only after multiple torsions.

Key words: Ureteric reimplantation - Ureteric torsion - Urinary obstruction.

With every operative procedure including ureteric reimplantation, whether it be into the bladder, colon, skin, or other ureter (uretero-ureterostomy) or a plastic reconstruction of the renal pelvis, special attention must be paid to the anatomical course of the ureter. First, the ureter should be neither sharply bent nor anastomosed under tension (2, 4). Likewise, the ureter should not be not rotated around its longitudinal axis (1). To facilitate the orientation of the ureter, it has been proposed that stay sutures should be placed at one or two points on the ureter's circumference (3).

Employing only a single orientation suture, rotation of 360 degrees can pass unrecognised. With several sutures a torsion should be recognised but entanglement of the stay sutures is often difficult to avoid. The question arises as to whether it is worth the added effort to attempt to maintain the ureters in their normal axis of rotation during anastomosis procedures.

The following animal experiment was designed to investigate whether or not simple or multiple torsions of a ureter produce mechanical obstruction of urine flow or compromise the blood supply of that ureter.

METHOD

Operations were performed using intubation anaesthesia on 8 normal pigs weighing from 20 to 30 kg. In the first group of 5 pigs the distal ureter was reimplanted in the bladder using varying degrees of torsion. In the second group of 3 pigs the proximal ureter was twisted and reanastomosed to the renal pelvis. An intravenous pyelogram (IVP) was obtained after 6 weeks to check for mechanical obstruction. In addition, histological examination of the torted ureter was carried out.

Using a midline laparotomy incision the right ureter was mobilised for a constant distance of 15 cm between the bladder and the lower pole of the kidney. Prior to a reimplantation using the Politano-Leadbetter technique the ureter was rotated counter-clockwise 360 degrees from one to five times.

The experiment was limited to a counter-clockwise rotation to maintain constant condi-

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Fig. 1. IVP 6 weeks after ureteric torsion (360°) and reimplantation

Fig. 2. Histology of torted ureter (360°) without microscopic change

Fig. 3. Intraoperative 3-fold distal ureteric torsion (1080°)

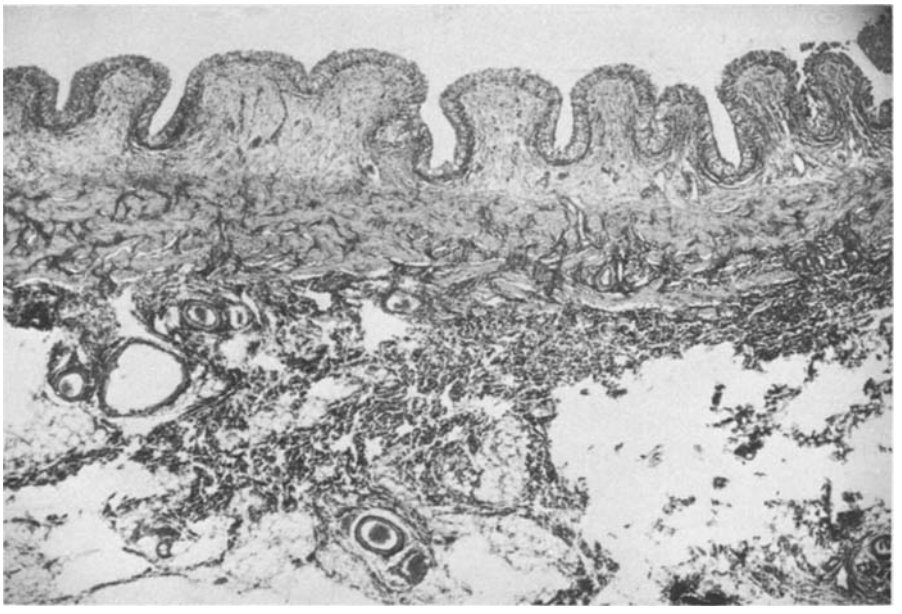

Fig. 4. Histology following 3-fold distal ureteric torsion showing no microscopic change

Fig. 5. IVP 6 weeks after 3-fold distal ureteric torsion with low grade ureteral dilatation

Fig. 6. 4-fold torsion (1440°) of the distal right ureter without hydronephrosis

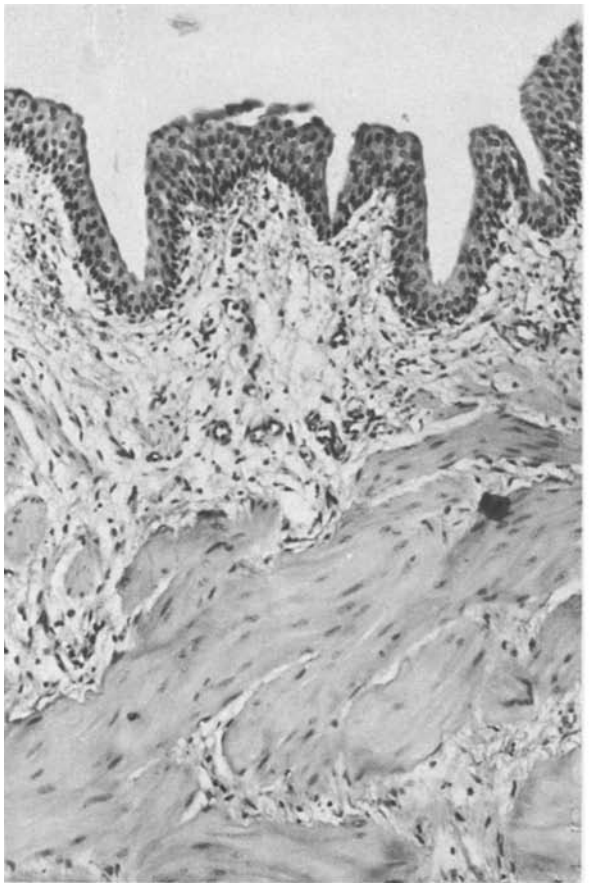

Fig. 7. Histology of a 4-fold torted ureter showing inflammatory changes without necrosis

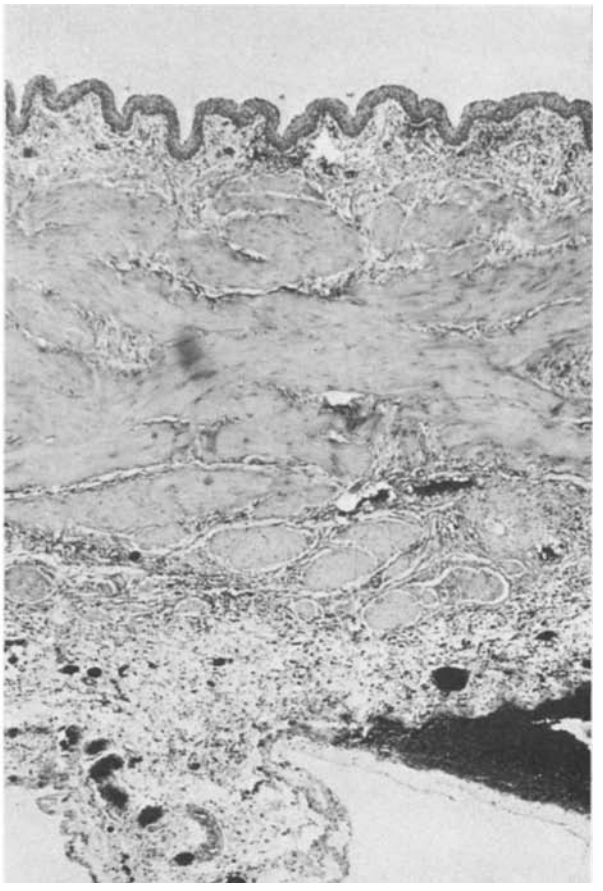

Fig. 8. Histology of a 5-fold torsion showing inflammatory changes but also without necrosis

Fig. 9. Postoperative IVP after proximal ureteric torsion of 360° and reanastomosis to renal pelvis showing low grade hydronephrosis

Fig. 10. IVP after proximal ureteric torsion of 720° showing resultant hydronephrosis

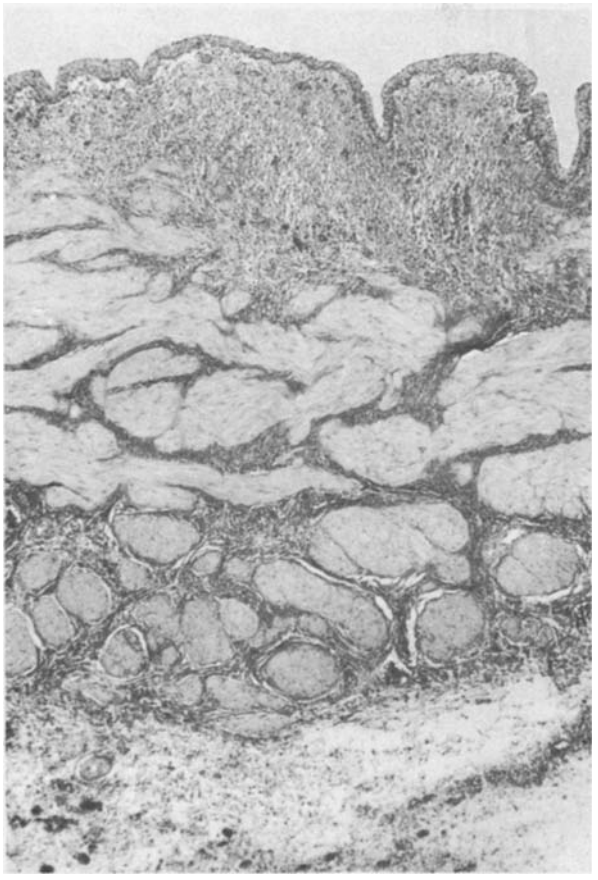

Fig. 11. Histology from the 2-fold proximally torted ureter with inflammatory infiltrate but without infarction

tions in this small series. Assuming the muscular fibres of the pig ureter are equally distributed into clockwise and counter-clockwise spirals, we concluded the direction of the rotation was of no consequence.

In the second group the proximal ureter was mobilized 10-15 cm, rotated 1-3 times and re-anastomosed to the renal pelvis using the Anderson-Hynes technique. Ureteric function was assessed after 6 weeks with an IVP and histological studies carried out.

RESULTS

In the first group of pigs and with distal ureteric rotation of 360-720 degrees no ureteric obstruction could be detected radiologically by IVP at 6 weeks (Fig. 1). Normal vascularity of the ureter was found at laparotomy and histologically the tissues were normal (Fig. 2).

With 3 complete rotations (Fig. 3) there was no visible or histological injury to the ureter. There were no specific pathological changes such as haemorrhage, necrosis, scarring or inflammatory infiltration (Fig. 4). However, radiographically, a low-grade obstruction was first seen in this group (Fig. 5). Thus, torsion of 1080 degrees appeared to compromise ureteric function before the integrity of ureteric tissue. This impression was confirmed by the findings of a 4-fold rotation. At laparotomy, shortening and tension were observed. Ureteric peristalsis was visibly altered so that as the bolus of urine proceeded distally, the ureter tended to untwist ahead of this impetus and thus exaggerate the amount of torsion in the distal ureter. The ureter reacted to this phenomen with increased peristaltic frequency, which could be clearly observed at the end of the operation. The IVP at 6 weeks showed obstruction with caliectasis and dilatation of the entire ureter. The same ureter which had at operation appeared shortened was now elongated with multiple constricted areas, secondary to the dilatation and torsion (Fig. 6). However, even this degree of obstruction produced only minimal histological changes in the ureter. These changes included flattening of the epithelium, oedema of the submucosa and patchy inflammatory infiltrates. No necrosis or scarring were seen (Fig. 7).

The 5-fold ureteric rotation led to complete mechanical obstruction of the ureter and subsequent non-function of the respective kidney. Six weeks postoperatively the circulation of the ureter was seen to be intact. Histologically, multiple inflammatory infiltrates without necrosis or scarring were found (Fig. 8).

In the second group of pigs the IVP showed low-grade obstruction after only 360 degrees of torsion. With 2-fold rotation (720 degrees) massive mechanical obstruction was observed at the uretero-pelvic junction (Figs. 9 and 10). The ureteric circulation was satisfactory and histologically only minimal infiltrates in the submucosa without signs of haemorrhage were found (Fig. 11).

Ureters which had been torted by 3 complete rotations led to total renal non-function secondary to proximal obstruction and ischaemic infarction of the ureteric wall. Even during the operation the ureter became oedematous and vascular congestion was apparent.

DISCUSSION

Based on the results of this study one can say that torsion of 360 to 720 degrees of the distal ureter in a pig does not influence the surgical results of a ureteric reimplantation. The limit appeared to be at 3 complete rotations as

interpreted by the appearance of low-grade obstruction on IVP. Only 4-fold torsion and more is unacceptable, reaffirming the old adage "the ureter is a very forgiving structure"

On the other hand we believe it necessary to caution against the assumption that because the human ureter is longer, it may tolerate more torsion since the angle of torsion per unit length would diminish. Our observation in vivo clearly shows that the bolus of urine effectively shortens the distance in the distal ureter over which the torsion is distributed. This compression of the torsion therefore negates any protection one might assume is gained with a longer ureter.

However, when anastomosis between proximal ureter and renal pelvis are concerned more attention must be paid to the axial torsion, as only 2-fold rotations (720 degrees) lead to mechanical obstruction.

Even though one should attempt to achieve an ideal axis of rotation of an implanted ureter it is reassuring to know that a rotation of 360 degrees is compatible with normal ureteric function.

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