Clinical Experience with An Artificial Spermatocele

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Artificial spermatoceles were implanted into three patients with congenital absence of the vas. In each case, the testicular biopsy demonstrated normal spermatogenesis, and the dilated epididymal tubule was packed with spermatozoa. The ciliated epididymal mucosa appeared normal despite the tubular dilatation. The spermatoceles were constructed of expanded polytetrafluoroethylene, and they were microsurgically implanted over the cut end of the epididymis. The grafts were aspirated monthly for up to six months, and the aspirates containing spermatozoa were used for artifical insemination. Spermatozoa were consistently retrieved from each patient, but no pregnancies have resulted. The most obvious finding was that the spermatozoa lacked motility. In the discussion, other problems related to artificial spermatoceles are reviewed, including epididymal development and sperm maturation, aspiration techniques, and sperm storage.

Key words: artificial spermatocele, congenital absence of the vas, expanded polytetrafluoroethylene.

J Androl 1984; 5:304–311.

Congenital absence of the vas deferens results in azoospermia but the testicular biopsy shows that these patients usually have normal spermatogenesis. Thus, andrologic surgeons have been intrigued with the possibility of implanting an artificial spermatocele in these patients in order to collect spermatozoa.

A variety of these devices have been developed for implantation. They have included vein grafts, alloplastic spermatoceles, and woven grafts. The aspirates from these devices have been used for artificial insemination.

In this report we have described our experience with an artificial spermatocele made of expanded polytetrafluoroethylene, trade name, Gore-Tex. Preliminary laboratory tests suggested this material offered several advantages: 1) it was well tolerated by the body, since it had been used in vascular surgery, 2) it did not leak spermatozoa, and 3) it was not permanently damaged by multiple punctures.

We implanted this graft into three patients, and we documented consistent sperm retrieval. There have been, however, no pregnancies. Nevertheless, we believe that our findings highlight some of the problems associated with these procedures. We hope that this information will stimulate further research and development.

Materials and Methods

Preliminary Experiments with the Graft Material

Approximately 20 ml of Baker's buffer was placed into a 100 ml glass beaker. Then a 12-cm section of no. 10 graft of expanded polytetrafluoroethylene was positioned into the beaker, so that the mid-portion of the graft was below the fluid level. The open ends of the graft dangled over the edges of the beaker.

Three ml of high quality semen were introduced into one open end of the graft (sperm density 70 million/ml and 80% motile spermatozoa). The semen drained into the most dependent portion of the graft which was surrounded by the buffer. After 6 hours, the semen specimen was poured out of the graft. The original 3 ml were retrieved and microscopic examination of the semen demonstrated 60 to 70% motility. The buffer from the beaker was examined for the presence of spermatozoa, but none were seen, suggesting no sperm leakage thru the graft. The same experiment was reproduced with four other semen specimens.

Similar experiments were carried out with other grafts which were punctured in two places with a 23-gauge needle at least 12 hours in advance. Again, the results suggested no sperm leakage.

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Submitted for publication October 24, 1983; revised version received March 14, 1984; accepted for publication March 19, 1984.

TABLE 1. Summary of Data from Three Patients with Congenital Absence of the Vas and Artificial Spermatocele

Pts.	Epididymal Development	No. Months	No. Taps	Maximal Sperm Density	% Motile Spermatozoa
A	1/2	6	6	30 mil/ml	0
B	3/4	3	4	25 mil/ml	0
C	1/3	4	4	15 mil/ml	0

Clinical Material

Three patients with congenital absence of the vas deferens had an artificial spermatocele implanted. The patients were 26, 29, and 31 years old. The implant was a 3- to 4-cm section of a no. 10 arterial graft made of expanded polytetrafluoroethylene. One end was closed with a continuous double layer of 6–0 nylon and the other end was sutured to the serosa of the epididymis after the distal tubule was carefully dissected free by microsurgical technique. The testis and the attached graft were replaced into the scrotum. The graft was positioned into a superficial Dartos pouch for future aspiration.

Sperm antibody studies were done on each patient. The serum, semen, and spermatocele aspirates were tested for sperm agglutinating antibodies by the method of Marmar et al (1980).

Results

The summary of data from the three patients is reported in Table 1. The development of the epididymis varied from caput alone in patient C to full development of the caput midsection and cauda in patient B. Aspirations were carried out for three to six months, with the number of taps ranging between four and six. The maximal sperm densities of the aspirate ranged from 15 to 30 million per/ml. The minimum sperm densities were never less than 5 million per/ml on any tap. However, there were no motile spermatozoa in any of the specimens.

The semen, serum, and aspirates were examined for sperm antibodies (Table 2). Although there were measurable titers in the semen and the serum, the aspirates were negative for antibodies.

TABLE 2. Titers of Sperm Agglutinating Antibodies in Three Patients with Congenital Absence of the Vas and Artificial Spermatoceles

Pts.	Serum	Semen	Aspirate
A	1:64	1:32	0
B	1:128	1:64	0
C	1:128	1:32	0

The sperm surface antibodies were not measured.

Figure 1A shows the testis and partly developed epididymis of patient B. Figure 1B illustrates the gross appearance of the dilated epididymal tubule with the serosa stripped away. On histologic examination, the testis biopsy appears normal (Fig. 2A), but the epididymal tubule is markedly dilated and densely packed with nonmotile spermatozoa and sperm parts (Fig. 2B). The epithelium of the epididymal tubule is shown at a higher magnification (Fig. 2C). There appears to be adequate preservation of the normal epithelial features. Although there were no motile seprmatozoa seen at surgery, the graft was placed over the cut end of the epididymis with the expectation of eventually better quality spermatozoa.

In Fig. 3A, the graft is sutured to the rudimentary caput of patient C. The attached graft and testes are replaced into the scrotum in position for future aspiration (Fig. 3B). The aspiration protocol is recorded in Table 3.

The graft in patient B became infected after three months, and it was removed (Fig. 4A). The closed end of the graft was still sealed by the double row of continuous sutures, and the graft did not leak. Figure 4B shows the histology of the graft. Spermatozoa, polymorphonuclear leukocytes, and an exudate on the luminal side of the graft are seen in the upper portion of the figure while bacteria are found within the graft material in the lower portion.

Discussion

A variety of prostheses have been used for artificial spermatoceles in laboratory animals and in humans. For example, Schoysman (1968) used a vein graft in patients with vasal aplasia. He achieved a few pregnancies, but these grafts developed early shrinkage and obliteration (Vickers, 1975; Schoysman, 1982). Despite covering the vein grafts with tunica vaginalis, place-

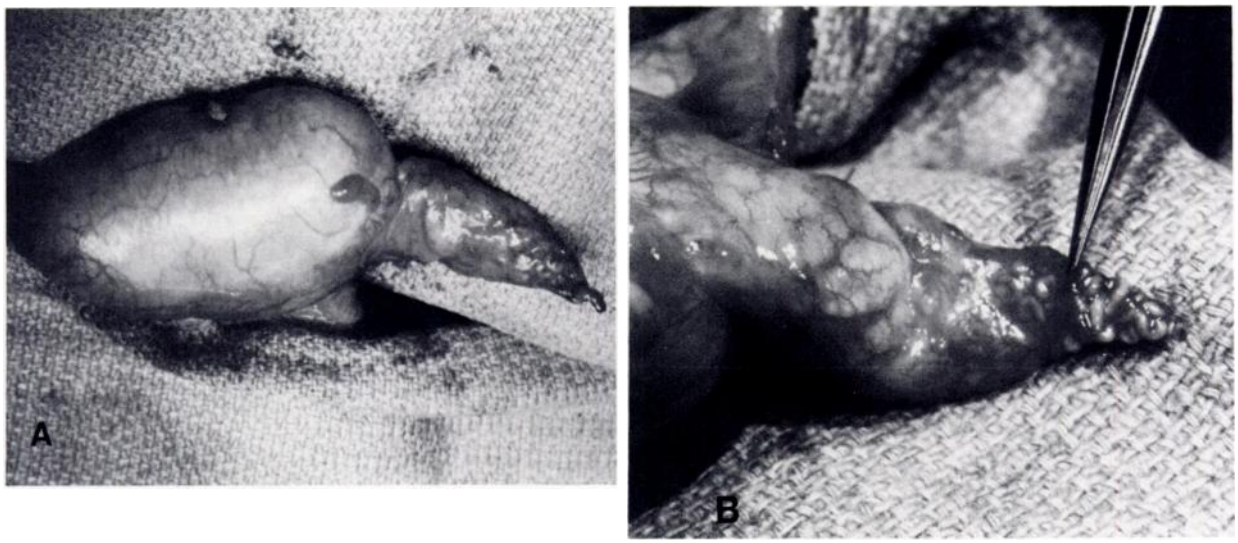

Fig. 1. A: shows the testes and the epididymis in a patient with congenital absence of the vas. B: demonstrates the dilated epididymal tubules with the serosa stripped away.

ment into a subcutaneous scrotal pouch, and placement of an indwelling irrigation catheter, the vein grafts were abandoned in favor of more durable prostheses.

Kelâmi et al (1977) developed an alloplastic spermatocele that was a silicone reservoir connected to a nonkinking tube system with an aspiration button. With this device, the button was tapped for spermatozoa and the reservoir was not punctured. Around the same time, Wagenknecht et al (1980) developed a one-piece alloplastic spermatocele made of a silicone cup with a Dacron® border, which was punctured directly. The Kelâmi prosthesis was used in mini-pigs, whereas the Wagenknecht device was used in rats and bulls. Both types of alloplastic spermatoceles have produced pregnancies in laboratory animals. Subsequently, they have been implanted in humans. A few human pregnancies have been reported (Schoysman, 1982; Wagenknecht, 1982), but the data are fragmentary.

Cruz (1980) employed a knitted graft of monofilament polypropylene. This material had been used extensively in vascular surgery, but the grafts leaked spermatozoa unless they were covered with tunica vaginalis. Covered grafts were implanted into a series of dogs, and then one was placed into a human patient. After four monthly aspirations and inseminations, the wife became pregnant and delivered a baby girl.

In the present report we used expanded polytetrafluoroethylene to create an artificial spermatocele for three patients with congenital absence of the vas. The preliminary experiments indicated that the material would not leak spermatozoa and that it could withstand multiple punctures with a 23-gauge needle. In human patients, spermatozoa were retrieved for up to six months, but the spermatozoa were nonmotile, and there have been no pregnancies.

Aside from the problems associated with prosthetic devices, it has become apparent that a greater understanding is needed of other factors related to these procedures (ie, surgical management of the epididymal tubule, the relationship of the epididymal development to sperm maturation, aspiration techniques, and sperm storage). For example, at exploration we utilized microsurgical techniques in order to tease the distal portion of the epididymal tubule into the graft and apply precise hemostasis. Although we were able to retrieve spermatozoa for a maximum of six months, this dissection did not insure long-term patency. Belker (1983) suggested that the tubule could be sutured to the tunica of the epididymis with 10–0 nylon. This approach, as well as other innovative techniques, will be required in the future to insure long term tubal patency.

In rats, Wagenknecht et al (1980) retrieved spermatozoa with better motility from those prostheses that were more caudal. These findings suggest a relationship between epididymal length and sperm maturation. At exploration, we found varying degrees of epididymal development in

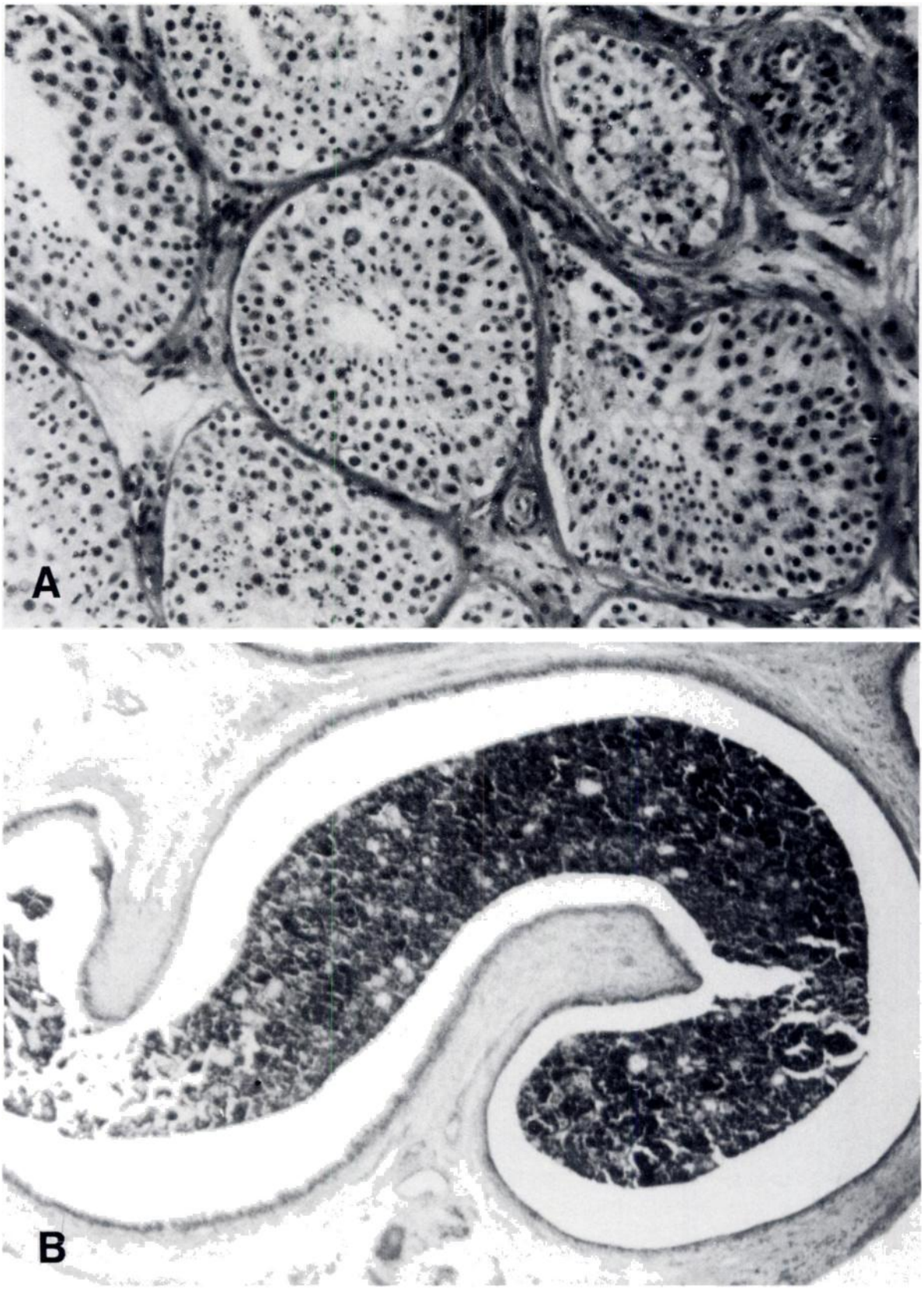

Fig. 2. A: shows a normal testicular biopsy in a patient with congenital absence of the vas. B: illustrates the dilated epididymal tubule densely packed with spermatozoa.

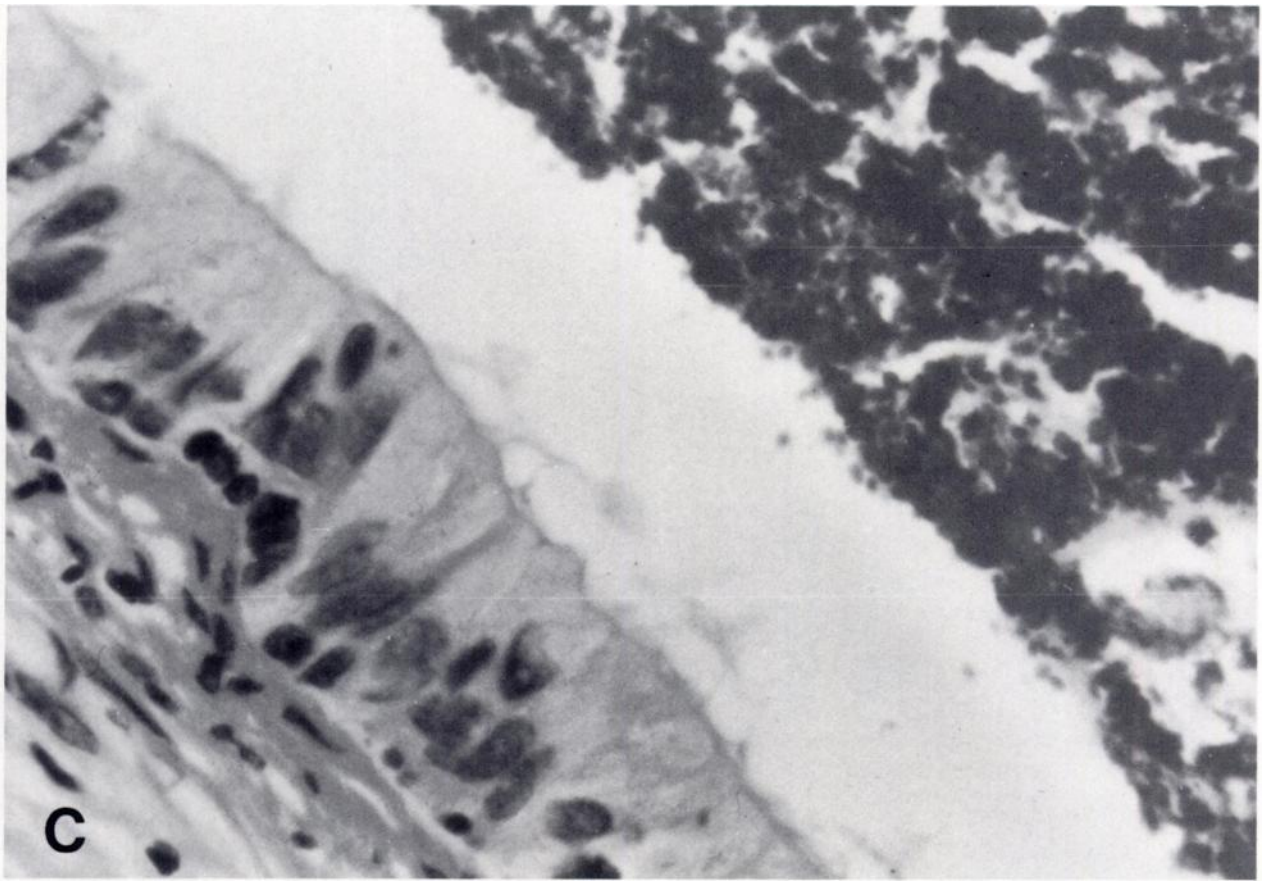

Fig. 2. C: shows a high power magnification of the epididymal lining. Note the preservation of the stereocilia border on the epididymal epithelium.

three patients with congenital absence of the vas. These findings agree with Schoysman (1982) who explored 118 cases of vasal aplasia. Sixteen patients had almost complete epididymal development, whereas the others had limited development of the caput.

It may be that some of these patients are not good candidates for artificial spermatoceles, since they have limited epididymal development. In order to test this hypothesis, more experience is needed with artificial spermatoceles in other types of patients who have full development of the epididymis and vas (ie, paraplegics, and patients with lengthy vasal occlusions). Data from these patients may improve future patient selection.

Wagenknecht et al (1980) also suggested that there was epididymal tubular atony as a result of long-term dilatation in humans with congenital absence of the vas. This implies that implantation of an artificial spermatocele in humans with life-long obstruction may not be comparable to the acute implantation in laboratory animals. In our cases, the histologic sections of the epididymal tubule showed marked tubular dilatation, but there was preservation of the stereocilia border. This suggests the potential for normal tubular absorbtion and secretion, but there may be reduced epididymal flow and greater sperm cell phagocytosis. Therefore, more specific studies are needed to evaluate the function and motility of the epididymal tubules in humans with congenital absence of the vas.

A variety of storage media have been used for spermatozoa retrieved from artificial spermatoceles. Wagenknecht et al (1980) froze bull spermatozoa in a lactose glycerine-egg yolk mixture for six weeks at −196 C. These specimens were thawed and successfully inseminated. These data may reflect species differences, since human spermatozoa that have been retrieved from artificial

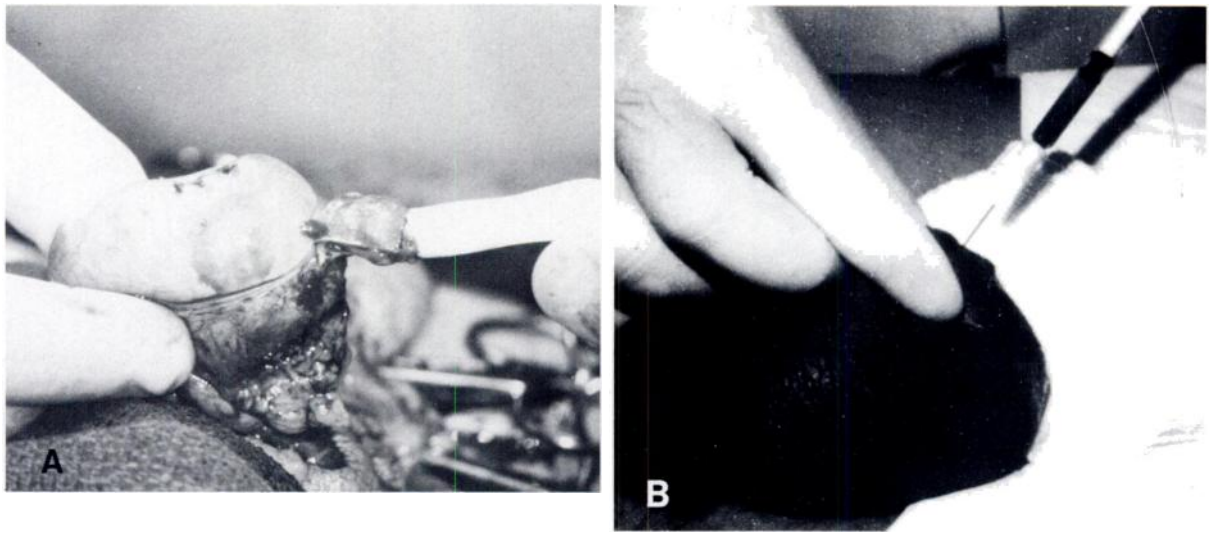

Fig. 3. A: shows the graft of expanded polytetrafluoroethylene sutured to the rudimentary caput of the epididymis. B: demonstrates aspiration of the graft using a 23-gauge needle attached to a tuberculum syringe.

spermatoceles did not freeze well (Vickers, 1975). In contrast, aspirated human spermatozoa have been placed in different types of media for storage and for possible enhancement of sperm motility. Cruz (1980) used 0.6 ml of seminal fluid and 0.3 ml of saline with 5% glucose when he achieved a pregnancy in a human patient. Others (Kelâmi et al, 1977; Wagenknecht et al, 1980) have used similar media, but in human patients the motility was poor.

In our cases, the retrieved spermatozoa were all nonmotile. We examined the aspirate for sperm antibodies, but the titers were negative. We then incubated the spermatozoa in a variety of media. There was no improvement in motility with Baker's buffer, 10% albumin, human semen, and 5% fructose. Clearly, more studies are needed on the role of the storage media in these cases.

Lastly, the timing and frequency of the aspiration needs to be clarified. Even though these patients are highly motivated, they seem reluctant to undergo needle aspiration more often than once a month. Furthermore, more frequent punctures may lead to infection, which is an alarming problem. Infected grafts of expanded polytetrafluoroethylene must be removed because our histologic date demonstrated evidence of bacterial invasion of the fabric. At the conclusion of the aspiration technique, we placed a 0.2–0.4 cc of buffered cephalosporin into the graft in an effort to guard against infection. In the future, more research is needed to standardize the aspiration procedure and the frequency of the taps. The most productive retrieval in mini-pigs was between the third and fifth postoperative days (Kelâmi, 1977). In dogs, grafts were punctured every other week (Cruz, 1980). In human cases, the grafts have been tapped as early as the first week postoperatively and again at monthly intervals to coincide with the wife's ovulation. The initial taps were usually bloody, but they eventually became clear.

Vickers (1975) removed a 12-inch segment of the

TABLE 3. The Protocol for Aspiration of Artificial Spermatocele—Use of Four Syringes and One Needle

Syringe 1—Start with a 1.0 cc tuberculin syringe attached to a 23-1 gauge needle. Load with 1.0 cc 1% xylocain. Inject into the skin, and puncture graft with needle and remove syringe.
Syringe 2—Attach empty syringe to needle already in the graft, withdraw aspirate for storage and insemination.
Syringe 3—Load another syringe with 1.0 cc Baker's buffer, wash inside the graft through the needle already in place, and remove washed material.
Syringe 4—Load final syringe with 1.0 cc Cephalosporin (250 mg/5 cc), introduce 0.2–0.4 cc into the graft, then remove the needle and the syringe.

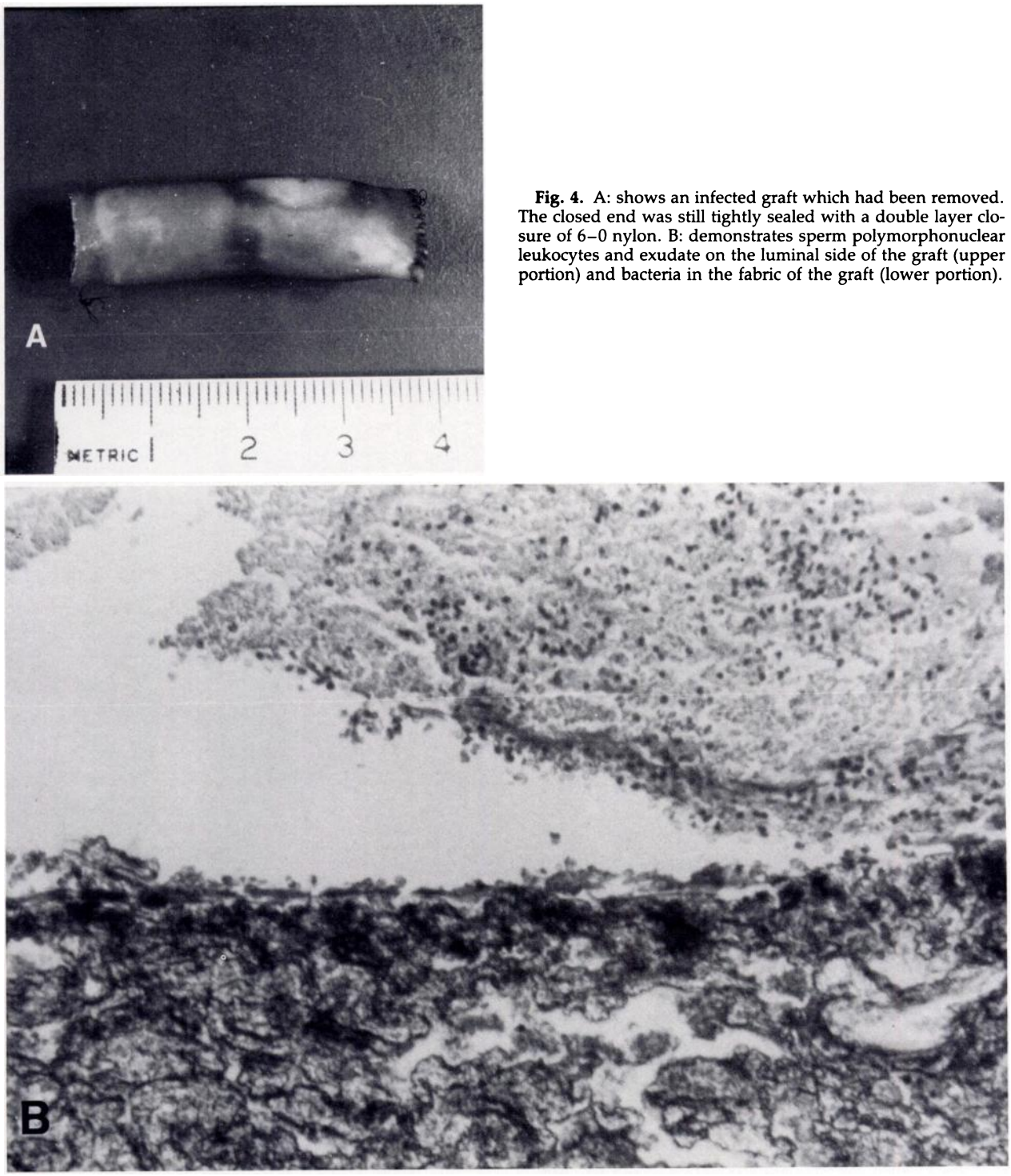

Fig. 4. A: shows an infected graft which had been removed. The closed end was still tightly sealed with a double layer closure of 6–0 nylon. B: demonstrates sperm polymorphonuclear leukocytes and exudate on the luminal side of the graft (upper portion) and bacteria in the fabric of the graft (lower portion).

epididymal tubule at operation. He expressed the spermatozoa between two glass slides, but insemination with this material was unsuccessful. In the future, however, spermatozoa from the epididymal tubule may be used for *in vitro* fertilization (Moore et al, 1983; Schoysman, 1982).

In summary, we believe that the practical use of an artificial spermatocele would be important for the armamentarium of the andrologic surgeon. However, much research is needed to improve our existing prosthesis and to better understand other factors associated with this procedure.

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