

# Splintless Microsurgical Anastomosis of the Ureter in the Dog

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**Summary.** In an experimental study in dogs, four different techniques of microsurgical anastomosis using Vicryl 8-0, have been compared: 1. Interrupted submucosal sutures; 2. Continuous submucosal sutures; 3. Full thickness interrupted sutures; 4. Full thickness continuous sutures.

Intravenous urography and electron microscopic studies three months post operatively showed that ureteric stricture had occurred in only 2 cases out of 24.

Microsurgical techniques are recommended for ureteric anastomoses.

**Key words:** Ureter, Anastomosis, Microsurgery.

## INTRODUCTION

One method of ureteric anastomosis currently used in humans is an end-to-end anastomosis carried out using the naked eye and a spatulated elliptical anastomosis with a submucosal or all layer suture with 4-0 or 5-0 chromic catgut (1, 2, 3, 4, 5).

The failure rate with this technique of anastomosis is high when a watertight suture is not achieved. Extravasation of urine in the area of anastomosis leads to periureteric inflammation and stricture. In 1971 Carlton et al. (6) reported a failure rate of 54% in cases of non-watertight splinted anastomosis of the ureter after injury. In addition, in 1977 Bright et al. (7) reported 11 unsatisfactory results with splinted ureteric anastomoses out of 59 cases of traumatic lesions of the ureter.

\*Contained in the publication are sections from Wolfgang Kramer's dissertation, which is currently in preparation

In 1962 Kosse et al. (8) reported excellent results in animal experiments using microsurgical suture methods: in 15 out of 18 dogs with extramucosal splintless watertight interrupted sutures (7-0 silk or 6-0 atraumatic chromic catgut) satisfactory anastomosis was detectable in the i. v. urogram after 3 months. The poor microsurgical results of Ibay 1963 (9) in the dog (6 strictures, 9 successful results out of 15 cases of ureteric anastomosis) appear to conflict with this, but can be explained, however, by the use of a two-layer suture technique (7-0 silk, 5-0 chrome catgut or catgut) which was too thick, with the aim of obtaining a watertight anastomosis. Gil Vernet (10) in 1979 also recommended a microsurgical continuous extramucosal suture in repair of the human ureter.

The aim of this study was to develop a microsurgical operative procedure which might lead to an improvement in end-to-end anastomosis of the ureter, especially for small ureters in infants.

## MATERIAL AND METHODS

Twenty four mongrel bitches (average body weight 17 kg) were studied under Halothane inhalation narcosis (Table 1):

After preparation under the operating microscope<sup>1</sup>, with 16-25 times magnification, an approximator was fitted at the passage from the abdominal to the pelvic third of the right ureter and the ureter severed transversely, the lumen of the ureter being calibrated in increasing steps with ureteric catheters. Afterwards the stumps of the ureter were microsurgically anastomosed at the approximator, free of tension and watertight,

<sup>1</sup> Operating microscope 1-H, Zeiss, Oberkochen, FRG

Table 1. Material and methods

| Group | Number of bitches | Average body weight (kg) | Average ureter diameter (charr) | Microsurgical anastomosis technique |
|-------|-------------------|--------------------------|---------------------------------|-------------------------------------|
| 1     | 6                 | 15                       | 4.8                             | Submucosal interrupted suture       |
| 2     | 6                 | 20                       | 6.3                             | Submucosal continuous suture        |
| 3     | 6                 | 15.1                     | 5.6                             | All layer interrupted suture        |
| 4     | 6                 | 19.3                     | 6.6                             | All layer continuous suture         |

using 4 different suture techniques without splints (Fig. 1).

Group 1 (6 bitches): submucosal interrupted sutures.

Group 2 (6 bitches): submucosal continuous suture.

In both methods the adventitia and muscularis, but not the epithelial layer of the ureter were included in the suture.

Group 3 (6 bitches): All layer interrupted suture.

Group 4 (6 bitches): All layer continuous suture.

In both methods the whole thickness of the ureteric wall, including the urothelium was included in the suture. The suture interval with all 4 operative techniques was approx. 1 mm. With the interrupted suture technique 8-9 sutures were made. Synthetic reabsorbable Vicryl<sup>®</sup><sup>2</sup> was used as the suture material, (Polyglactin 910) thread strength 8-0, with an atraumatic micro-point spatula needle. During the operation, urine from the bladder was extracted via a sterile cannula for microscopic and bacteriological investigation.

On the first post-operative day all dogs received a single dose of oxytetracycline (250 mg) subcutaneously in the wound area, as well as Penicillin G (10 000 IU/kg body weight) intragluteally from the first to fourth post-operative days. The threads were removed between post-operative days 10 and 12.

After 81-97 days the result of the operations was studied by:

#### 1. I. V. Urogram

Under Nembutal (pentobarbitone sodium 25 mg/kg body weight i. v.) narcosis an i. v. urogram was carried out and films taken 6 min and 12 min after intravenous injection of 30 ml Conray 60<sup>3</sup> (megluminio-talamate).

The results were classified according to a scheme which relates to the individual X-ray results in the i. v. urogram.

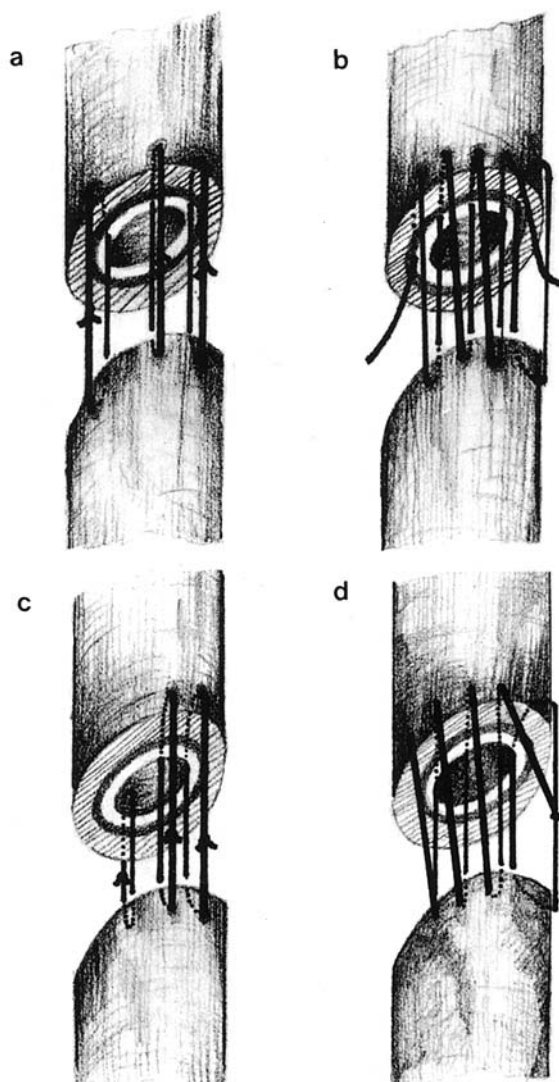


Fig. 1a-d. Microsurgical suture techniques. a Submucosal interrupted suture. b Submucosal continuous suture. c All layer interrupted suture. d All layer continuous suture

<sup>2</sup> Ethicon, Somerville, New Jersey, USA

<sup>3</sup> Byk Gulden Lomberg Chemische Fabrik GmbH, Konstanz, FRG

Table 2. Results of microsurgical anastomosis techniques in the ureter

| Group | Average diameter of ureter (charr) | Microsurgical suture technique | No. of sutures per anastomosis (suture interval 1 mm) | Urine culture |             | Radiological classification |          |            |
|-------|------------------------------------|--------------------------------|---|---------------|-------------|-----------------------------|----------|------------|
|       |                                    |                                |   | pre-op.       | post-op.    | Grade I                     | Grade II | Grade III  |
| 1     | 4.8                                | interrupted suture submucosa   | 7 - 11  | all sterile   | all sterile | 2                           | 4        | -          |
| 2     | 6.3                                | continuous suture submucosa    | -   | all sterile   | all sterile | 1                           | 3        | 2          |
| 3     | 5.6                                | interrupted suture all layer   | 8   | all sterile   | all sterile | 2 <sup>a</sup>              | 3        | -          |
| 4     | 6.6                                | continuous suture all layer    | -   | all sterile   | all sterile | 5                           | 1        | -          |
| Total |                                    |                                |   |               |             | 10                          | 11       | 2          |
|       |                                    |                                |   |               |             | 21 successes                |          | 2 failures |

<sup>a</sup>1 dog died before the i. v. urogram

## 2. Bacteriological and Microscopic Investigation of the Urine from the Bladder

After sacrifice of the animals by an overdose of Nembutal® the bladder was punctured under sterile conditions at the beginning of the post-mortem, and the result of the urine investigation compared with the initial findings (Table 2).

## 3. Macroscopic Examination of the Segment of Ureteric Anastomosis

Special attention was paid to the condition of the anastomosis (possible periureteric concrecence, hour glass phenomena, kinking phenomena) as well as possible signs of obstruction of the ureter operated on, and the renal pelvis on the side not operated on.

## 4. Photo- and Scanning Electron Microscopic Studies of the Zone of Anastomosis

The segment of ureter having undergone anastomosis was removed and fixed in a perfusion solution, according to Sotelo (11), for 6-8 h. After fixing, the sections of ureter were washed for 3-4 h in 0.24 M phosphate buffer pH 7.4, dehydrated by means of an alcohol series in ten steps from 10% - 70% each for 60 min, and bisected longitudinally.

One half was prepared for photomicroscopic study dehydrated via the alcohol series to absolute alcohol, mounted in Araldite, 4 µm thick and "Trichrome Goldner" stained serial longitudinal sections. The microscopic preparations were then magnified x 20 - 100.

The second half of the ureter was longitudinally bisected a second time for scanning electron microscopic study. One half was used for examination of the luminal structure of the anastomosis and the other part was accurately divided in the direction of elevation and development of the anastomosis, in order to localise the suture in the wall of the ureter. In addition, the preparations obtained from the second half were dehydrated with a continuation of the alcohol series to absolute alcohol, and then the alcohol substituted in an ethanolamyl acetate series in 10 steps from 10% to absolute amyl acetate, each time for 60 min. The preparations, dried according to the method of "critical drying" (12, 13, 14, 15), were treated with gold and examined using a Stereoscan 150 S<sup>4</sup> scanning electron microscope.

## RESULTS

The post-operative course of events up to the sacrifice of the animals was normal.

### 1. I. V. Urogram

Good results were obtained in 21 out of 23 dogs (Table 2). Only in 2 of the 23 dogs was a stricture of the ureter with clear signs of obstruction close to the anastomosis in the ureter and renal pelvis detectable. One dog died under Nembutal narcosis before the final i. v. urogram. In view of these findings, a radiological classification was made (Fig. 2).

<sup>4</sup>Cambridge, Cambridge, UK

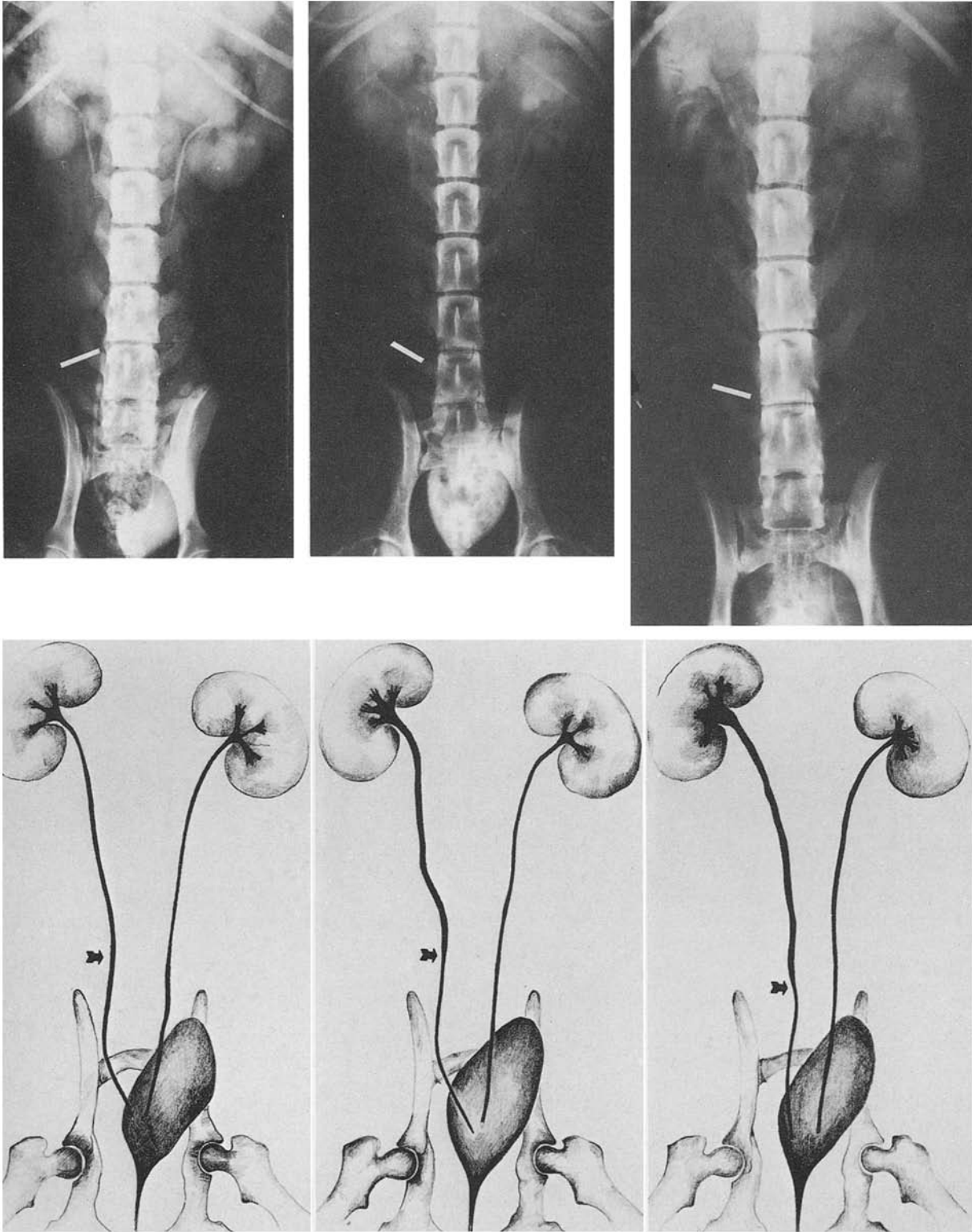


Fig. 2. Radiological classification of the operation results. (Arrow indicates site of anastomosis.)  
Grade I: Extensive anastomosis, ideal operation result. Grade II: Minimally distended ureter and kidney pelvis. Grade III: Distended ureter and kidney pelvis, obstruction

## 2. Bacteriological Studies (Table 2)

All dogs remained bacteriologically sterile pre- and post-operatively.

## 3. Macroscopic Studies

In 22 out of 24 animals including the dog which died before the intravenous urogram, the anastomosis had healed with no evidence of inflammation. No difference could be detected by naked eye between the upper ureter and renal pelvis

on the left non-operated side when compared to the right, operated ureter. In the 2 cases in which an ureteric stricture occurred, periureteric fibrosis in the area of anastomosis was evident with signs of obstruction in the ureter and renal pelvis above.

## 4. Photo Microscopic Studies

The wide zone of anastomosis showed regular alignment of all layers of the ureteric wall. The musculature was partly constricted in the area

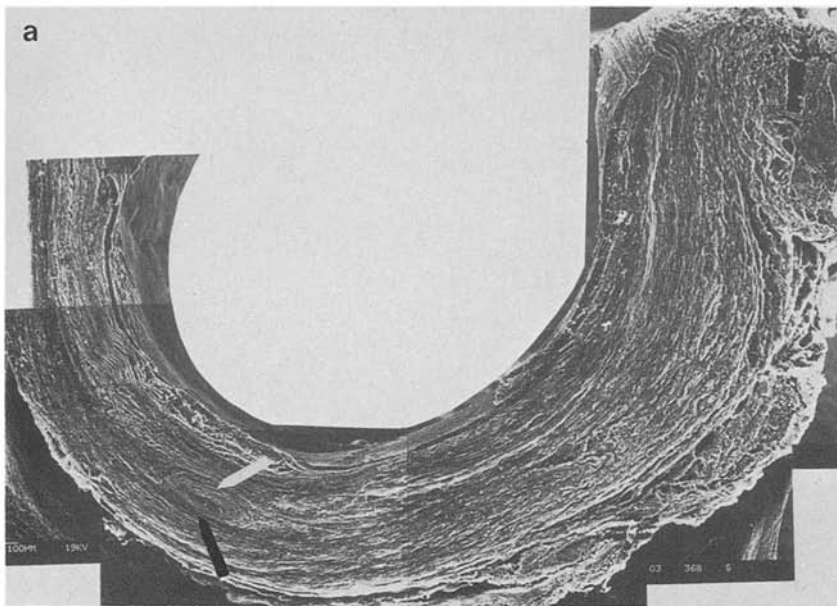


Fig. 3a. Submucosal interrupted suture of the ureter, 3 months after anastomosis; scanning electron microscopical panorama picture of anastomosis in transverse section (x 70). Arrow: Submucous tissue granuloma

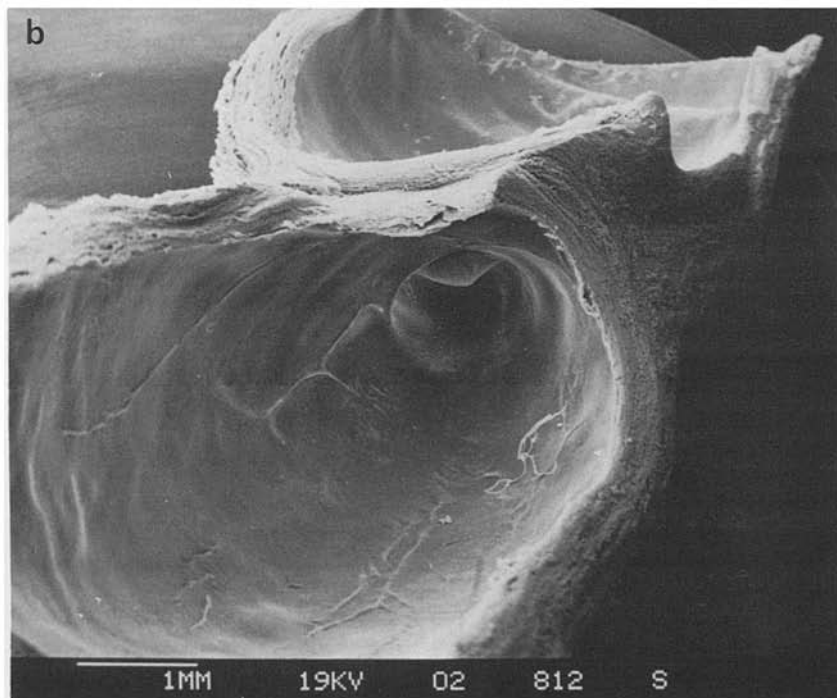


Fig. 3b. Submucosal continuous suture of the ureter, 3 months after anastomosis; anastomosis stricture (x 15)

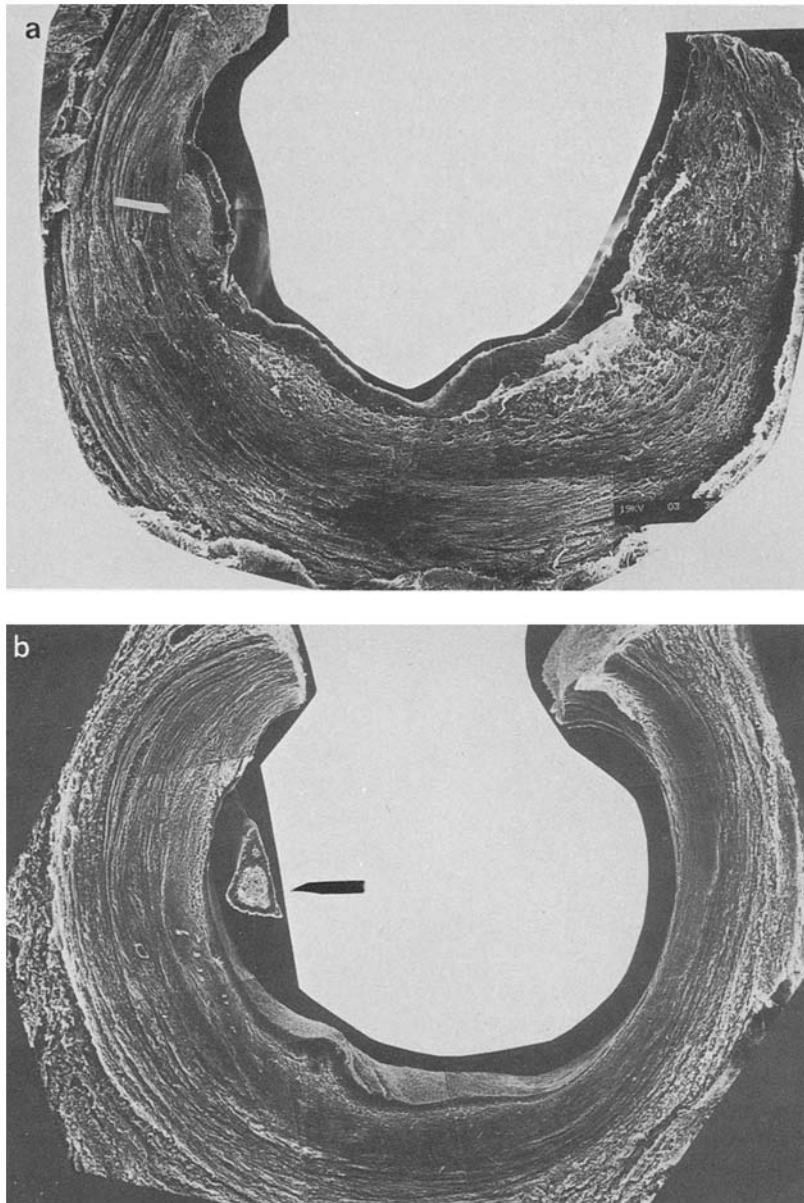


Fig. 4a-c. All layer continuous suture of the ureter, 3 months after anastomosis; a Scanning electron microscopic panorama picture of the anastomosis in transverse section (x 70). Arrow: Submucous tissue granuloma. b Scanning electron microscopic panorama picture in transverse section (x 81). Arrow: Intraluminally situated threads. c Clear constricted sections of the urothelium (x 37)

of anastomosis and was scarred in parts. Urothelium and submucosa were not appreciably scarred. The original suture position could only be located by small fibre granulomas.

##### 5. Scanning Electron Microscopic (SEM) Studies

In all groups reabsorption of the suture material at the site of anastomosis occurred and in 22 out of 24 ureters studied granulation tissue (Fig. 3a) was evident. All intraluminal threads, whether from interrupted or continuous sutures, were covered with epithelium at three months (Fig. 4a). Threads which extended further into the lumen were reabsorbed after this time and replaced by granulation tissue and surrounded by epithelium

on all sides (Fig. 4b). Both with the submucosal and/or all layer continuous suture constricted sections were occasionally seen (Fig. 4c) in which the urothelium was heaped up. The SEM studies in the 2 cases in which strictures of the ureter had occurred showed considerable narrowing of the lumen as a consequence of poor alignment of the ends of the ureter (Fig. 5).

##### DISCUSSION

Our results show that unsplinted microsurgical ureteric anastomoses are successful and in this study lead to good results in 22 out of 24 cases whichever of the four methods of suture was employed. By ensuring that the edges of the ureters

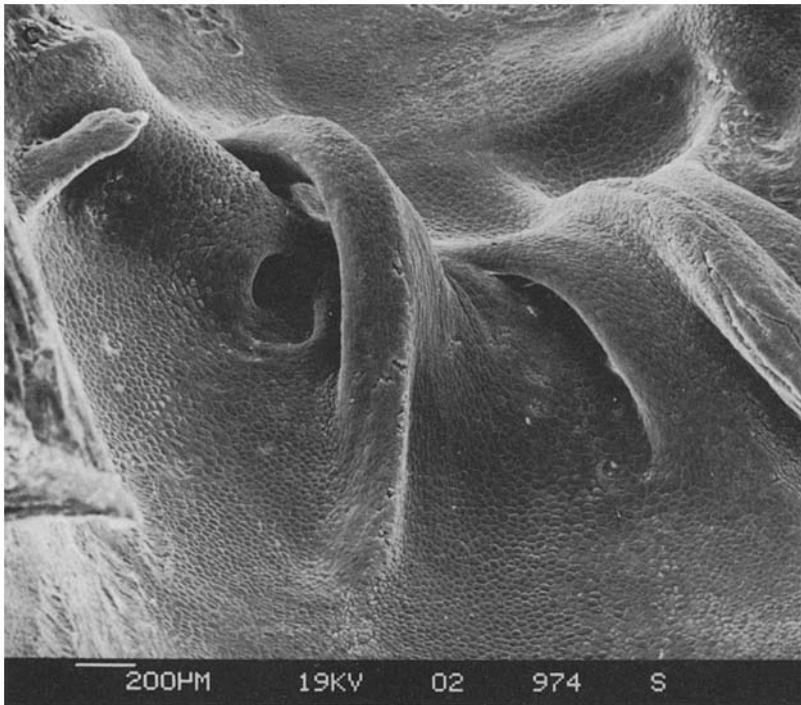


Fig. 4c

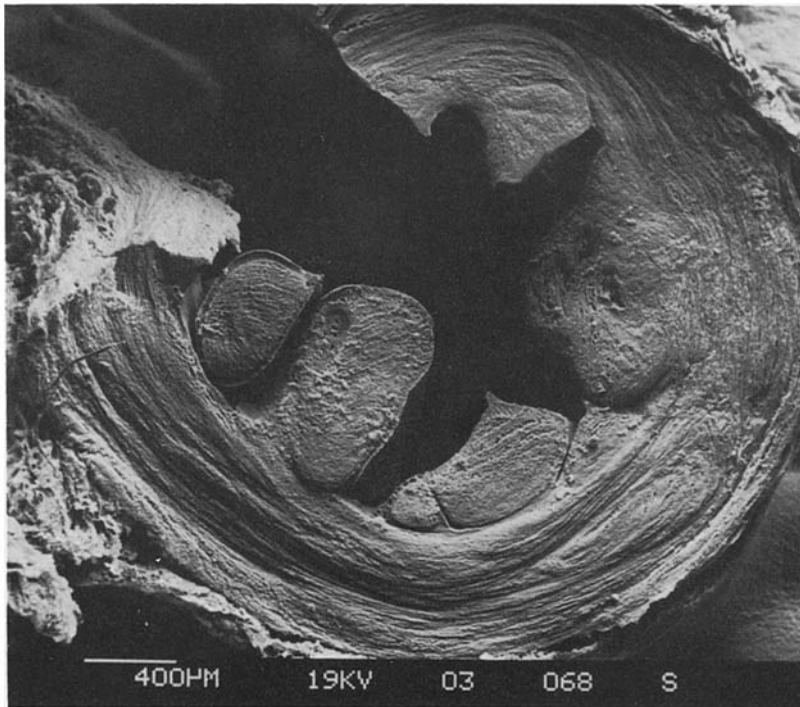


Fig. 5. All layer continuous suture of the ureter 3 months after anastomosis; coulisse-shaped narrowing of the lumen (x 29)

are closely applied to one another and that the suture interval is small, a watertight seal can be achieved which obviates the need for post-operative splinting. Periureteritis with subsequent stricture of the anastomosis is largely avoided. However, continuous submucosal or all layer suture can give rise to stricture of the lumen if the threads are pulled too firmly (Fig.

3b). The two failures observed were due to poor adaptation of the edges of the wound.

The Vicryl proved itself to be satisfactory in terms of thread quality, manipulation, knot firmness and reabsorption (16, 17, 18). Encrustations were not observed even on intraluminal threads which became epithelialised by 3 months (Fig. 6).



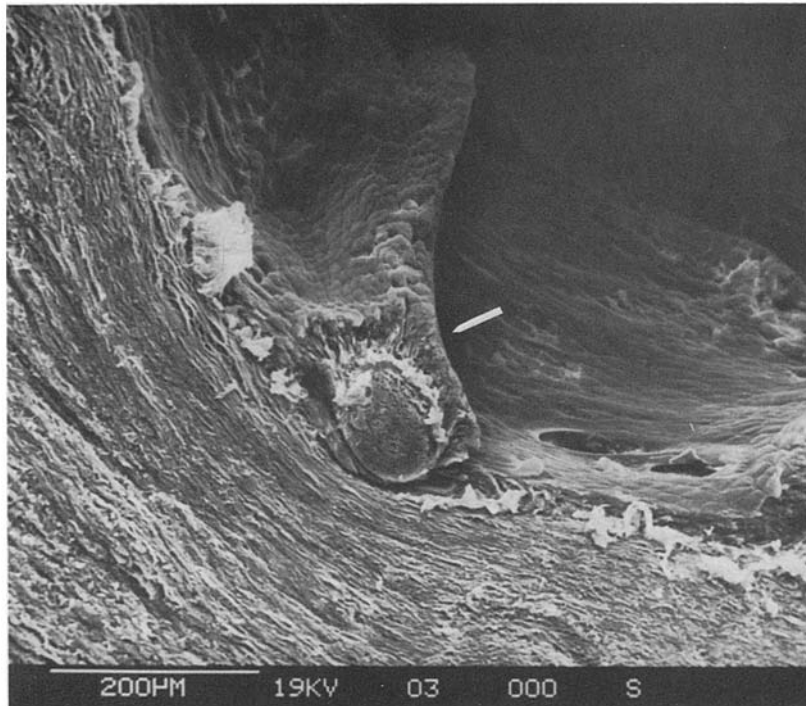


Fig. 6. All layer interrupted suture of the ureter, 3 months after anastomosis, epithelisation of the intraluminally situated threads (x 450)

The ureteric lumen in this study was 5.8 Ch. and corresponds approximately to the size of the ureter in children between the ages of 0 and 12 years (19). We suggest that microsurgical operative techniques described here for splintless ureteric anastomoses are suitable for clinical use and strongly indicated in small children.

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