Urol Res (1999) 27:214–218

ORIGINAL PAPER

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Microsurgical epididymovasostomy in the rat: comparison of end-to-side and two invagination techniques

Received: 5 May 1998 / Accepted: 7 December 1998

Abstract Most cases of obstructive azoospermia are caused by epididymal obstruction for which the classical treatment is epididymovasostomy (EVST). We have compared the widely used end-to-side, invaginated end-to-side and invaginated end-to-end operations. Ninety microsurgical two-layer EVST were carried out on rats. The technical advantages were assessed and patency of anastomoses and conception rate, the length of the operation and amount of suture material used measured in each group. There were no significant differences in patencies and conception rate between the three groups. The invagination techniques took significantly less time than the more usual end-to-side operation, and less suture material was used. The invagination techniques are easier to learn, simpler to perform and involve less manipulation, reduce trauma and cause less laceration to the ductus deferens and epididymal tubules. Economically considered, the operations save the expenditure of both time and suture material. Of paramount importance in making the choice is the size of the ductus deferens and that of the epididymal tubules.

Key words Obstructive azoospermia · Infertility · Epididymovasostomy · Microsurgery

Introduction

Ten to twenty percent of all couples remain unwillingly childless [4]. In about 5% of the patients this infertility is due to obstruction of the male reproductive tract, the frequency of the various sites of the obstruction is summarized in Table 1. An obstruction of the efferent passages with consequent azoospermia may be congenital or the result of secondary changes [5, 12] and, independent of the site of the obstruction, normal spermatogenesis is the rule. Surgical reconstruction of the male reproductive tract in a case of azoospermia is the most effective way of treating this condition in infertile men. An obstruction in the region of the epididymis can be bridged over by an epididymovasostomy, although an ideal form of this operation has not so far become available. The numerous animal experiments and more than 24 reported procedures have made the difficulty of dealing with anatomical structures of the order of 30 μm, and the attempt to ensure, as atraumatically as possible, an exact, spermtight, tension-free adaptation of unequal lumens, only too clear. We have compared the standard procedure of end-to-side EVST with two invagination techniques from the point of view of the success rate (patency, rate of conception) and economy (time, suture material).

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Material and method

Forty-five mature male Wistar-rats (300–540 g) were separated into three equal groups and subjected, under an operating microscope (Yasargil SY2.1, Studer Medical Engineering, Switzerland) at a magnification of ×40–×70, to bilateral microsurgical double-layer epididymovasostomy (EVST). The external and internal suturing of the anastomoses was carried out with 11–0 non-resorbable suture material (Ethilon, Ethicon, Germany), using an atraumatic needle (BV-6). After dissection and mobilization of an epididymal loop in the region of the cauda epididymidis, the muscular coat of the ductus deferens was adapted to the tunica epididymidis. An aperture was then made in the epididymal loop and the internal anastomosis completed by:

(1) end-to-side adaptation of the epididymal lumen to the lumen of the ductus deferens with four anastomotic sutures;
(2) end-to-side invagination of the epididymal loop into the lumen of the ductus deferens for a distance equal to three times the diameter of the epididymal tubule with an invagination suture.
(3) division of the epididymal loop, identification of its afferent limb and end-to-end invagination of the epididymal tubule into the lumen of the ductus deferens for a distance of three times the diameter of the epididymal tubule, using an invagination suture.

Finally, the external anastomosis was completed by adapting the muscular coat of the ductus deferens to the tunica epididymidis with a total of six stitches (Fig. 1a–c).

Table 1 Frequency of the localization of an obstruction in the male reproductive tract [7]

	Frequency (%)	Cause
Obstruction of the epididymis		
Caput	29	Young's syndrome
Corpus/Cauda	19	Post-infective
Obstruction of the ductus deferens	11	Post-infective Post-operative
Agenesis of the ductus deferens		
Bilateral	18	Congenital
Unilateral	5	
Obstruction of the ejaculatory ducts	4	Congenital Post-infective Traumatic

Table 2 Time required for suturing the anastomosis (average in minutes)

$n = 30$	End-to-side	Invaginated end-to-side	Invaginated end-to-end
End-to-side	15.6 ± 3.0	Sig	Sig
Invaginated end-to-side	Sig	4.9 ± 1.8	Sig
Invaginated end-to-end	Sig	Sig	11.5 ± 3.1

Sig significant at level $P \leq 0.001$ (Student's *t*-test)

Table 3 Suture material used per anastomosis (centimetres)

$n = 30$	End-to-side	Invaginated end-to-side	Invaginated end-to-end
End-to-side	30.1 ± 3.0	Sig	Sig
Invaginated end-to-side	Sig	17.7 ± 2.9	ns
Invaginated end-to-end	Sig	ns	18.3 ± 4.4

Sig significant at level $P \leq 0.001$ (Student's *t*-test), *ns* not significant at level $P \leq 0.01$ (Student's *t*-test)

Table 4 Microscopically confirmed patent anastomosis

$n = 30$	End-to-side	Invaginated end-to-side	Invaginated end-to-end
End-to-side	25/30 (83%)	ns	ns
Invaginated end-to-side	ns	26/30 (87%)	ns
Invaginated end-to-end	ns	ns	27/30 (90%)

ns not significant at level $P \leq 0.05$ (χ^2-test)

Table 5 Conception rates after epididymovasostomy

$n = 15$	Controls	End-to-side	Invaginated end-to-side	Invaginated end-to-end
Controls	62.2%	Sig	Sig	Sig
End-to-side	Sig	2/15 (13%)	ns	ns
Invaginated end-to-side	Sig	ns	5/15 (33%)	ns
Invaginated end-to-end	Sig	ns	ns	5/15 (33%)

Sig significant at level $P \leq 0.05$ (χ^2-test), *ns* not significant at level $P \leq 0.05$ (χ^2-Test)

A note was made of the time taken for each stage of the operation and of the suture material used. The animals were paired with up to three sexually mature females for an observation period of 12 weeks. The conception rate was compared with that of a control sample of 30 animals for several pairing cycles. After the end of this observation time the animals were assessed in terms of fertility, and the anastomoses examined microscopically and with the naked eye for granulation tissue due to spermatozoa and patency.

The excised specimens were embedded in paraffin, serially sectioned at 10 μm through the entire region of the anastomosis and examined histologically. The sections were stained with hematoxylin-eosin.

Results

Analysis of the operation times showed an asymptotical reduction over the period of observation. The invagination techniques are easier to learn and to perform. It was revealed that the lumen of the epididymal tubule is of decisive importance for the technique of EVST.

With the invagination techniques, the dissection and the establishment of the anastomosis requires a significantly shorter time, and with invagination EVST the end-to-side anastomosis can be completed significantly more quickly than can the end-to-end operation (Table 2). Furthermore, significantly less suture material is used with the invagination techniques (Table 3). Histological examination of the anastomoses showed that, with invagination, the majority underwent complete resorption of the included epididymal tubule, and the final condition revealed a smoother transition of the epithelium between ductus deferens and epididymal tubule (Fig. 2).

The invaginated end-to-side anastomosis showed a smaller number of cases of granulation tissue due to spermatozoa (10%) in comparison with the end-to-side (33%) and the invaginated end-to-end operations (63%). The various techniques of EVST do not differ significantly with regard to the macroscopic and microscopic patency of the anastomosis (Table 4). In comparison with the control sample, the three techniques show a significant difference in the rate of conception, but do not differ significantly between one another. The invaginated anastomoses tend to show better results (13% vs. 33%) (Table 5).

Discussion

Today, at a time of such highly technical procedures in reproductive medicine as the microsurgical extraction of spermatozoa from the testes (TESE) or from the efferent seminal ducts (MESA) and the artificial fertilization of ova [the intracytoplasmic injection of spermatozoa (ICSI)], the surgical reconstruction of obstructed seminal ducts has taken on a greater significance. Not only from the point of view of an improved success rate, but also as a result of economic motivation [9], a more sophisticated therapy should appear.

The history of the diagnosis and treatment of obstructive azoospermia goes back as far as 1857 [1]. Experimental investigations and clinical experience led to greater understanding of the anatomy of the efferent

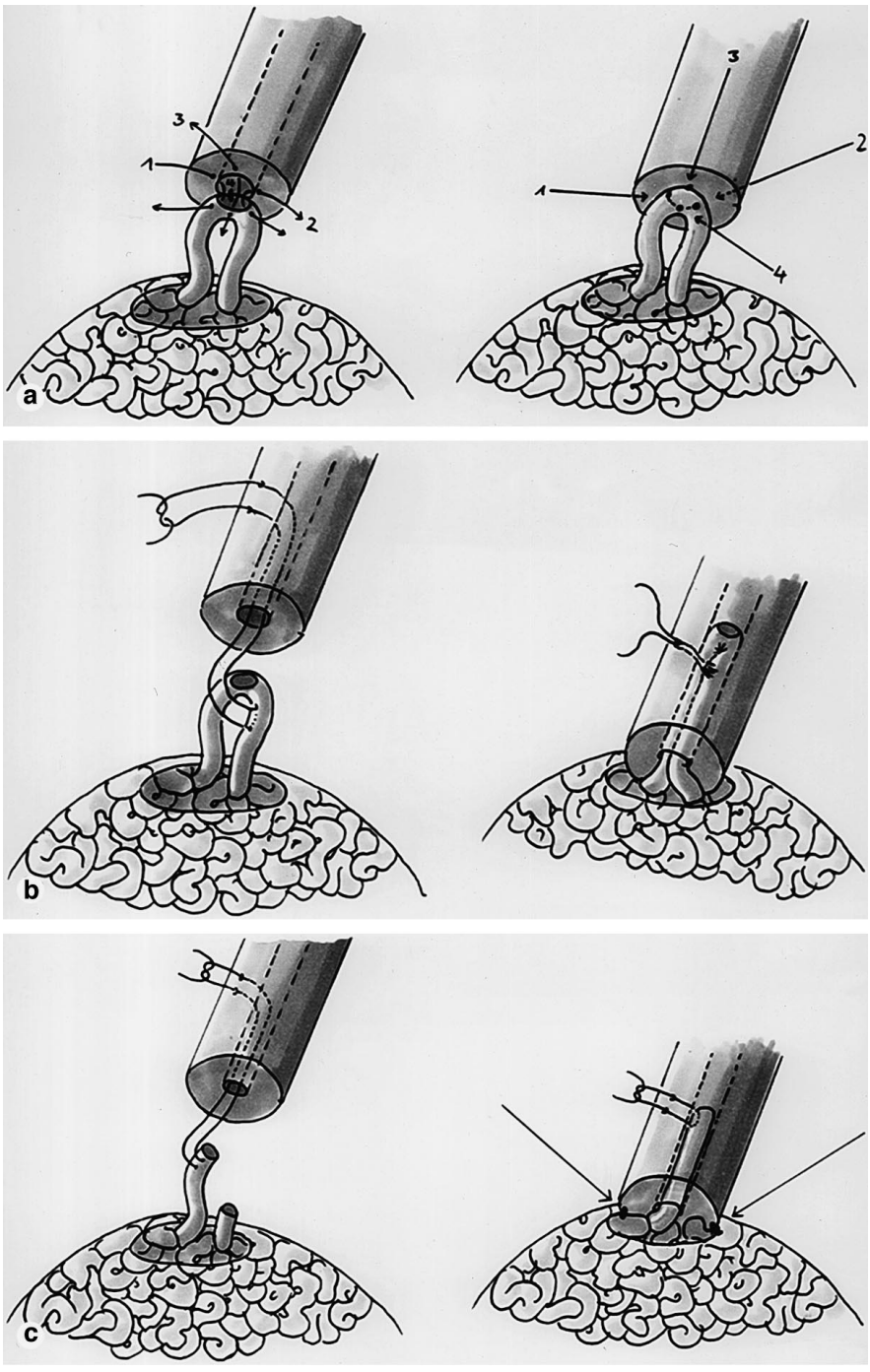

Fig. 1a–c Various techniques for epididymovasostomy. **a** Epididymovasostomy: end-to-side, not invaginated. **b** Epididymovasostomy: end-to-side, invaginated. **c** Epididymovasostomy: end-to-end, invaginated

seminal ducts and the physiological maturation of spermatozoa, especially in the epididymis, and thus to more sophisticated surgical techniques [6, 8, 11, 13, 16, 21, 23].

The microsurgical technique is a prerequisite for atraumatic treatment of the epididymal tubules, ductus deferens and the neurovascular structures. The aim of every microsurgical reconstructive procedure is the exact adaptation of lumens with different diameters and a spermtight and tension-free anastomosis. An end-to-end technique with EVST was first reported in 1977. A patency rate of more than 80% [20] has not been achieved by other investigators. Since then the microsurgical two-layer end-to-side anastomosis began to appear [3, 22, 27]. Various modifications of this technique were used in clinical and preclinical investigations (Table 6). So far, invagination varieties of EVST have only been undertaken as animal experiments, and have not been compared with the standard procedures of end-to-side anastomosis.

In our investigations we have been able to achieve a significantly shorter operation time with the invaginated

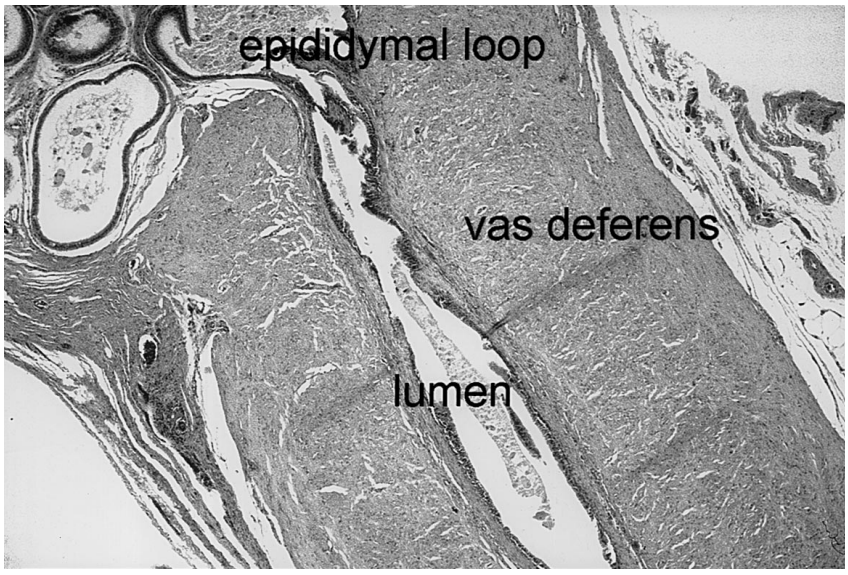

Fig. 2 Histological confirmation of a patent end-to-side invagination epididymovasostomy with complete resorption of the invaginated epididymal tubule

Table 6 Microsurgical epididymovasostomy

Author	Year	Technique	Number	Patency (%)	Conception (%)
Silber [19]	1978	E-E	14	86	–
Dubin [2]	1984	E-S	46	39	13
Wagenknecht [28]	1985	E-S	22	55	23
Fogdestam [3]	1986	E-S	41	85	37
Thomas [27]	1987	E-S	50	66	42[a]
Lee [10]	1987	E-S	169	37	20
Southwick [24]	1988	E-S	102	40	20
Silber [23]	1989	E-S	190	73 (caput)	43 (caput)[a]
				78 (corpus)	72 (corpus)[a]
Shekarriz [18][b]	1991	E-S	15	63.2	–
		Invaginated E-S	15	80	–
Stefanovic [25, 26][b]	1991	Invaginated E-S	15	100	–
		Invaginated E-E	15	97	–
Schlegel [15]	1993	E-S	110	70	44[a]
Pomer [14][b]	1994	E-S	15	63	–
		Invaginated E-S	15	80	–
Kolettis [9]	1997	E-S	55	85	44
Seaman [17][b]	1997	E-S	10	73	–
		E-S (Laser)	10	82	–
Freiburg[b]	1998	E-S	15	83	13
		Invaginated E-S	15	87	33
		Invaginated E-E	15	90	33

E-E end-to-end, *S-S* side-to-side, *E-S* end-to-side
[a] Conception rate with positive spermiogram
[b] Animal experiments

techniques than with the conventional end-to-side EVST. The greater length of time taken with end-to-end EVST is due to the difficulty of identifying the afferent limb, and a 5% error rate has been reported. The invagination techniques are easier to learn and simpler to perform, and, owing to the limited dissection and the consequent preservation of the nerves and vessels, a more atraumatic anastomosis is possible. In addition to the reduced operation time, the invagination techniques permit the use of less suture material, which is particularly important from the economic point of view.

We consider the decisive factor in choosing the best operative procedure for EVST is the size of the epididymal tubule and the lumen of the ductus deferens. When the former is large, the end-to-side technique is easier, but when it is small, the invaginated epididymovasostomies are easier. Should the epididymal duct be severed accidentally, the invagination end-to-end anastomosis is still available. As far as patency of the anastomosis, which is about 90%, is concerned, we have been unable to find any significant advantage in the invagination techniques. Other groups [14, 18, 25, 26] have been able to show advantages in the invagination techniques, with the patency rate for the end-to-side anastomosis significantly lower (about 65%).

The conception rates following EVST were significantly different from those of the control samples. The operation, the construction of the anastomosis and possible damage to nerves and vessels led to a significant reduction in the fertility. The individual techniques of

EVST do not differ significantly in terms of the conception rate. The tendency to achieve a better conception rate together with similar patency by means of the invagination techniques is possibly due to the atraumatic treatment plus the preservation of the neurovascular structures.

Kolettis and Thomas [9] were able to show that in cases of epididymal obstruction, epididymovasostomy is both more effective and more economical in terms of the patency, pregnancy and "baby-take-home" rates than technical reproductive measures such as microsurgical epididymal sperm aspiration (MESA) with subsequent ICSI.

In conclusion: in the presence of an obstructive azoospermia reconstruction of the seminal ducts is the first treatment of choice. The invagination techniques offer simpler and more economical alternative forms of EVST, as well as being capable of achieving equal conception and patency rates.

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