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Autologous everted vein graft for repairing long-section urethral defects

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Summary. In 21 male dogs a 4- to 10-cm sections of the urethra was replaced by an autologous vein graft. After an observation period of 21–380 days (mean 118), the results of radiological, endoscopic, macroscopic and histological examination were evaluated for 19 animals; 2 of the animals died perioperatively. Micturition was normal in 18 of 19 animals until they were killed. One animal died on the 30th day due to a high-grade meatal stenosis with a subsequent episode of urine retention and ascending urinary infection. Gross examination of the graft in this animal, however, revealed a good result. The local surrounding tissue was found to be ideal in 11 animals, and 5 showed satisfactory results. Three times we observed a pronounced stenosis, so that in these cases results were judged to be unsatisfactory. Postmortem examinations showed the neo-urethra to be a tube made up of connective tissue completely lined by urothelium. In our opinion the results of these animal experiments could at least be equalled in clinical application.

Key words: Urethra – Autologous graft – Jugular vein – Animal experiment

A number of surgical techniques designed to repair long-section urethral defects have been described. For one-stage repair, free or pedicled skin grafts are usually used [1–4, 8, 18, 26, 27]; two-stage urethroplasties [10, 22, 24, 25, 28] are usually performed in complicated cases in which there have been several preliminary surgical interventions. Although the methods described above yield good results when performed by skilled hands, there is still a need for simpler methods of repairing urethral defects. In the course of this search homologous, autologous as well as alloplastic materials were tried out (M. Bressel, personal communication; A. Hashmat, personal communication; [5–7, 9, 11–17, 19–21, 23]). In a series of animal experiments we tested whether an autologous everted venous graft could successfully be applied in urethral surgery.

Material and method

The animal experiment was conducted with 21 mongrel dogs, average weight 19 kg. Part of the external jugular vein was used for the graft. The urethra was exposed proximal to the penile bone, followed by excision of a section measuring 4–10 cm. At the same time the jugular vein was explored and a part cut out that exceeded the artificially induced urethral defect by 20%. Since the vascular endothelium necrotizes without blood supply, we everted the veins. Thus the endothelium remains intact for some time, maintaining its borderline function and the newly developed urethral epithelium grows into the adventitia of the vein.

Following eversion, the graft was anastomosed end to end to the urethral stumps with inverting 5/0 Dexon interrupted button sutures over a transurethral catheter. In 10 consecutive cases fibrin tissue adhesive was used in order to ensure early onset of water tightness.

The transurethral catheter was fixed to the glans penis with a silk suture and cut off in close proximity. The procedure was terminated by slipping the prepuce over glans and catheter. The transurethral catheter was left in place for a period of between 5 and 7 days. The animals received 30 mg gentamicin twice a day from the time of operation until removal of the catheter.

After an observation period of 21–380 days (means 118 days), the result was documented and evaluated by radiological, endoscopic as well as gross and histological examinations.

Results

Two animals were lost due to perioperative complications and were not included in our evaluations. Micturition was normal in 18 of 19 animals until they were killed (Table 1). One animal died on the 30th day due to a high-grade meatal stenosis with a subsequent episode of urine retention and ascending urinary infection. However, gross examination of the graft site revealed a good result. Other late complications can be seen in Table 1.

Good results

An ideal local situation was found in 11 of 19 animals (including the case mentioned above). The urethrogram showed no caliber changes whatsoever on the graft

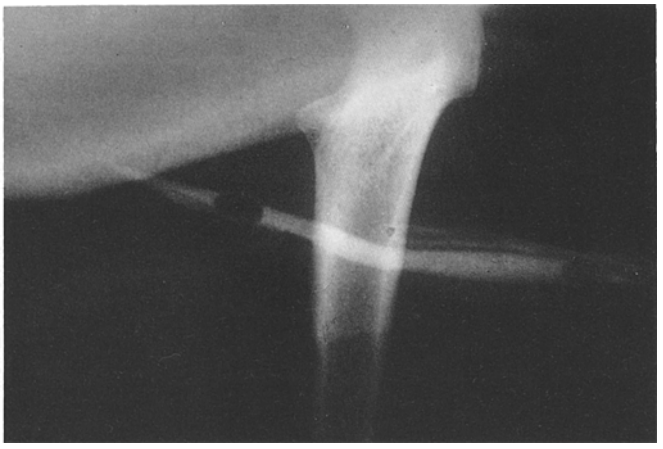

Fig. 1. Urethrogram shows neo-urethra between air bubble at penile bone (6 months after operation)

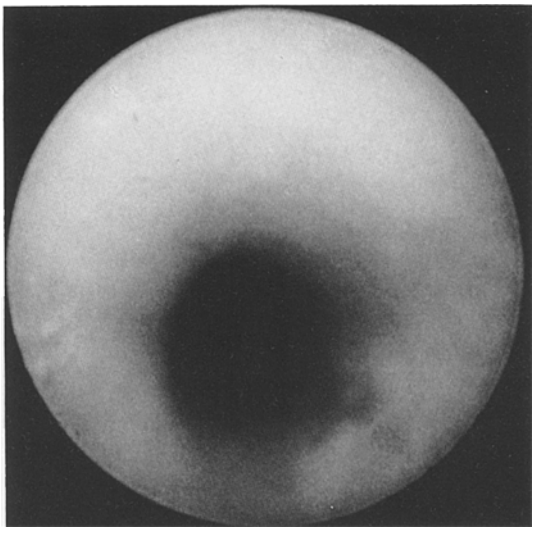

Fig. 2. Endoscopic view into a neo-urethra (6 months after operation)

Table 1. Complications

	n
Perioperative complications	
Hemorrhage at the site of graft removal	1
Pneumonia	1
Impaired wound healing	2
Late complications	
Meatal stenosis	3
Pneumonia	1
Fistula (accompanied by meatal stenosis	1

(Fig. 1). Endoscopically, the neo-urethra could only be distinguished by the somewhat reduced wall elasticity in the region of the graft. Lumen and epithelium were noncontributory (Fig. 2). Under gross examination the neo-urethra appeared to be a tube made up of connective tissue with a stable caliber; the tube was lined by a nonspecific epithelium (Fig. 3). Histological examination revealed a normal urethral epithelium in all cases; however, there were considerable plications in the area of the neo-urethra (Fig. 4).

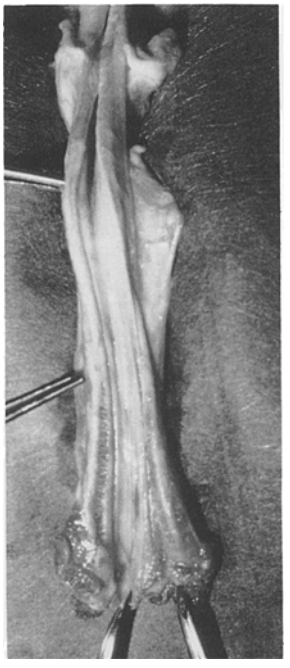

Fig. 3. Neo-urethra 13 months after operation

Satisfactory results

Results were satisfactory in 5 of 19 animals. In 1 case a large diverticulum had formed at the proximal anastomosis, but micturition went on undisturbed. In another animal the urethrogram revealed a fistula at the proximal anastomosis, and meatal stenosis was also diagnosed in this dog. Three of the six strictures found were of

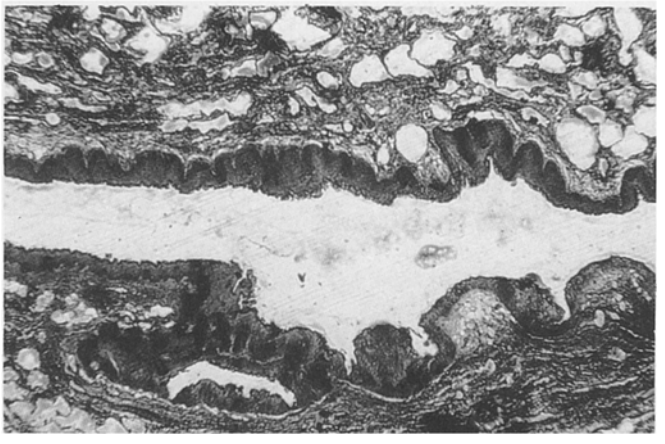

Fig. 4. Border between normal urethra and neo-urethra (6 months after operation)

Fig. 5. Short stenosis at the proximal anastomosis

moderate degree (Fig. 5). Clinically, these could easily be treated by internal urethrotomy, so the cases were therefore judged to be satisfactory.

Unsatisfactory results

In 3 of 19 animals we observed a pronounced stenosis. Two of these 3 animals had been operated on at the start of our experimental series, and so it is likely that faulty technique caused this failure. The third case was uneventful both during and after the operation, and we are therefore unable to offer any explanation for the stenosis.

Discussion

Of all the materials that have been used for urethral replacement, alloplastic grafts have proved to be least useful in clinical application; only in the rarest of cases did epithelial tissue develop above the graft [11, 14, 19, 21]. Millroy has recently reported promising results using a new method: A coil made of a special metal alloy is inserted into the urethra, guided by an endoscope [6]. It still remains to be seen whether expectations will be justified in the long run.

From the group of homologous materials, lyophilized umbilical cord, dura and veins have generally been preferred [9, 12, 17]. Although results published so far have been promising, periods of observation do not exceed 1 year.

Apart from autologous materials such as skin, prepuce and meshgraft specimen, the mucosa of the bladder has also been described favorably (A. Hashmat, personal communication; [13, 15]). Results are altogether positive, particularly in cases of hypospadias. However, the relative complexity of this technique has to be taken into consideration.

The tunica vaginalis seems to be suitable for use as a patch in urethral repair [5]; however, as far as we know, pedicled tubularized tunica vaginalis grafts have only been used successfully in animal experiments (M. Bressel, personal communication).

The idea of using blood vessels for autologous urethral repair seems logical. Frang tested veins and Hashmat arteries, both in animal experiments. While Frang was able to achieve relatively good results on dogs, Hashmat reports on a series of tests with dogs using arterial grafts, observing late stenoses in all cases a year after surgery [20, 21]. Bressel used vein patches for urethral repair in humans but also described late stenoses. All patients had to be reoperated (M. Bressel, personal communication).

In our opinion an ideal graft should fulfil three criteria: (1) It has to be easily available; (2) epithelialization has to be guaranteed; and (3) until epithelialization sets in, watertight separation between lumen and periurethral tissue has to be maintained as long as possible in order to prevent passage of urine into the surrounding tissue; such penetration may later induce the risk of shrinkage.

Theoretically, the use of an everted vein plus a fibrin tissue adhesive as adjuvant ought to eliminate these risks. The vascular endothelium facing the neo-urethral lumen becomes necrotic within a short period of time, this being a possible explanation for Bressel's unsatisfactory clinical results with vein patches. However, by eversion of the endothelium the blood supply from the surrounding tissues is maintained by diffusion. There is histological evidence of the vascular endothelium up to 3 weeks postoperatively. Thus, the borderline function is preserved in the decisive period. In addition, the fibrin tissue adhesive guarantees rapid onset of water tightness at the site of the anastomosis.

In the technique we are using, the everted vein merely serves as a matrix for the neo-urethra. The latter is a tube made up of connective tissue which is completely lined by urothelium. Despite our own very critical assessment, we believe this method to be promising, both from a theoretical and practical point of view. In clinical application the saphenous vein would be suitable; it is easily available, but the diameter of the lumen might be too small, especially in younger patients. Ultrasound examination before the intervention is therefore essential.

As a rule transition from experimental to clinical application of a method is somewhat promlematic. However, we believe that in this particular case – due to the better postoperative care and treatment available to patients – the success rate of the animal experiments could at least be equalled.

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