

# The Hydrodynamic Consequences of Transuretero-Ureterostomia\*

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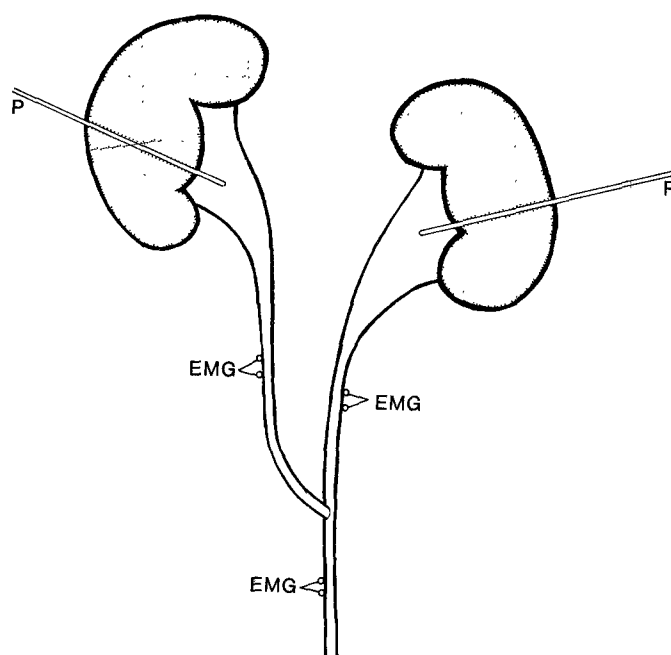
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**Summary.** A transuretero-ureterostomy was performed in 8 pigs. In 4 pigs a non-dilated urinary tract was seen and pressure and electromyographic recordings showed that the procedure did not affect the electromyographic impulses in the recipient ureter. Impulses from the donor ureter were not transmitted to the common distal ureter. Two pigs died postoperatively from urinary leakage and two pigs developed stasis.

**Key words:** Ureteral dynamics, Pelvic pressure, Transuretero-ureterostomy.

## Introduction

Transuretero-ureterostomy has been recommended as a successful procedure in reconstructive urological surgery [7]. The procedure was conceived in 1894 by Boari and Casati [1] and first performed in humans in 1934 by Higgins [6]. Hodges et al. [7] are credited for the first large series of successful results. The complication rate of the operation is reported as being low [7, 8] and the simplicity of the technique is one of its advantages in comparison to other reconstructive surgical procedures. Boyarsky et al [2] demonstrated in a dog study that impulses from one ureter could ascend in the other ureter the so-called yo-yo effect. In a clinical case by Djurhuus et al. [4] impulses in incomplete duplication were seen from both limbs to the common trunk but from the obstructed limb impulses were not always transmitted, a finding which could explain dilatation. The aim of this study is to examine the hydrodynamic consequences of anastomosing one ureter end-to-side to the contralateral ureter.



**Fig. 1.** Localization of copper electrodes for electromyographic recordings

## Material and Methods

Eight female pigs (weight 30–35 kg) were used in the experiment. Food and water was withheld 8–10 h prior to surgery. Ketamine was used as preanesthetic and Halothane 1–2% was the anesthetic used in a semiclosed system with the pigs on spontaneous respiration. Under aseptic conditions the pigs were opened in a midline incision and the ureters were exposed retroperitoneally. The right donor ureter was transected at the point of the linea terminalis and passed retroperitoneally across the vena cava and abdominal aorta (Fig. 1). Care was taken that no torsion took place. An oblique end to side anastomosis was made using atraumatic dexton 6-0 and continuous sutures. The distal part of the ureter on the right side was ligated, and after administration of 1 g of ampicillin retroperitoneally the operation was completed by a three layer abdominal closure. The pigs were treated with ampicillin 1 g daily for 8 days.

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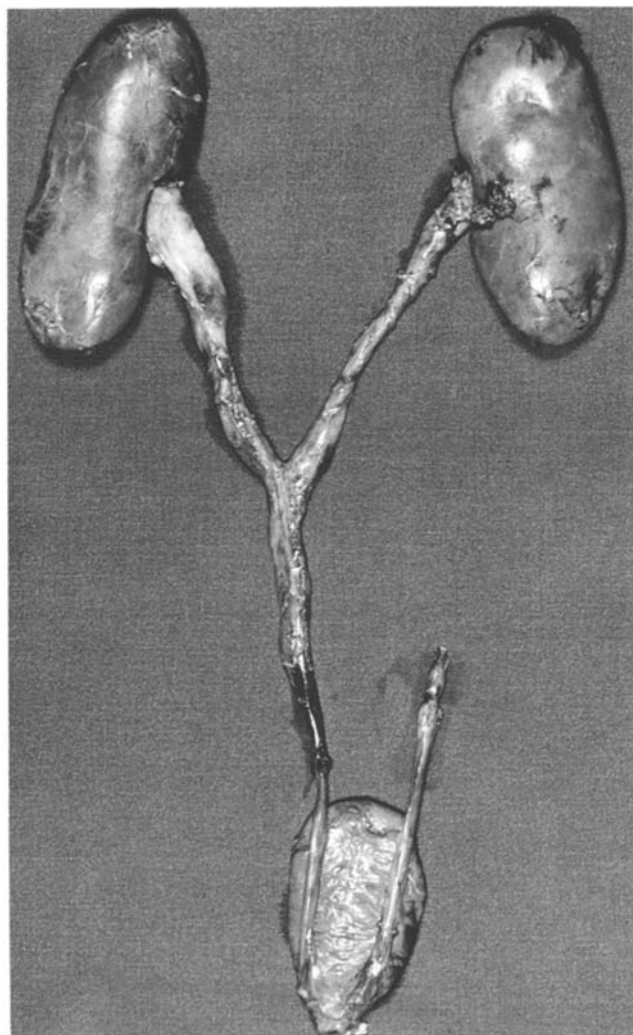


Fig. 2. Urinary tract dissected after procedure

Ten to fifteen weeks later the pigs were re-operated and the urinary tract inspected. The renal pelvis on both sides was punctured with an intravenous catheter through which the pelvic pressures were measured. Pairs of copper electrodes were placed approximately 10 cm distal to the renal pelvis on both sides and on the common distal ureter (Fig. 1). After optimal pressure and electromyographic tracings were obtained the recordings started with a con-

trol period of 10 min. The pigs were then given 500 cc of isotonic saline intravenously, followed by furosemide (0.5 mg/kg weight) and recordings under forced diuresis were obtained. Diuresis was measured during the basic period as well as following furosemide administration.

The pressures and EMG-signals were recorded on a Bryan UV-amplifier and recorder.

## Results

Two pigs were sacrificed due to leakage of the anastomosis on the sixth and seventh postoperative day. In two other pigs the donor side was found dilated caused by stenosis at the ureteral anastomosis. Four of the pigs had a normal gross morphology system bilaterally (Fig. 2). Only pigs with normal non-dilated systems were considered for the analysis.

Table 1 shows pressure and diuresis recordings during the study. The pelvic pressure was stable during the basic period (range 3–31 cm H<sub>2</sub>O). The increase in pelvic pressure during forced diuresis was 0–29 cm H<sub>2</sub>O, and pressures went back to basic pressure in all pigs. The diuresis during the basic period varied from 5–11 cc/10 min with a mean of 6.5 cc/10 min. The diuresis following furosemide administration was between 126 cc and 352 cc with a mean of 231.5 ss. The observation period during forced diuresis was from 20 to 25 min.

Not all the electromyographic impulses from the upper part of the recipient ureter were transmitted to the common trunk, but whenever an impulse was registered in the common trunk, it was always secondary to an impulse in the upper parts. No impulse was transmitted from the donor ureter to the common trunk and we found no evidence of retrograde impulse transmission of the recipient or donor's ureters (Fig. 3).

## Discussion

Transuretero-ureterostomy is claimed to be a procedure with a low complication rate. However, we only succeeded in 4 out 8 pigs with a satisfactory urinary tract without

Table 1. Pelvic pressures and diuresis

Pig no.	Basic			Forced diuresis		
	start rec/don.	end rec/don.	diuresis/ 10 min	start rec/don.	end rec/don.	diuresis
1	30/6	31/7	11 cc	31/8	39/37	200 ml cc
2	12/12	12/12	5 cc	12/12	15/15	350 ml cc
3	3/1	3/3	5 cc	3/2	3/5	126 ml cc
4	11/14	11/14	5 cc	11/14	18/30	250 ml cc
mean			6.5 cc			231.5 ml cc

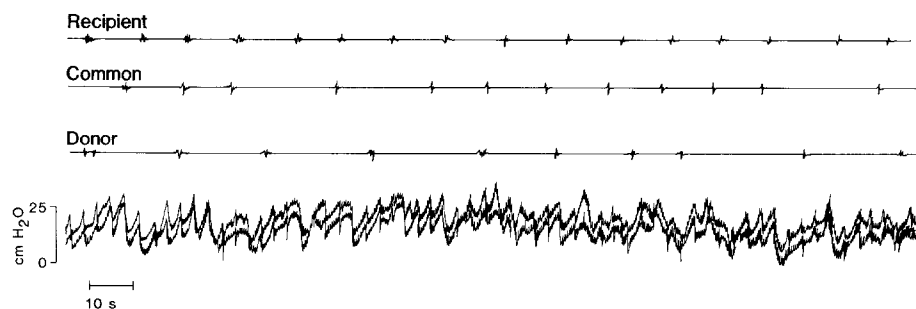


Fig. 3. Electromyographic recording

hydronephrosis postoperatively. As Boyarsky et al. [2], reported in their dog study, our complications consisted of leaking anastomosis and hydronephrosis. In animals it is difficult to use stents and drainage as recommended in humans. This may explain some of our complications. In humans Ehrlich and Skinner [5] reported on 5 cases of transuretero-ureterostomy in which damage to the recipient and/or donor ureter necessitated major reconstructive efforts. The risk of damaging a normal recipient ureter and kidney has been the major objection to the procedure [8], but Hodges et al. [7] found 97 normal recipient kidneys following the procedure in 100 patients over a period of 25 years. In a dog study [2] ureteral dyskinesia, to and fro peristalsis and retrograde peristalsis from one ureteral limb to the other was shown by cinefluorography and ureteral pressure recordings. In the present study we measured the pelvic pressure and not the ureteral pressure in order to avoid possible obstruction artefacts. The electromyographic recordings, however, showed that the peristaltic activity in the recipient ureter was unaffected by the transuretero-ureterostomy and that impulses from the donor ureter were not transmitted to the common distal ureter. A bolus of urine from the donor ureter was not able to initiate an electric impulse in the common distal ureter.

Retrograde impulses from one leg to the other were neither seen, but this finding does not indicate that reflux of urine does not take place. For activation of the ureter two factors are necessary, first distension of the ureter by urine, and second a propagating action potential.

Distension without a propagating signal may only lead to coordinated transport if the triggering level of the ureter is lowered [3]. The common trunk was subjected to normal transport, and triggering from the intact system. Coordinated bolus transport from the donor system did not lead to peristalsis on the common trunk. Transmission of an action potential from the donorsystem to the recipient system was not possible for two reasons, first no action potential transversed an anastomosis and second an electrical triggering must be sustained by distension and thereby lowering of the membranepotential if decrement is not to occur.

The study therefore points at a possible long-term adverse effect to the donor ureter due to slight flow hindrance as demonstrated.

## Conclusion

Transuretero-ureterostomy is an easy procedure in reconstructive urologic surgery, which does not affect the transmission of electromyographic impulses in the recipient ureter. Impulses are, however, not transmitted from the donor ureter to the common distal ureter.

In incomplete ureteral duplication in the human it was previously demonstrated that antegrade transport is present in both limbs but that a relatively obstructed limb may be the consequence of hindered transmission of peristaltic activity to the common trunk. Since we in the present study found no evidence of peristaltic transmission to the recipient ureter one may speculate a possible source of obstruction to the donor system although this was not evident in gross anatomical terms in this study.

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