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Urethral Replacement with Autologous Venous Graft: An Experimental Study in the Dog

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Summary. This study investigated the experimental replacement of the urethra with autologous vein grafts. A free transplant of external jugular vein segments were used to replace a resected urethral segment in dogs. We suggest that replacement of the urethra with autologous graft could be applicable in the reconstructive surgery of the urethra.

Key words: Experimental, Urethra, Autologous vein transplantation.

Introduction

The treatment of urethral stricture is one of the oldest problem in urological surgery and one which has not yet been solved. Dilatation or internal urethrotomy have been the commonest methods of treatment for several years.

Urethral surgery was developed by Denis Browne [3], who introduced the method of replacement of the damaged section of urethra with an epithelial tube from the skin of penis. The method elaborated for hypospadias has been used by Johanson [6] for the treatment of strictures; this method has been further developed by Gil-Vernet [5] and Turner Warwick [11].

The method most applicable in clinical practice to the posterior part of the urethra has become generally accpeted as a consequence of the work of Michalowski's and Modelski's [7, 8] and others [1, 4, 9]. The disadvantages of these methods is that they can be performed only in two stages. Timofejevich [10] suggested urethral homotransplantation. Brannan [2] has reported the experiences of autotransplantation of tube-shaped preputium.

Searching for a simpler method we have performed experiments for the replacement of the damaged urethra with autologous vein graft.

Method

We have performed studies on ten male dogs, disregarding their age and weight. During the preliminary experiments we removed a 3–4 cm section of the long saphenous vein and placed it in physiological saline solution at body temperature. Following this the urethra behind the pubis was explored and a 3 cm length was resected. A polyethylene catheter was then inserted into the urethra, and when it became visible at the distal end of the resected part of the urethra the everted piece of vein was pulled on to it to replace the resected urethral segment. The catheter was then inserted into the proximal part of the urethra for 4–5 cm. The vein was then fixed into the place of the resected urethra both at the distal and the proximal ends with sutures of Dexon 0000 (Fig. 1).

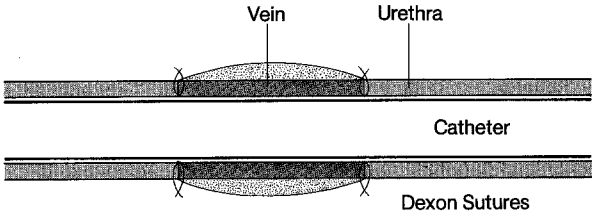

Fig. 1. Basic pattern for grafting the venous segment replacing the urethra

The diameter of the saphenous vein corresponded to that of urethra. The vein grafts were a little longer than the resected segment of the urethra, but despite this tension occured following the fixation. To avoid this tension, we subsequently implanted segments of the same length of the external jugular vein. In these cases, the diameter of the implanted vein segment was larger than that of the urethra, i.e., a positive disproportion developed. This procedure made a tension free fixation possible. By means of sutures we elevated first the distal then the proximal ends for fixation with a small amount of Histoacryl-N-blau (Melsungen) tissue glue. The site of operation was then closed. The polyethylene catheter was removed 4–5 days later. The animals were not treated postoperatively. Urethrography was performed with a Uromiro. Macroscopic observations were followed by microscopical ones, which were based on slides stained with haematoxilin-eosin, elastica Van-Gieson, Masson-Goldner.

Results

Our preliminary experiments demonstrated that saphenous segments were not suitable for substitution although the

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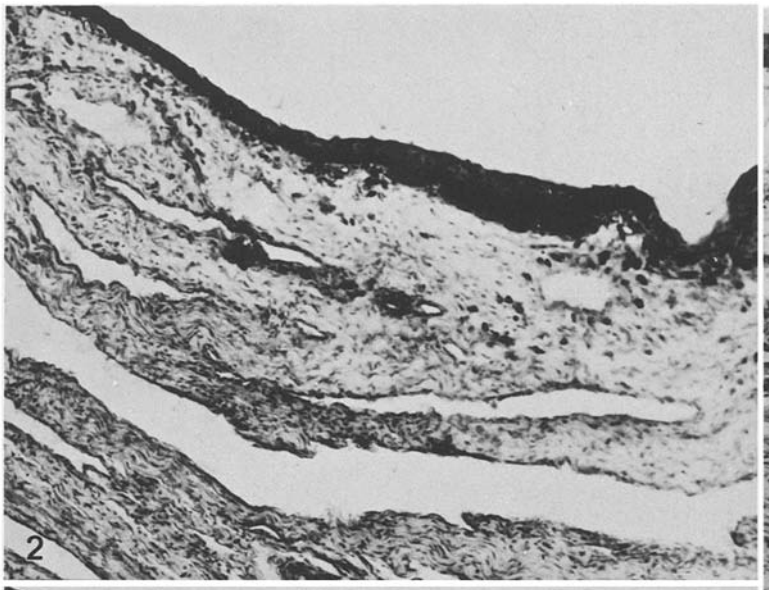

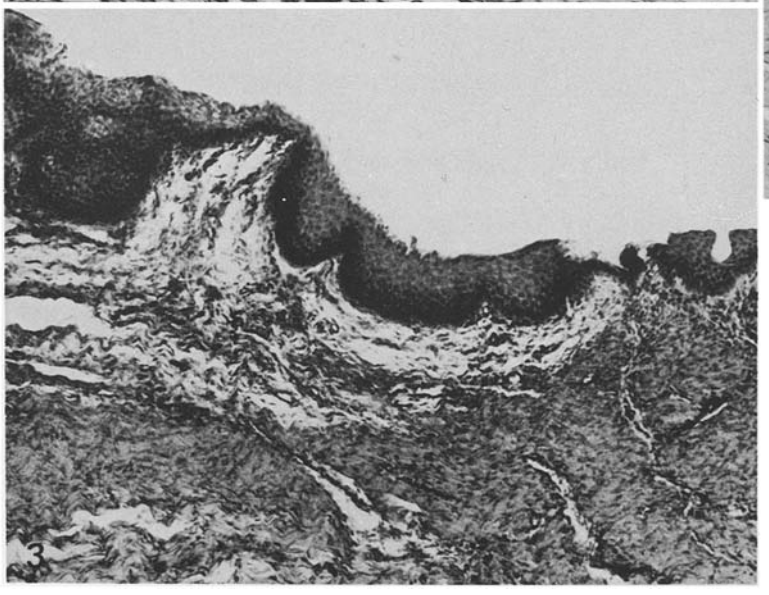

Fig. 2. Section of urethra-vein borderline after 73 days. Hematoxilineosin, x103

Fig. 3. Ureoepithelial-lined surface and conncetive tissue after 180 days. Masson-Goldner, x18.9

Fig. 4. The transformed vein covered by uro-epithelium after 316 days. Van-Giesson

grafts were nearly of the same length and diameter. At the fixation the tension became so great that all grafts failed. We gave up this method and used only everted external jugular vein grafts. Our results refer to these series of experiments. The excised urethral segment was substituted with an autologous graft of everted external jugular vein in ten cases. In two cases marked stenosis developed with a minimal lumen. One of the animals was killed on the 88th, and the other on the 240th day.

No fistula or graft rejection occurred. A polyethylene catheter was used as a splint, because the Histoacryl-N-blau prevented polymerisation on its surface. A catheter of the correct diameter ensured that no glue, even if used in a minimal amount, could penetrate into the lumen.

A tube-like formation consisting of connective tissue developed after a while, the inner surface of which was uneven and covered with transitional epithelium. In Fig. 2 the histological picture of the anastomosis, stained with haematoxilineosin (x 103) is shown. No evidence of the vein could be discerned. This experimental animal was alive for 73 days. In Fig. 3 a section after fixation and staining with Masson-Goldner is shown. In the place of venous structures, fibres of connective tissue could be observed clearly; its surface was uneven but was covered with urothelium. This animal was killed on the 180th day. In Fig. 4 the histological picture of an animal which was killed on the 316th day is shown. The transformation of the venous structure can be observed clearly; it is covered with urothelium. This section was stained with Van-Gieson.

Urethrography showed that, except in the two cases mentioned above, the lumina were 4 mm in diameter and the outlines were uneven. Figure 5 shows the urethrogram of an animal which was killed on the 315th day. The first table shows the number of days of survival, the lumen size of the urethra, and the time of sacrifice; no animal was lost before sacrifice.

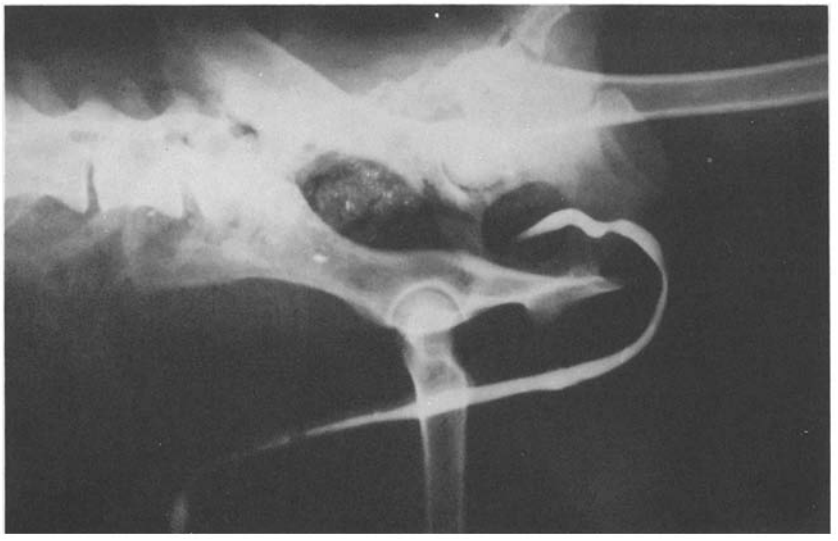

Fig. 5. Urethrogram after 316 days. *Arrows* showing the transplanted vein segment

Table 1.

Serial No. of operation	Days of survival	Lumen Patency	Cause of death	Remarks
501	60	yes	killed	–
502	73	yes	killed	–
503	–	yes	–	alive
504	316	yes	killed	–
505	88	minimal	killed	marked stenosis
506	180	yes	killed	–
507	270	yes	killed	–
508	240	minimal	killed	marked stenosis
509	120	yes	killed	–
510	90	yes	killed	–

Discussion

These preliminary experiments show that a longer graft of identical diameter is not suitable for the replacement of the urethra because of the narrowing of the graft.

In the course of the experiment an everted jugular vein segment, a little wider than the urethra, 4–5 cm in length, was implanted in the place of the resected urethra which was 3 cm long. The grafts were not rejected. Fistulas did not develop. In most cases the transplanted grafts, in spite of the uneven surface, remained passable. The restructured veins are covered with urethelium which spread from the edges of the urethra. It is assumed that the adventitia of the veins are covered with urothelium which spread from the cal effects of urine and facilitates the growth of urothelium. A further advantage is that urine can not leak into the surrounding tissues since the tissue glue ensures a water-tight fixation.

Urethrography showed that, except in two cases, the lumen of the implanted grafts was 4–5 mm in diameter, which corresponded with the lumen of the intact urethra. The place of the graft segment was marked by moderately uneven outlines. Figure 5 shows the urethrogram of an animal which was killed on 316th day. Table 1 shows the number of operated cases, days of survival postoperatively and the results.

No obstruction could be observed in the upper urinary tract.

Our results suggest that the replacement of damaged urethral segments with autologous vein graft could be applicable to reconstructive surgery of the urethra.

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