Microsurgery in Pediatric Urology

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The use of the operating microscope has recently made possible anastomosis of blood vessels as small as 1/3 mm in diameter. Microvascular surgical techniques originated in laboratories engaged in organ transplantation on rats and mice [1–4]. However, these techniques have had numerous clinical applications including reimplantation of digits, distant transfer of detached free-skin flaps, reversal of vasectomy, bench repair of renal vascular lesions, and free transfer of vascularized bone grafts [5]. There are a number of applications of this new surgical technology to pediatric urology, and this paper will address itself to some of those applications.

CRYPTORCHIDISM

Of cryptorchid testes, 1–5% are intraabdominal and cannot properly be brought down into the scotum by conventional methods. In such cases division of the spermatic vessels may allow the testicle to be brought into the scrotum, but there is a severe risk of testicular ischemia and atrophy. It is always tempting simply to excise these high intraabdominal testicles because of the technical difficulty of getting them into the scrotum. In addition it is often rationalized that these testicles are not really normal to begin with, are unlikely to be fertile anyway, and therefore why not remove them?

We would advise efforts to save these testicles for the following reasons. Rat studies have definitely demonstrated that the intraabdominal environment is very detrimental to spermatogenesis, therefore, even if the testicle has a

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diminished capacity for spermatogenesis on a congenital basis, its sperm production can still be enhanced by placing it in the proper scrotal environment [6–8]. In many cases this can be the difference between a subnormal sperm count and a normal sperm count. In fact it is now clearly known that patients with unilateral cryptorchidism are less fertile than patients with both testes descended [9]. One testicle may be enough for fertility in many instances, but both testicles usually have some decrease in sperm producing capability even in patients with unilateral cryptorchidism. Therefore, if any extra function can be obtained from the cryptorchid testis by placing it in the proper scrotal position, this could enhance the fertility of patients with unilateral cryptorchidism. There are definite instances of patients as old as 15 years of age with bilateral cryptorchidism being converted from total azospermia to somewhat reasonable sperm counts by orchidopexy even at this late age [10]. So the age-old doctrine that one testicle is enough and 2 are more than enough may not entirely apply to the situation where neither testicle is completely normal. In these instances one needs as much testicular function as possible in order for fertility to occur.

Once one decides not to remove the intraabdominal testicle, it should not be left in the abdomen because of the considerably increased risk of ultimate development of malignancy [11]. Proper scrotal position for this sort of testicle allows frequent and regular examination.

Technique

The basic method of microsurgical anastomosis is depicted in Figure 1. For small vessels, 10-nylon suture on a BV-6 needle is preferable. Interrupted suturing is necessary because the continuous suture technique that is so commonly used in macrovascular surgery results in clinching and relative obstruction to the anastomosis. This clinching would occur with large vessels also but the effect is not as important or as noticeable. With tiny vessels (1.5 mm or less) interrupted sutures are critical. The first 2 anterior rows of sutures are placed 120° apart so that the posterior vessel walls are allowed to fall away. One or 2 sutures are then placed between these first 2 anterior rows of sutures. Once this is completed the vessel is rotated 180°, and the posterior row, which consists of the remaining unsutured 240° of the vessel circumference, is then sutured in the anterior position. When one is operating on delicate tissue-paper thin veins whose walls tend to collapse, the surgical area should be flooded periodically with saline solution using a 10 cc syringe. This underwater suturing technique helps float the ends of the veins open for easier anastomosis. The operating microscope is used for all dissection and suturing, and 6–16 X is generally sufficient, though for tiny vessels 24–40 X is often necessary. A #3 jeweler's forceps are used for dissecting large vessels and for finer vessels, #4 and #5 jeweler's forceps are used. One can use any kind of neurosurgical clip for the vascular clamp. A complete set of microsurgical instruments, which I prefer, is available from a number of suppliers [12].

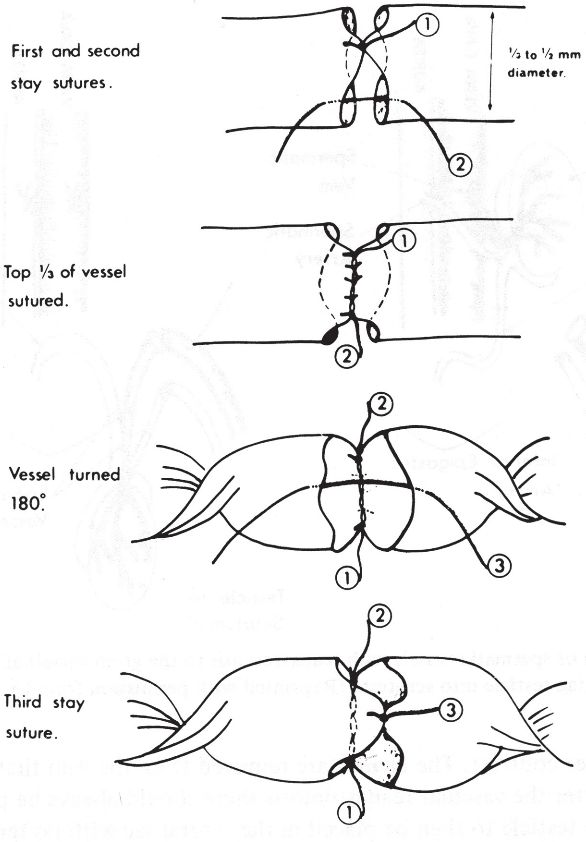

Fig. 1. Basic outline for microsurgical end-to-end anastomosis. (Reprinted with permission from Urology 6:150, 1975.)

An intraperitoneal approach tends to be the easiest for an intra-abdominal testicle. Spermatic vessels are detached from the aorta and the vena cava. One does not have to dissect very close to the aorta and vena cava to get adequate length on the spermatic vessels. These vessels are then reanastomosed to either the deep or superficial inferior epigastric vessels in the groin area (Fig. 2). Occasionally the spermatic vein may be somewhat larger than either epigastric vein, and it may be necessary to utilize a branch of the saphenous vein swung up into the groin area as an alternate vessel. Total ischemia time for both anastomoses should be under 30 min. Good pulsation and flow should be easily noted under the microscope, and there should be no doubt about the adequacy of the anastomosis with simple microscopic observation. Suturing is rendered easier by having a yellow piece of plastic cloth underneath the vessels being anastomosed

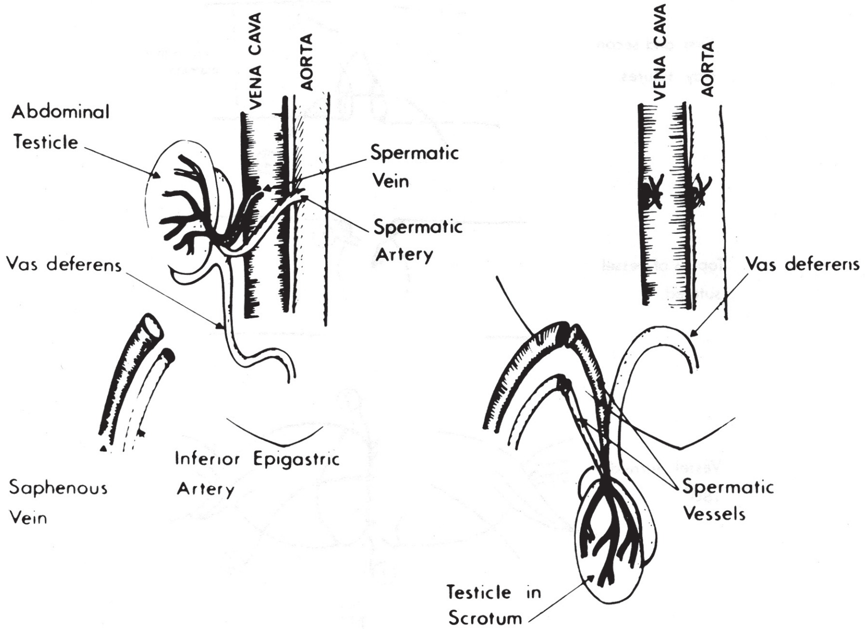

Fig. 2. Division of spermatic vessels with reanastomosis to the groin vessels allows adequate length for bringing testicle into scrotum. (Reprinted with permission from Urology 6:150, 1975.)

to allow proper contrast. The clamps are removed from the vein first and then the artery. After the vascular reanastomosis there should always be plenty of length for the testicle to then be placed in the scrotal sac with no tension. The vas deferens appears not to be the withholding factor in getting the testicle down. It is only the vessels that create the problem.

This procedure thus allows tension-free placement of the high testis into the scrotum. Although the long-term results regarding fertility will not be known for many years the immediate results appear good. No testicular atrophy is detectable on palpation. Without a microvascular approach, the testis would either have to be removed or allowed to remain in the abdomen where an occult neoplasm might develop. With this technique a viable testis is preserved in a position favorable for future observation.

Since 1903, when Bevan first recommended division of the spermatic vessels to bring a high testicle down into the scrotum, this procedure had met with varying results. In 1903, Bevan and in 1910, Moschowitz tried to simply divide the vessels and place the testicle in the scrotum, and they actually claimed good results [13, 14]. Mixter tried this in 1924 in 15 cases and reported atrophy in 13 of them [15]. Wangensteen in 1927 condemned the procedure on the basis of consistent testicular atrophy in dogs [16]. MacCollum in 1935 reported testicular atrophy in every single case that he performed if one submitted the patients to 10-year follow-up [17]. The procedure therefore fell into total disrepute until Fowler and Stephens in 1963 showed that by dividing the vessels high and not dissecting their attachment to the cord it was possible to preserve more of the anastomotic circulation via the artery to the vas deferens [18]. With their very careful and meticulous technique of simply dividing the spermatic vessels and doing nothing else they noted that only half of these testicles showed severe atrophy. Brendler and Wulfsohn attempted this procedure in 1967 on 5 patients, but the report did not have a long-term follow-up [19]. Summarizing this long history, therefore, it seems generally risky to divide the spermatic vessels without planning to reanastomose them. Occasionally one can get away with this, however, it would make sense that the better the blood supply to the testicle, the greater the chance that there will be normal fertility in the long-term follow-up. Therefore, if microsurgical reanastomosis can be performed, this would be advisable.

Hodges et al [20] should be given credit for first dreaming up this concept since they tried it in 1964 on a series of dogs using a patch of aorta. The problem is that no one would subject a child to this sort of risky vascular procedure merely to fix the testicle. The advent of microvascular suturing technique now makes it possible to perform the operation that Hodges originally conceived without any vascular risk to the child.

Testicle transplants have been performed by Lee and Gittes in rats [6, 21]. Their vas deferens anastomosis was unsuccessful, but their vascular anastomosis was successful. They noted completely normal LH and FSH levels in animals that underwent testicle transplant along with removal of their original 2 testicles. However, in animals that were rendered cryptorchid, they noticed a quickly rising FSH, indicating impairment of spermatogenesis and a later rise in LH, indicating eventual damage to the interstitial cells on a longer term basis. Their experimental work therefore would give strong argument for the viability of testicles after division of their vessels and reanastomosis and would also argue in favor of transplanting abdominal testicles as soon as possible from their unfavorable environment into the scrotum.

VASOVASOSTOMY

The technique for microscopic vasovasostomy has been reported adequately in the urologic literature during the last half year, and there is not a great need for very detailed redescription here since it is mostly a matter for adult urologists [22–25]. However, very frequently when an infant herniorrhaphy is performed, the vas deferens is inadvertently damaged and many times is found in the hernial sac specimen sent to pathology. The important question which then faces pediatric urologists when such a complication is encountered or discovered is *when* to repair the vas deferens. Obviously it would be convenient to wait until the child is somewhat older and the vas deferens is somewhat larger. However, will this period of waiting result in deterioration of germinal cell reproduction due to back-pressure on the seminiferous tubules? Or will delay of the microscopic reconstruction result in a diminished chance for utlimate fertility in that testicle? We do not have enough information yet to answer that question definitively, but information now coming out of our work with vasectomy reversal in adults gives us some firm basis for making some suggestions as to when to do the repair.

In the vasectomy reversal work that has been done on adults it has been noted that the increased pressure in the proximal portion of the vas deferens is transmitted down to the epididymal tubule and through the rete testis to the seminiferous tubules. The pressure is considerably dampened on the way down so that it takes a very long period of time for permanent damage to result to the seminiferous tubules. Generally speaking, 10 years of less of obstruction rarely leads to sufficient damage to prevent the attainment of a normal sperm count after vasectomy reversal. However, greater than 10 years of obstruction in the adult results in a decreased success rate in terms of sperm production.

Generally the early phases of sperm production are not seriously hindered by the chronic obstruction. It is only the later stage of sperm maturation that is affected. Thus, in certain patients whose vasectomy was performed more than 10 years ago, with successful reanastomosis of the vas, we see a large amount of early forms of spermatazoa that have not had a chance to mature. This implies damage to Sertoli cell function from the chronic obstruction. In any event large numbers of immature sperm incapable of fertilization are sloughed from the tubules and found in the ejaculate. With time a considerable amount of function returns, but the odds for success in these patients are less. We would therefore have to recommend relief of obstruction with a microscopic vasovasostomy as soon as possible *if there is increased back-pressure* on the other side of the obstruction.

We know that the increased pressure inside the vas deferns after vasectomy is created by secretion of fluid both from the testes and the wall of the vas. Therefore, if there were no fluid secreted, it would be a safe guess that there would be no increase in pressure and the testicle would be spared damage from back-pressure. If we assume that the prepubertal testicle and the prepubertal vas deferens are not secreting fluid in very significant amounts, then it would probably be safe to defer re-hookup of the vas deferens until some time just prior to or just after puberty. This would give the structures time to enlarge somewhat, making the operation easier, and this delay would not be likely to result in any permanent harm to the seminiferous tubules. The lack of fluid flowing through the vas deferens in the prepubertal stage might predispose to adhesions and stricturing of the suture line no matter how carefully and perfectly an anastomosis is done. Thus, on the basis of information we presently have available, it would appear that, in cases of damage to the vas deferens during an infant or child herniorrhaphy, it would be wise to defer reconstruction of the vas deferens until just about at the time of puberty.

Technique

We have shown in a number of other publications that the major reason for failure of vas reanastomosis is in inaccurate reapproximation of the mucosa of the lumen. The leakage of sperm across an inaccurate suture line will result in sperm granuloma and secondary obstruction in almost every case. Thus, the goal is to perform a perfect water-tight 2-layer anastomosis (Fig. 3). The 9–0 or 10–0 nylon interrupted sutures are used for the mucosa, and either 9–0 or 8–0 nylon would be adequate for the muscularis. The inner lumen of the vas deferens is less than 1/3 mm in diameter and yet the outer diameter is 2–3 mm. The thick

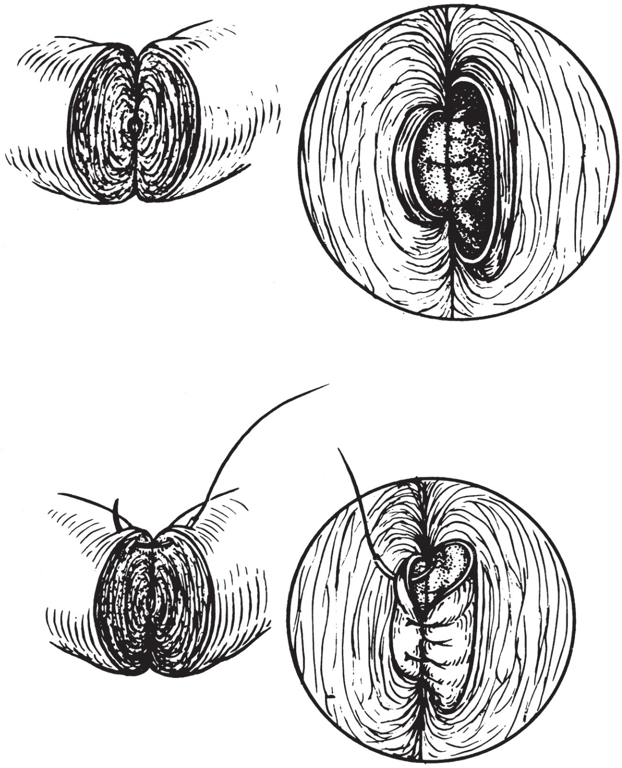

Fig. 3. A 2-layer microscopic anastomosis of the vas deferens with 9–0 or 10–0 nylon is the best way to ensure a leakproof, stricture-free reconstruction. (Reprinted with permission from Surg Gynecol Obstet Oct. 1976.)

wall of the vas is almost entirely muscle, and this is utilized at the time of intercourse for rapid peristaltic propulsion of sperm from the epididymis into the ejaculate. Reanastomosis of the vas is somewhat more difficult than the vascular procedures previously described because this thick wall can get in the way of visualization of the lumen and the separate mucosal layer is rather delicate and can tear much more easily than the thick wall of the microblood vessels. Therefore this procedure should not be attempted until one is first familiar with techniques of microvascular repair.

The basic approach is similar. Two stay sutures are placed 120° from each other in mucosa and tied. If possible, a third stitch is placed in between these 2 stitches that have been made at 120°. The vas is then rotated 180° by means of a microclamp (again which can be obtained from several instrument makers). Now, one is looking at the posterior wall of the vas which consists of 240° of the circumference. This approach is essential if one is to be able to complete the posterior wall and easily visualize the lumen. At this point 3 more sutures are placed within the mucosa, one in the center and one on either side. This is usually sufficient to create a water-tight anastomosis. The muscularis is much easier to suture but takes a longer time because many more sutures are necessary. Instead of using a BV-6 needle it is necessary to use a GS-16 needle because the outer wall of the vas deferens is tough; a good deal of trauma would be introduced in trying to drive a round needle through it. In addition, because of the leakage of seminal fluid and the small amount of bleeding along the muscular edge of the cut ends of the vas, it is necessary for an assistant to irrigate with saline from time to time to keep the field perfectly clear. One-tenth of a milliliter of blood can totally obscure the lumen and make the placing of accurate stitches impossible.

TESTICULAR TRANSPLANTS

Since it is possible technically to do a good microvascular anastomosis of the spermatic vessels and since it is technically possible, though more difficult, to obtain a perfect vasovasostomy, it is obvious that testicles can now be transplanted without too much difficulty. The work done by Lee and Gittes demonstrates that these testicles are endocrinologically quite normal. Their technique for vasovasostomy was not adequate, and they could not get proper sperm transfer in their animals. However, we do feel that this problem has now been solved. Certainly, from an experimental point of view in animals, this is a great model. We can transplant child testicles into adults and adult testicles into children in the rat model. By using a syngeneic graft there will be no rejection to worry about, and it will be possible to determine to what effect testicular function is influenced by the environment of the animal and to what extent it is intrinsic. This work remains to be done in the rat but will be of immense consequence to our understanding of basic reproductive biology.

From a clinical point of view, it is quite obvious that if we have identical twins and one of them is infertile from one cause or another, it would be quite possible to take the testicle from the fertile one and transplant it to the infertile twin and have a successful outcome. If fertility were the only reason for having this procedure, then artificial insemination would be adequate and no complicated procedure such as a testicular transplant would be necessary. However, in certain religious groups, such as orthodox Jews or Moslems, artificial insemination is not an acceptable practice, and a testicle transplant would be an excellent solution to their dilemma. It may even be that, in HLA identical sibs or closely matched father and son combinations, where a minimal amount of immunosuppression would be needed, testicle transplants some day could be utilized. Also, if for one reason or another an HLA identical sib or identical twin had lost the hormone-producing function of both testicles, then a testicle transplant would probably be preferable to long-term male hormone replacement. Indications for this procedure clinically are obviously going to be rare but when they do occur, technically it will be possible.

OTHER POSSIBLE USES OF MICROSURGERY IN PEDIATRIC UROLOGY

Because infants and children are simply inherently small it is obvious that microsurgery will have greater value among this group than adults. Certainly for complicated ureteral repairs or complicated renal vascular procedures in children microsurgery will be very valuable. It is possible to obtain objectives on the operating microscopes that have such a long focal distance that using the microscope inside the body presents no formidable difficulty. It is difficult to imagine all the possible uses of the microscope in pediatric surgery, but suffice it to say that whenever your visualization appears to be poor and you feel you are having a hard time ascertaining the accuracy of an anastomosis, the microscope may be of use.

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