Vasectomy or male sterilization has recently emerged as one of the simplest, most popular and most readily available forms of voluntary family planning. In the Asian subcontinent the number of vasectomies has exceeded female sterilizations and/or IUD insertions for several years. It is estimated that six million vasectomies were performed in India alone in the years from 1968 through 1972. In Pakistan, Bangladesh and Nepal, male sterilizations exceed female sterilizations. In Latin America and Arab countries as well, men are showing considerable interest in the procedure whenever it is available.

Vasectomy has become increasingly popular in developed countries during the last few years. Spurred by publicity on the hazards of various female methods of fertility control, family men throughout the world have discovered that this simple, one-time procedure can spare their mates the inconvenience of daily pills or IUDs, not to mention the more complicated female sterilization.

Vasectomy, performed on healthy, psychologically well-adjusted men, does not significantly affect male hormonal balance, sexual desire, capacity for erection, or ejaculation of semen. The operation involves the cutting or blocking of each vas deferens, the two tubes which carry sperm from the testes to the penis (see Fig. 1). Through a small incision in the scrotum, the surgeon cuts, ties, coagulates, and/or clips the vasa. Local anesthesia is commonly used. After resting briefly from the 10- to 15-minute procedure, the patient walks out of the office, clinic, or mobile unit.

Vasectomy provides some advantages that no other birth control method can offer. It is:

- effective, as a one-time procedure that eliminates the need to buy and use contraceptives;
- safe, with slight morbidity and almost no mortality;
- simple, requiring minimal extra training for most physicians;
- short, taking only 10 to 15 minutes;
- convenient, since only local anesthesia is required;
- inexpensive, compared with female sterilization which requires more extensive surgery and equipment;
- culturally acceptable in many countries, especially where the man makes the crucial decisions on sexual activity or reproduction;
- culturally preferable in countries where women hesitate to go to a male doctor and female doctors and paramedics are scarce.

On the other hand, vasectomy also presents certain obvious disadvantages. For example:

- Surgery is required.
- There are occasional complications such as bleeding or infection. (This subject will be covered in a future report.)

This report on male sterilization was prepared by Judith Wortman and P. T. Piotrow, Ph.D., on the basis of published studies, unpublished papers and discussions with individual investigators. The assistance of Drs. Joseph E. Davis, Caroline Dey, Frederick Frenelli, Louis Keith, Stanwood Schmidt, J. Joseph Spedel and Keith Waterhouse in reviewing the report is much appreciated. Frances G. Conn is executive editor.

The Summary on pages 1 and 2 has been prepared for the general public. The remainder of the report is designed primarily for professional family planning personnel. Comments, letters and additional updated material will be welcome for later publications.

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Vasectomy does not provide full protection until sperm already stored in the reproductive system are ejaculated (a matter of days, weeks or months).

• It is not suitable for men who desire children at a future date because, in most cases, it is not reversible.

• Psychological problems related to sexual behavior may be aggravated by any operation involving the male reproductive system.

• For men who equate masculinity with the ability to make a woman pregnant, vasectomy holds little appeal.

Today, while vasectomy is increasing in popularity among couples who have all the children they want, research on male fertility control is focusing on simpler techniques and reversibility. Among the new developments being tested are clips, electrocautery, plugs, valves, and chemicals.

This report deals both with well-established techniques for performing vasectomy and with experimental methods as reported by different physicians. A future report will deal with effectiveness, complications, and side effects of vasectomy.

**HISTORY**

Vasectomy, a simple procedure designed to block the passage of sperm through the vas deferens, was not understood until the 19th century and was not performed as a method of voluntary fertility control until the 20th century. It is clearly different from castration, a form of sterilization which eliminates the production of male hormones through removal or impairment of the testes.

Traditionally, castration was performed on persons selected to serve as court eunuchs, or in certain religious orders, or as punishment. There is no place for castration in modern voluntary fertility control programs. Some physicians object even to the term "sterilization" in referring to vasectomy because the testes and germ cells are left intact. Vas occlusion or surgical birth control has been suggested instead.

An early reference to vas occlusion was made by the English surgeon and anatomist John Hunter in 1775. While performing a dissection, Hunter noted an obstructed vas deferens in the cadaver on which he was working (58). In 1830 Hunter's student, Sir Astley Cooper, began experimental work on vasectomy. Using dogs, he ligated the artery and vein of the spermatic cord on one side without touching the vas; on the opposite side, he ligated the vas itself. On the side where the artery and vein were obstructed, the testis became gangrenous. On the side where only the vas was obstructed, the tissue remained healthy and sperm survived in the ductal tract up to the point of obstruction. The epididymis, or convoluted portion of the vas, gradually enlarged to accommodate the sperm (29).

In 1853 Felix Guyon, a French surgeon, concluded that blocking the vas caused atrophy of the prostate gland (70). This finding encouraged genito-urinary surgeons of the 1890s to perform vasectomies concurrently with prostate operations in order to reduce the size of the gland and to avoid postoperative epididymitis (54). One of the first such operations is credited to Dr. H. G. Lennander of Upsala, Sweden, who in 1897 published a report on his technique (98). Today, some surgeons continue to perform vasectomies in conjunction with prostate operations. Although with the procedure used currently the prostate is not found to shrink significantly, the incidence of postoperative epididymitis is reduced.*

Dr. Harry Sharp of Indiana (USA) reported performing a vasectomy in 1899 on a mentally ill patient whose complaint was excessive masturbation. The patient consented to the operation, believing it would relieve his obsession. The results, undoubtedly psychological, were favorable. In the next ten years, Sharp performed 456 voluntary vasectomies on both healthy and institutionalized men for the purpose of sterilization (109).

In the early 20th century, vasectomies were sometimes carried out for eugenic reasons on criminals, the mentally ill, the retarded, or those with hereditary disease (58, 96). Paradoxically, even as its contraceptive effects were being documented, the operation was performed by Eugen Steinach, an Austrian exile, for the purpose of overall bodily rejuvenation. From his experiments on rats, Steinach determined that following ligation of the vas, the sperm-producing tissue degenerated while at the same time there was hypertrophy (excessive growth) of the hormone-producing tissue, which, in turn, caused renewed germ cell production. This process was originally thought to counter the effects of aging (112). Later, Steinach's hypothesis was refuted, but doctors and scientists continued to advocate the operation for contraceptive purposes.

As national family planning programs were initiated in South Asia in the 1950s and 1960s, vasectomy filled the obvious need for a simple, inexpensive birth control technique that could be offered on a one-time basis. In East Pakistan (now Bangladesh) and India, female physicians were scarce and women living in rural areas would not go to a male doctor for a pelvic examination, much less sterilization.

*Personal communication, J. E. Davis, November 1973.
tion. Vasectomy, on the other hand, could be offered by male doctors to male volunteers. This factor, plus a system of remuneration or incentives for canvassers, physicians, and volunteers, stimulated large-scale vasectomy programs.

Meanwhile in the United States and Europe vasectomy received a major boost when adverse publicity about the oral contraceptive coincided with a feminist campaign to encourage greater male responsibility in reproduction. In the USA, the number of vasectomies jumped from a quarter of a million in 1969 to three quarters of a million in 1970 and is now leveling off at about half a million.

Although the number of vasectomies performed throughout the world fluctuates from year to year depending on publicity, national budgets or program guidelines, the simple procedure of vasectomy has clearly taken its place as a major technique in voluntary family planning.

Fig. 1. Male reproductive system showing the area of vasectomy.

Preoperative preparations vary. In many cases, the patient is asked to wash and shave the scrotum and/or the underside of the penis and the inner thighs before coming to the health center. In other cases, practitioners or their assistants prefer to handle these preparations themselves immediately before the vasectomy. Preliminary cleansing reduces the bacteria in the pubic area. Solutions used for cleansing include an aqueous antiseptic such as benzalkonium chloride (tincture of Zephiran) or a one percent solution of chlorhexidine or an antiseptic soap such as PhisoHex (27, 94).

Somewhat different procedures were developed for massive vasectomy programs. For example, in November-December 1970 vasectomies were performed on a large-scale in Kerala state, India. When the patient arrived at the vasectomy camp site, he was directed to a booth where his name and relevant facts were recorded. He was then escorted to an area partitioned by sheets where a physical examination was performed. If a skin disease was found in the genital area, the patient was not considered eligible for a vasectomy. Instead, the disease was treated and the patient told to wait until the infection had cleared before having his vasectomy. If the patient proved healthy, he was then led to a section for preoperative shaving and washing, and finally, to the operating theater (6).

**ANESTHESIA**

Most physicians choose to perform vasectomy in an outpatient facility. Because local anesthesia is safe, quick, and inexpensive, it was recommended for use in developing countries by the International Planned Parenthood Federation Panel of Experts, which met in Bombay in February 1973. In a hospital setting general anesthesia is sometimes used, but it is now increasingly reserved for complicated cases (76).

**Local Anesthesia**

Local anesthesia has many advantages. Patients recuperate rapidly after surgery and complications caused by local anesthesia are rare. Administration of the anesthetic, usually 1.5 cc of one or two percent lidocaine (lignocaine, Xylocaine), is simple. After palpatung the thin skin high in the scrotum to locate an area without blood vessels, the physician may either inject the anesthetic under the skin and then deeper into the sheath of the vas (48, 56), or more likely, he will inject first, make the scrotal incision and then inject additional anesthetic into the vas sheath (16, 36, 74, 116).

If a patient is apprehensive, he may be given a tranquilizer or sedative. Ten milligrams of intravenous diazepam (19), or an oral tablet of diazepam (11, 43) are sometimes used. Most doctors find such medication unnecessary, however.

To minimize patient discomfort, the practitioner may roll the vial of anesthetic in his hands until the chill is removed. A fine needle (23-27 gauge) is used for the injection (20, 77). Local anesthesia decreases the abdominal discomfort which may be felt when the vas is drawn out of the scrotal sac (41). Although some physicians believe that injecting anesthesia directly into the vas further diminishes abdominal discomfort (40), the majority do not do so because of possible damage to the pampiniform plexus of veins (77). In 1972 Gould reported adding methylprednisolone acetate (Depo-Medrol) to one percent lidocaine hydrochloride to minimize patient discomfort. Of 100 patients on whom the combined drugs were used, 75 reported no discomfort at all, 23 reported slight discomfort lasting one day, and two reported moderate or severe discomfort (55).
There is no consensus as to whether adrenaline (epinephrine) should be added to the local anesthetic. Physicians who find that adrenaline both prolongs the effect of local anesthesia and reduces bleeding (74) administer it in a 1:100,000 concentration (11, 16, 17, 24, 58, 63, 94, 123). The reduction in bleeding is caused by the constriction of arteries. Since a prolonged impairment of the blood supply may damage healthy tissue, if adrenaline is added, the local anesthetic should be injected only into the skin, not the deeper tissues (103). Vasectomy is a short and relatively bloodless procedure and, therefore, the need for adrenaline has been questioned.

**General Anesthesia**

General anesthesia, although not routinely used for vasectomy, may be required in special cases in which:

- The patient has a physical problem such as a scarred inguinal area or a very thick scrotum (16, 75).
- The physician is using a time-consuming or complicated technique in dividing the vas and separating the ends (121).
- Intrascrotal pathology is present (i.e., hydrocele, varicocele) which could make isolation of the vas more difficult.
- Additional rest and care are required for other reasons, for example, to prevent postoperative morbidity or resurgence of a pathological condition (20, 60).
- A patient is allergic to local anesthetics.

Dr. Joseph Davis, Professor and Chairman of the Department of Urology at New York Medical College and President of the Association for Voluntary Sterilization (USA), reports that a local anesthetic such as procaine hydrochloride has at times permanently interfered with the vas peri-stalsis and sperm transport which are necessary for reversibility (118). More studies are needed to substantiate this finding.

General anesthesia is more expensive than local and requires additional equipment and trained manpower. It poses a special hazard for men in poor health, particularly those with respiratory or cardiac problems (16). Therefore, local anesthesia is likely to remain more suitable for routine vasectomies except where other factors complicate the prognosis.

**PROCEDURE**

Exclusive of anesthesia, a vasectomy operation, from the scrotal incision to closure of the incision, usually takes 10 to 20 minutes (27, 50, 71).

As Dr. Siddharth D. Khandwala of the Family Planning Hospital in Bombay has observed, there are almost as many different techniques for vasectomy as there are doctors performing them.* There is no international statistical comparison of failure rates and complications with different vasectomy techniques to help physicians select the best method. While some techniques have been discarded, others have persisted because a particular physician or group of physicians is skilled in their application and has achieved a high success rate.

Specific differences are found in techniques for immobilizing the vas, for making the scrotal incision, for treating the cut ends of the vas, and for removing segments of vas (see Table 1). Physicians are still experimenting to find simple and safe techniques which would provide complete protection against the passage of sperm and, at the same time, improve the chances of later reversibility.

**Identification and Isolation of the Vasa**

The two vasa are seen as white tubular structures lying one on each side of the scrotum. They are the most solid structures in the midscarotum and can be differentiated from blood vessels because they do not pulsate (20). In some cases, however, the vas may be difficult to identify. Bands of cremaster muscle, thrombosed veins or thickened lymphatics have been mistaken for vasa (77). Locating the vas is specially difficult in patients who have a thickened scrotal skin, an unusually thin vas, a thick matted spermatic cord, an undescended testicle, or a cremaster muscle which contracts and pulls the testes upward (77, 99).

Under normal circumstances, the vas can be felt under the skin by palpating the scrotum. Both vasa should be identified before proceeding so that the same vas will not be resected twice by mistake (58).

Although the spermatic cord containing the vas includes blood vessels, the vas itself can usually be separated from these vessels and worked into a position directly beneath the scrotal skin by manipulation between the fingers. Once the straight portion of vas is identified high in the scrotum, it is usually held immobile between the thumb and forefinger. At this point, practice varies. A preferred technique has not yet been established. Most practitioners inject the local anesthetic while holding the vas to avoid any patient discomfort. Others wait to inject the anesthetic until after the vas is firmly anchored by an instrument and the fingers are free.

To insure immobility, some practitioners pass a straight needle through the scrotal skin, under the vas and out through the skin again (99). Others secure the vas through the skin with a towel clip or a special vasectomy clamp (see Fig. 2). Dr. Russell Morgan of St. Luke's Hospital in Bethlehem, Pennsylvania (USA) warns, however, that grasping the vas carelessly with a pointed towel clip may pierce a vein and cause a hematoma. He prefers, therefore, to isolate the vas after the scrotal incision is made (92).

**Scrotal Incision**

The vas, firmly anchored in the front of the scrotum in an area without blood vessels, is then covered only by the dartos muscle and the scrotal skin. After the local anesthe-

*Personal communication, S. Khandwala, November 18, 1971.
tic has taken effect, an incision is made high in the scrotum through the skin and muscle exposing the straight portion of the vas and its sheath. Either a single incision may be made in the scrotal raphe (midline) (11,26,56,92,93) or two incisions may be made, one over each vas (17,34,48,51,56,51,126). If a single incision is used, the physician usually identifies each vas carefully to make sure that the same vas is not cut twice.

**Action on the Vasa**

The action performed on the vasa to assure occlusion and thereby to prevent passage of sperm is obviously the most crucial step in the vasectomy. The procedure chosen usually determines both the effectiveness of the operation and the likelihood of future reversibility.

In most vasectomy techniques, both vasa are cut. The ends are then sealed by ligating, fulgurating, clipping, or any combination thereof. A segment may or may not be removed (see p. D-8). Because there is always a possibility that the severed ends of the vas may grow back together or be rejoined by the formation of granulation tissue, these occluded ends are often turned away from each other, or the sheath of the vas is pulled around one of the cut ends, thus creating a barrier of fascial or connective tissue.

**Ligation**

Practitioners disagree as to whether absorbable or non-absorbable materials should be used in tying the vas. Absorbable materials such as catgut are used by many physicians (24,51,62,118). They do not require later removal, but the danger is that they may be absorbed before the vasa are sufficiently blocked (17,38).

Nonabsorbable materials such as silk (17,41,45,48,73,74,79,88), cotton (63,85), dacron (14), or stainless steel wire (92) have been used with good results and are generally considered safe. However, there have been a few scattered reports documenting tissue irritation, sperm granuloma (a mass formed around an accumulation of sperm and cellular debris) and subsequent recanalization (42,103). (These materials, especially silk and cotton, continue to be used, however, by those physicians who have not encountered any complications or failures with their use (40,89).)

The vas is thick walled and has a narrow lumen. Therefore, it is difficult to determine the precise tension required for ligating the lumen without destroying wall tissues. Davis cautions against using too fine a ligature. Tied too tightly it may cut through the vas allowing sperm to leak through. In most cases epithelial cells follow the sperm and become affixed to the vas ends permitting recanalization (36,64,77,105). The cutting action of the sutures is probably accelerated by peristaltic waves which push the sperm against the ligature (104).

If the vas ends are ligated, Laroque suggests that the operator hold a long strand of suture material until both vasa are tied off. This reduces the risk of ligating the same vas twice and also prevents the ends of the vasa from slipping back into the scrotum before occlusion is confirmed (82).

**Electrocoagulation**

Fulguration of the vas (coagulation with a needle electrode) is intended to destroy the epithelial lining without disrupting the surrounding musculature (13). An active proponent of fulguration, Dr. Stanwood Schmidt of the University of California Medical School in San Francisco, states:

Ligatures should not be used because they often cut into the lumen of the vas, inviting leakage of spermatozoa, sperm granuloma, and possible recanalization (105).

On the other hand, he argues that fulguration creates a firm scar at each end of the vas, thereby preventing granuloma. Furthermore, Schmidt suggests that if fulguration is used:

- Resection of a long segment of the vas as is sometimes advocated, is unnecessary, mutilating, and may prevent subsequent surgical vasovasostomy (104).

After locating the vas high in the scrotum, Schmidt fulgurates the proximal vas with a needle electrode introduced approximately 4 mm in the lumen. As the current is turned on, the needle is simultaneously withdrawn so that the full thickness of the vas is not destroyed. Only the mucosa and underlying cells are affected. The muscle is not blanched, nor are surface blood vessels destroyed. The distal end of the vas is fulgurated on the cut surface only and the vas sheath is closed over it with a single suture. This creates a fascial barrier between the vas ends and offers protection against recanalization. The tissue so treated is neat and regular compared to the irregular tissue resulting from ligation. Using this method, Schmidt has not yet encountered any failures among 1,550 consecutive cases."

It is impossible to say exactly which factors account for the great effectiveness of this procedure—fulgurating, interposing a fascial barrier, or a combination of the two techniques. Fulguration in conjunction with the fascial barrier technique is also recommended by Dr. George Denniston of Seattle, Washington. In order to prevent damage to other tissue, he insertsthe electrocaucuty needle 2 mm into the lumen of the vas and withdraws the needle as soon as the current is turned on. Only the end of the vas turns white, leaving a cone of cauterized tissue (41).

Not all physicians experimenting with electrocoagulation have been satisfied. Hanley reports that his patients suffered pain along the spermatic cord (60). Scott reports cord edema with pain extending up to the inguinal canal lasting several days (105).

Schmidt, on the other hand, who coagulates only a small portion of the inner wall of the vas, notes that his patients do not experience pain.

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<th>Author and Date</th>
<th>Reference Number</th>
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<th>Scrotal Incision Size and Location</th>
<th>Instrument Used to Grasp the Vas</th>
<th>Action on Each Vas and Treatment of Ends</th>
<th>Length of Vas Removed</th>
<th>Material Used for Closure of Skin Incision</th>
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<tr>
<td>Altman 1972</td>
<td>12</td>
<td>local (2 ml of 1% lidocaine in epinephrine)</td>
<td>single, left side of scrotum</td>
<td>atraumatic vasectomy forceps</td>
<td>vas cut; ends crushed and doubly ligated</td>
<td>unspecified</td>
<td>a single inverted mattress suture of fine catgut with knot buried</td>
</tr>
<tr>
<td>Blandy 1972</td>
<td>16</td>
<td>local (1% lidocaine in 1:100,000 epinephrine) general unspecified</td>
<td>unspecified</td>
<td>tenaculum forceps</td>
<td>vas cut; ends ligated with 000 black silk suture</td>
<td>unspecified</td>
<td>one vertical mattress suture of 000 plain catgut</td>
</tr>
<tr>
<td>Brodsky 1973</td>
<td>22</td>
<td>local (2 cc of 1% lidocaine solution)</td>
<td>two incisions 1/2 inch transverse</td>
<td>unspecified</td>
<td>removal unspecified</td>
<td>unspecified</td>
<td>a single Dexon suture</td>
</tr>
<tr>
<td>Bruce 1973</td>
<td>25</td>
<td>local (5 ml of 2% lidocaine solution in epinephrine)</td>
<td>single, midline 1 cm long</td>
<td>Allis forceps</td>
<td>vas crushed on either side of forceps, then cut; one end pulled out of covering and crushed again; both ends ligated with No. 1 chromic catgut suture</td>
<td>1 cm</td>
<td>absorbable sutures</td>
</tr>
<tr>
<td>Gersh 1972</td>
<td>51</td>
<td>local (1 ml of 1% lidocaine)</td>
<td>two incisions 1/4 inch long</td>
<td>Allis forceps; grasps vas while needle passed under vas holds it in place</td>
<td>vas cut; ends ligated with 000 catgut; mucosa fulgurated with needle electrode</td>
<td>1 cm or less</td>
<td>adhesive bandage</td>
</tr>
<tr>
<td>Greene 1971</td>
<td>56</td>
<td>local (2 ml lidocaine)</td>
<td>two incisions 1-1.5 cm vertical</td>
<td>towel clip before incision; Allis forceps after incision</td>
<td>vas electrocoagulated; 1/2 cm</td>
<td>1/2 cm</td>
<td>plain catgut</td>
</tr>
<tr>
<td>Hobbs 1972</td>
<td>61</td>
<td>local (3-5 ml of 1% lidocaine in 1:200,000 epinephrine)</td>
<td>two incisions 1/2 inch long</td>
<td>Allis forceps</td>
<td>vas cut, crushed, ligated with chromic catgut suture; vas ends folded back on themselves and ligated again</td>
<td>1/2-1 inch</td>
<td>a single suture of braided silk</td>
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<tr>
<td>Howard 1973</td>
<td>63</td>
<td>local (1% lidocaine in 1:100,000 epinephrine)</td>
<td>single, midline 1 cm transverse</td>
<td>unspecified</td>
<td>vas cut; ends ligated 5 cm</td>
<td>0000 chromic sutures</td>
<td></td>
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<tr>
<td>Morgan 1972</td>
<td>92</td>
<td>local (unspecified)</td>
<td>single, midline 4 mm vertical</td>
<td>Allis forceps</td>
<td>vas cut; ends ligated 1 inch with two ties of monofilament stainless steel wire</td>
<td>1 inch</td>
<td>sterile adhesive tape</td>
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<tr>
<td>Moss 1972</td>
<td>94</td>
<td>local (1% lidocaine in 1:100,000 epinephrine)</td>
<td>single, midline 3 mm long</td>
<td>towel clip</td>
<td>vas cut, two medium tantalum clips applied to each end</td>
<td>5 mm</td>
<td>nothing</td>
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Table 1—Vasectomy Techniques Used in Selected Studies, 1971-1973 (Cont.)

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<tr>
<th>Author and Date</th>
<th>Reference Number</th>
<th>Anesthetic</th>
<th>Scrotal Incision Size and Location</th>
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<th>Material Used for Closure of Skin Incision</th>
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</thead>
<tbody>
<tr>
<td>Schmidt 1973</td>
<td>104</td>
<td>local (1% lidocaine)</td>
<td>two incisions, upper part of scrotum</td>
<td>Allis forceps</td>
<td>vas cut; mucosa and submucosa of proximal vas fulgurated; distal vas fulgurated on cut surface only; ends placed on different fascial planes</td>
<td>none</td>
<td>cotton or no sutures</td>
</tr>
<tr>
<td>Scott 1972</td>
<td>107</td>
<td>general (unspec)</td>
<td>two incisions</td>
<td>unspecified</td>
<td>vas cut; upper end ligated and folded back on itself</td>
<td>1.5-2 cm</td>
<td>continuous fine catgut</td>
</tr>
<tr>
<td>Tauber 1973</td>
<td>114</td>
<td>local (unspec)</td>
<td>single, midline towel clip</td>
<td>0.5-1 cm</td>
<td>vas cut; ends fulgurated and clamped with tantalum clips</td>
<td>1 cm</td>
<td>nothing</td>
</tr>
<tr>
<td>Weiss 1972</td>
<td>123</td>
<td>local (5 cc of lidocaine in 1% epinephrine)</td>
<td>two incisions</td>
<td>two towel clips before incision; mosquito forceps after incision</td>
<td>vas cut; ends stapled twice</td>
<td>unspecified</td>
<td>plain catgut with a subcuticular stitch</td>
</tr>
</tbody>
</table>

*lidocaine hydrochloride = lignocaine, Xylocaine hydrochloride*

### Clips

A third and still experimental method for interrupting the passage of sperm is the application of clips to the vas. The major advantages of clips, as summarized by Dr. William Moss of the University of California, are:

- Clipping is faster than ligating.
- It is easier to judge pressure precisely in applying clips than in tying sutures.
- Tantalum, the metal from which clips are made, is strong, nonabsorbable, and biologically inert (94).
- A vasectomy is potentially reversible when clips are applied to the vas.

Either four or six clips are usually used to divide each vas so that two or three clips appear on each cut end (see Fig. 2). Dr. Moss brings one loop of vas through a midline scrotal incision and then applies two medium tantalum clips (Weck Hemoclip) to the proximal and distal ends of the loop before dividing. The clip closest to the cut end is firmly closed while the adjacent clips are applied in an occluding but noncrushing manner. The same procedure is then carried out on the second vas through the same scrotal incision. Five millimeter segments of vas are removed for histological study to verify that only vas was removed.

Some doctors prefer to use more than two clips on each vas (93). In a 1971 study, Jhaver et al. determined that at least two clips were needed on each end. In experiments with dogs, these investigators found that some clips were displaced postoperatively. This was caused by contractions in the vas with a subsequent buildup of pressure behind the clips plus possible tissue necrosis (destruction) of the vas wall. Usually the clips were found in the scrotum adjacent to the vas. When Jhaver tried to reverse the procedure in several cases where the clips were still in place, he had difficulty prying them open (69).

Most physicians using clips report a low failure rate. Dr. Abel Leader of Houston, Texas, who like Moss applies two clips to each end of the vas, removes a segment of vas and stitches a fascial barrier over the proximal end (toward the testis). He encountered only two failures in 1300 vasectomies in which clips were used. One failure, early in the series, apparently occurred because only one clip was applied to each vas. Investigators now agree that one clip is insufficient (84). A future report will deal with clip sterilization in the female.

Although physicians throughout the world are using clips with increasing frequency, they are still experimental. There is need for research which will improve their design, their applicators, and procedures for their use. Also, there is need for information concerning the effect clips have on the vas musculature, the inner mucosa, and the portions of the vas proximal and distal to their placement.

### Staples

A procedure similar to clipping was described recently by Weiss and Vallejos (123). With a specially designed instrument, they applied staples to the vas (see Fig. 11). This seems to be the only published report to date on staples.

### Preventing Recanalization

Simple ligation, or fulguration, or in some cases even multiple clipping of the vas is not always effective in preventing
recanalization (the growing together of the vas ends). Even ligation plus the removal of a segment of the vas may not be sufficient to prevent recanalization \(60,83\). The following procedures are sometimes used as a safeguard:

- The ends of the vas are folded back on themselves, pointing away from each other, and ligated a second time \(20,64,61,68,73,116\).
- The ends are crossed and ligated together.
- One end is ligated; the other is folded back upon itself and then ligated \(107\).
- A fascial plane is interposed between the ends of vas by burying one end inside the connective tissue sheath and leaving the other outside the sheath \(66,73,124\).

Some of these techniques may be combined. The consensus among participants at the workshop on clinical aspects of male sterilization at the Second International Conference on Voluntary Sterilization was that turning the ends of vas back upon themselves and interposing a fascial barrier is effective and should be encouraged \(37\).

### Removal of a Vas Segment

Most of those performing vasectomy remove a segment from the straight portion of each vas high in the scrotum and far from the convoluted epididymis. A high resection may make future reanastamosis possible but there is disagreement as to how large a segment should be removed. A few practitioners remove none of the vas at all. Some suggest that as little as \(1/4\) inch or less than \(1\) cm \(24,114\) is adequate. Others recommend almost three inches or \(8\) cm \(17,27\). Most practitioners remove \(1\) to \(3\) cm \(14,20,38,40,48,56,61,74,92,107,114,118,126\).

If histological examination is desired, removal of a vas segment provides a specimen which will confirm that vas and not some other structure was removed. By preventing a natural rejoining of the vas ends, removal of the large segment also prevents future surgical rejoining should this be desired. The smaller the segment removed, the easier it is to rejoin the ends surgically at a later time.

### Suture of the Scrotal Incision

After the action on the vas is concluded, Davis recommends ligating all bleeding vessels in the scrotal wall as well as vessels around the vas to prevent hematomas. Once the problems of bleeding are resolved, the scrotal incision is closed.

Most doctors use absorbable sutures such as catgut to close the scrotal incision \(11,16,17,24,27,48,56,68,123\). A single mattress suture, used to match the skin edge, may include the underlying dartos muscle to block bleeding into the scrotum by small vessels at the skin edge and thus reduce the incidence of postoperative hematoma. The suture knot is buried deeply in the scrotum \(11,26\).

Other practitioners object to catgut, believing that it may produce minor skin sepsis \(32,34\). They prefer nonabsorbable sutures which are removed after four days, at which time the wound is examined to be sure it is healing properly. Hobbs uses a single braided silk suture which stays in place five days \(61\). Williams uses a continuous Dexon suture, including the skin and deeper layers of the scrotum in order to foster hemostasis (the arrest of bleeding) \(124\). Konsim uses clips to close the incision.

If the incision is small enough (one centimeter or less) the skin edges come together closely and sutures may not be necessary \(77\). In such cases, the doctor or the patient himself applies slight pressure with sterile gauze to assure hemostasis, and a small dressing or adhesive bandage is placed over the incision site \(51,94,116\).

Fig. 2. A vasectomy operation in which Weck Hemoclips are applied to the vas. The steps are as follows:

1. An incision is made high in the scrotum directly over each vas.
2. A loop of vas is drawn through the scrotal incision.
3. A clip is applied to each end of the loop with a special applying forceps (see Fig. 10).
4. A second clip and possibly a third is applied at each end of the loop.
5. The segment of vas between each set of clips is cut out.
6. The scrotal incision is closed.

Weck Hemoclips are manufactured by: Edward Weck & Company, Inc., 49-33 31st Place, Long Island City, New York USA. Cost: $32.50 (US) for 250 clips.

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*Personal interview, J. E. Davis, July 1973.*
Neumann argues the case against applying clips or sutures to the scrotal incision. He points out that a small incision shrinks after surgery, that if there is any oozing or bleeding, it will be noticed more readily and can be treated more promptly without sutures, that sutures and clips are uncomfortable, and that the patient must return for their removal (95). Another investigator, Leader, adds that "necrosis of the skin edges, swelling and the bleeding associated with passage of the needle are avoided" if sutures and clips are not used (85).

**POSTOPERATIVE CARE**

At the conclusion of the procedure, a small gauze bandage is usually placed over the incision and held in place by an athletic supporter or scrotal suspensory, (14,22,24, 68,74,114,116). The dull ache (dragging sensation) in the scrotum that some patients feel when walking after vasectomy is alleviated to some extent by this support (41). A patient wears the support for 24 hours (41,50), two to three days (14,74), one week (51), or even two weeks (94). An ice bag applied to the scrotum also helps counteract swelling and relieves discomfort (14,22,41). Mild analgesics are sometimes prescribed for pain (41,61).

**Rest**

Most doctors suggest that vasectomy patients rest 15 minutes to a half hour before going home (16). Some permit patients to leave immediately if they can avoid driving or do not have far to go. Many doctors believe there is a greater danger of hematoma formation or other complications if the patient moves about immediately after the operation. Therefore, they advise rest periods ranging from three to four hours (48,51,121) or up to 24 or 48 hours (20,22,28,123).

Nevertheless, many men have returned to work the same day without serious consequence if no heavy labor was involved. Moss found that 21 percent of his patients returned to work the same day, 58 percent the following day, and 17 percent a day later (94). In any case, the patient is advised to refrain from physical exertion for one day and from heavy physical work for two days (58). The IPPF Panel of Experts recommended, however, that vasectomy should interrupt a man's daily life as little as possible. The Panel discouraged any unnecessary enforcement of a long rest period, especially if a man needed to return to work quickly to produce income.

During the large-scale vasectomy program in Kerala state, India, held in 1970, incentive payments equal to 101.00 Rs in cash, food, and clothing were used both to encourage men to accept vasectomy and to compensate them for time lost from work. After the operation, local patients were transported to their homes, and others taken to bus terminals or train stations. As an incentive, those men who had a vasectomy while employed in government, commercial and industrial concerns were given six days leave with pay. All were advised to rest a few days and do only light work for ten days after the vasectomy (81).

**Bathing**

Most doctors instruct their patients to keep the scrotum dry for 24 hours (28,58,77,94). Even physicians who permit bathing immediately after the procedure advise their patients to dry well and sometimes to powder the scrotum (107).

**Sexual Intercourse**

How soon after vasectomy may a patient engage in sexual intercourse? The answer varies. Some doctors advise no intercourse for five to seven days (14,41,58,74) so that the proximal stump of the vas can heal before pressure is placed on it by ejaculation. Some doctors recommend waiting ten days or longer (20,42,51). Gersh justifies this interruption in sexual activity on the basis of his "clinical impression of a high incidence of sperm granuloma formation if this routine is not followed" (51). Although some physicians suggest that their patients resume intercourse as soon as they "feel like it" (28,61,99,116), it is unlikely that patients will desire intercourse immediately after the procedure.

**POSTOPERATIVE SPERM COUNT**

A major disadvantage of vasectomy as a method of fertility control is that the operation does not bestow immediate sterility as does female sterilization. Until all sperm between the site of vasectomy and the point of ejaculation are expelled, the patient is capable of causing a pregnancy. The expulsion of sperm stored in the reproductive tract may take anywhere from one week to several months. Postoperative semen tests are now recommended until the patient is sterile.

Generally, vasectomy patients are asked to submit a postoperative semen sample at either six weeks (16,17, 24,28,107), eight weeks (45,51,116,122), or twelve weeks (60,67,100,123), and every two to four weeks thereafter until two consecutive sperm counts are found to be negative. The time required for two consecutive negative sperm counts may vary from five days (27,91) to six months or more (91). Drs. Hans Klapproth and Ira Young of The George Washington University Medical Center do monthly semen analyses until two consecutive specimens are free of sperm. In a study of 900 vasectomy patients, 94.5 percent were sterile ten weeks after their operation (75). It is
important that a time interval of one to four weeks be interspersed between tests. Although a procedural failure may become evident if live sperm are found in a specimen early in testing, it takes longer, perhaps two weeks or more, to be sure that natural recanalization has not occurred.

In India where as many as 320 vasectomies have been performed in a single day, there is little opportunity for follow-up sperm counts (59). In some vasectomy camps, the men are encouraged to have their semen examined at the nearest health center at the conclusion of the three months. They are given a supply of condoms to use until that time

The number of ejaculations, rather than a given time period, may be the more precise criterion in determining sterility (27,36,44,49,60,77). Davis, Schmidt, and Edwards do not begin collecting semen samples until after the patient has had ten ejaculations. The International Planned Parenthood Federation recommends that doctors require at least 12 ejaculations, while still others suggest 15 (13) or even 20 (32) prior to seeking semen samples.

Members of the workshop on clinical aspects of male sterilization at the Second International Conference on Voluntary Sterilization agreed unanimously that a patient whose specimen, after 10 to 15 ejaculations, still contained an occasional immotile sperm should be considered sterile (37).

Occasionally viable sperm have been found after 24 (91) and even 32 ejaculations (60). Marshall and Lyon found that only 65.5 percent of their 200 patients were sperm free after 12 ejaculations. After 24 ejaculations, however, 97.5 percent were sperm free (91).

A number of physicians have reported that irrigation of the vas during the vasectomy procedure decreases the postoperative sperm count. In 1971, von Friesen of Sweden reported the injection of a 1/1000 solution of ethaeridine into the vas through a blunt cannula developed for this purpose (120). A year later Craft and McQueen in Great Britain showed that the number of postoperative sperm could be reduced by irrigating the distal end of the vas with 20 ml of sterile water injected under pressure. In their study, only six percent of those undergoing vasectomy plus irrigation had positive sperm counts 15 weeks later as compared to 26 percent undergoing simple vasectomy (36). Urquhart-Hay, reporting on the use of a 1/1,000 solution of eufalvane for irrigation of the distal end of each vas, concluded also that the solution was nonirritating and an effective spermicidal agent (117).

Another way to reduce postoperative sperm counts might be ejaculation just prior to vasectomy (91). To date, the effectiveness of this method has not been evaluated.

There is some disagreement concerning the best ways of determining a sperm count. Some doctors argue that the specimen should be centrifuged before examination. Al-
other surgical procedures, are best performed by well-trained physicians who perform them frequently.

In rare instances, perhaps a dozen or two reports in all medical history, two vasa have been found on one or both sides of the scrotum and a third on the opposite side. Bilateral interruption of two vasa leaves the third functioning (16).

Physicians recommend the use of contraceptives in the immediate postoperative period to avoid impregnation while sperm stored in the reproductive tract are expelled.

**EQUIPMENT**

Many instruments used for vasectomy were originally designed for other procedures. Towel clips, Allis clamps and forceps, for example, are readily available in any operating room and can be used in performing vasectomy. As vasectomy becomes more common, however, many physicians have been dissatisfied with traditional instruments and have designed new equipment specifically for vasectomy. The new instruments can be classified into two categories: (1) those which grasp the vas in order to separate it from surrounding structures, and (2) those which are used to occlude the ends after each vas is cut.

**Instruments to Isolate the Vas**

Instruments designed to grasp the vas are applied either to the exterior scrotal skin (see Fig. 3 for the Tinkler Vasectomy Clamp, Fig. 4 for the Leader Vas Isolation Forceps) or the vas itself after the scrotal incision is made (see Fig. 5 for the I.L. Craft Vasectomy Forceps, Fig. 6 for Lee's Vasectomy Hook, and Fig. 7 for the Leader Vas Hook and Fig. 8 for the Spermex® Vas Elevator).

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**Fig. 3.** The Tinkler Vasectomy Clamp is a six-inch stainless steel clamp used to secure the vas deferens through the scrotum before infiltration of a local anesthetic, or incision. The instrument is ratchet-controlled, with bowed jaws and beaded ends. The ends encircle the vas and grip the scrotal skin bluntly to minimize discomfort (115). Manufactured by Down Brothers, Mayer and Phelps, Ltd., Church Path, Mitcham, Surrey, England. Cost: £6.60 (United Kingdom).

**Fig. 4.** The Leader Vas Isolation Forceps, used to grasp the vas, is 5-1/2 inches in length and made of stainless steel. Its beaded ends encircle the vas through the scrotal wall and hold it firmly in place before injection of the anesthetic and subsequent incision. Manufactured by V. Mueller, Division of American Hospital Supply Corporation, 6600 West Touhy Avenue, Chicago, Illinois 60648 USA. Cost: $31.50 (US).

**Fig. 5.** The I.L. Craft Vasectomy Forceps, made of stainless steel, has fine overlapping points to encircle and hold the vas deferens after incision (36). Manufactured by Rocket of London, Ltd., Imperial Way, Watford Herts WD2 4XX, England. Cost: £2 (United Kingdom).

**Fig. 6.** Lee's Vasectomy Hook is made of stainless steel and is 18 cm long. The hook is used to separate the vas from its sheath and to hold it for the next step in the operation. Manufactured by Han Jin Instrument Co., 71, 3-Ka, Chong-Ro, Chong-Ro-Ku, Seoul, Korea.

**Fig. 7.** The Leader Vas Hook is passed under the vas after the scrotal incision and lifts it free of surrounding structures. Made of stainless steel, it is six inches long. Manufactured by V. Mueller, Division of American Hospital Supply Corporation, 6600 West Touhy Avenue, Chicago, Illinois 60648 USA. Cost: $27.50 (US).
Fig. 8. The Spermex® Vas Elevator is inserted after the scrotal incision under the vas and through the sheath to elevate and maintain the vas so that it cannot slip back into the scrotum. A groove in the hooked end guides the scalpel as it transects the vas and prevents underlying structures from being cut. The instrument is sold as part of a disposable vasectomy kit. Manufactured by Atlan-Tol Industries, Inc., 15 Westminster Street, Providence, Rhode Island 02903 USA. Cost: $59.95 (US) for a pack containing four disposable kits.

Instruments to Occlude the Ends

Two kinds of instruments may be used to block the cut ends of the vas—those which clamp (see Fig. 9 for the Bliss Vasectomy Prosthesis, Fig. 10 for the Hemoclip Applying Forceps and Fig. 11 for the LDS Instrument for Stapling) and those which use an electric current to fulgurate the vas ends (see Fig. 12 for the Birtcher Hyfrecator and Fig. 13 for the C.D.S. Cautery, Mark III).

Instrument Kit

The US Agency for International Development has prepared a basic instrument kit for standard surgical vasectomy which is available to qualified physicians or organizations engaged in family planning work in developing countries.

Fig. 9. The Bliss Vasectomy Prosthesis, shown above at more than double its actual size, consists of two stainless steel cuffs separated by a polyethylene spreader. Each cuff is stamped with a waffle iron pattern to prevent slipping. After applying the prosthesis to the vas, the vas is cut between the cuffs and/or a segment is removed. Normally, the ends of the vas retract, but because the spreader holds them apart, they cannot grow back together (18). The Prosthesis comes in different sizes to match the diameter of the vas. Manufactured by Xomed, 444 Cooper Road, Cincinnati, Ohio USA. Cost: $4.80 (US) per pair.

Fig. 10. The Samuels Hemoclip Applying Forceps, made of stainless steel, is used to apply clips to the vas. An indentation near the tip holds the clip firmly as it is applied to the vas. Manufactured by Edward Weck & Company Inc., 49-33 31st Place, Long Island City, New York USA. Cost: $36.75 (US).

Fig. 11. The LDS (ligating, dividing, stapling) instrument has curved jaws for grasping the vas. A slip-on disposable cartridge contains pairs of staples and a knife blade. By compressing the pistol grip handle, the vas is automatically stapled twice and cut between the staples, leaving a gap of 1/2 to 3/4 inch. If a specimen is desired, the instrument must be applied a second time. Because the action is compressive and hemostatic, there is no tissue destruction, and therefore the staples remain firmly in place. The staples themselves are stainless steel and cause no tissue reaction. The instrument is mentioned favorably in at least one clinical study (122). Manufactured by United States Surgical Corporation, 919 Third Avenue, New York, New York 10022 USA. Cost: LDS instrument—$395.00 (US), disposable loading unit containing staples for ligating and dividing six times without reloading—$159.00 (US), 15 times without reloading—$199.00 (US).

(see Fig. 14). Inquiries about this kit may be addressed to the following organizations:

- The International Project of the Association for Voluntary Sterilization
  708 Third Avenue
  New York, New York 10017 USA
- Medical Director
  The International Planned Parenthood Federation
  18-20 Lower Regent Street
  London, SW1Y 4 PW, England
- The Pathfinder Fund
  850 Boylston Street
  Chestnut Hills
  Boston, Massachusetts 02167 USA
  Attention: Mr. Richard Gamble
Family Planning International Assistance
810 Seventh Avenue
New York, New York 10019 USA
Attention: Mr. John Palmer Smith

US Agency for International Development
Local Mission

Local Family Planning Associations

Also, medical kits may be purchased directly from McKenna Surgical Supply, 5402 Port Royal Road, Springfield, Virginia 22151 USA. Cost: $75.17 (US).

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Fig. 13. Especially designed for use in vasectomy, the C.D.S. Cautery Mark III is a portable solid-state instrument used for fulguration of the vas. The concentric bipolar needle electrode concentrates the electric current in the vas mucosa and reduces the amount of coagulating power needed. The luminal epithelium of the vas but not the muscular layer is destroyed. The extent of blanching in the vas lumen can be controlled by withdrawing the needle or switching off the current by a finger switch on the electrode holder. The instrument is battery powered and can be used where electric current is not dependable. Designed by Carmichael, Decker and Schmidt, the instrument is now being perfected by Battelle Memorial Institute, Seattle, Washington. (Not yet marketed.)

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Fig. 14. Basic instrument kit for vasectomy prepared by the US Agency for International Development.

1 - Instrument pan and cover (not included in this photograph) ........................................... 1 ea.
2 - Control Syringes, 5cc Luer-Lok ................................................................. 2 ea.
3 - Needles, hypodermic, 22g, 3/4" long ......................................................... 12 ea.
4 - Needles, hypodermic, 25g, 3/4" long ......................................................... 12 ea.
5 - Forceps Halstead, mosquito, curved 9" stainless steel ....................................... 2 ea.
6 - Forceps, Allis intestinal, 5 x 6 teeth 6" .................................................. 2 ea.
7 - Holder, needle, Collier, 5" ........................................................................ 1 ea.
8 - Blades, carbon steel, N/S Blades sz. 10 ........................................................... 8 pkg.
9 - Handle, surgical knife, B-P No. 1000 No. 3 .............................................. 1 ea.
10 - Forceps, hemostat, straight, 5 1/2", Kelly ................................................ 4 ea.
11 - Scissors, news suture, standard, 5 1/2" angled on flat stainless .................. 1 pr.
12 - Needles, taper point, mayo, half inch circle, sz. 6 ........................................ 2 pkg.
13 - Needle, skin, suture, straight, triangular point, 25" .................................... 2 pkg.
14 - Clamps, towel, Backhaus 3" ..................................................................... 4 ea.

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Fig. 12. The Birtcher Hyfrecator is a spark-gap instrument used for fulguration. The extent of electrocoagulation for vasectomy is determined by the speed at which the electrode is withdrawn from the vas lumen. Manufactured by Birtcher Corporation, Medical Division, 4371 Valley Boulevard, Los Angeles, California USA. Cost: $135.00 (US) plus shipping costs; $5.00 (US) for transformer.
Although the number of experimental approaches to vasectomy has increased greatly over the past few years, there has been little progress toward standardization. At present there is no agreement as to whether a surgical or nonsurgical approach will eventually be most effective.

Surgical Sterilization

On the whole, surgical experimentation has involved cutting the vas and inserting therein a device or foreign body such as a plug, tube, wire, thread or valve made of metal, plastic, sponge, velour, or other material. Since none of these devices has yet proved practical or effective, they are only discussed here for research interest. Some of the problems encountered are:

- perforation through the vas wall;
- slippage of the device;
- scarring which interferes with the nerve and/or blood supply to the vas wall;
- incomplete occlusion due to variability either in the size of the human vas deferens or distention of the vas when it is obstructed;
- tissue abrasion and bleeding caused by rigidity of the device;
- a buildup of tissue debris which will prevent passage of sperm should reversibility be attempted;
- aggravation by the foreign body of a preexisting infection;
- introduction of infection by the foreign body;
- introduction of a hard device which might perforate scrotal tissue placed under pressure by activity.

Three surgical methods currently being tested in humans are: the Intravasal Thread, the Reversible Intravas Device, and the Phaser Valve.

Intravasal Thread (IVT)

Dr. Hee Yong Lee, Professor of Urology at Seoul University, Korea, has for many years inserted a nylon- or silicone-covered silk thread into the vas to occlude it. The intravasal thread (IVT), about 1 to 2 cm in length and from 0.4 mm to 0.8 mm in diameter (according to the size of the vas lumen) includes at one end two 8 cm long filaments which attach it to the vas. These filaments permit both insertion and later removal of the IVT without cutting the vas. Because the filaments are tied outside the vas there is no danger that the IVT will migrate. The thread is inert and causes no tissue reaction.

The IVT is inserted as follows: a single medial incision is made in the scrotum and 4 cm of the vas are exposed. A needle with thread attached is inserted into the vas. While the central portion of the thread fully blocks the lumen of the vas, the filaments are tied externally around the vas tight enough to keep the IVT in place but not so tight as to cut through.

Total azoospermia was achieved in 93.85 percent of the 504 cases reported, which is a relatively high failure rate of over six percent. Most failures were due to vas dilatation, possibly caused by the intravasal pressure of sperm production which permitted sperm to pass around the block. This problem was particularly evident with the 1 cm thread.

In 42 attempts at reversal by removing the thread, sperm reappeared in 35 cases (83.33 percent). Dr. Lee has compared this figure with the successful reanastomosis in 81 percent of 144 patients who had undergone a standard surgical vasectomy. Fertility was not restored in 16.67 percent of the patients largely because of extensive fibrosis, accidental division of the vas during removal of the thread, or incomplete removal of the thread. Reversibility was best achieved with 1 cm of nylon (88.67 percent) (87).

Reversible Intravas Device (R–IVD)

A second method of occlusion developed by Dr. Nathan Brodie in New York, is insertion into the vas of a 1 cm long, bead-like strand of propylene.

After administering a local anesthetic and incising the scrotum, the surgeon slits the exposed vas horizontally. The vas lumen is then dilated by a special probe scored at 1.5 mm. The propylene device is inserted 2 to 3 cm into the vas, beginning with the smallest bead which is 0.7 mm in diameter and ending with the largest bead which is approximately 1.4 mm. At this stage, the surgeon places Prolene ligatures between the third and fourth beads and then between the fourth and fifth beads to secure the device. The nonbeaded portion (approximately 1 cm) is then cut off leaving the beaded portion (about 1 cm) inside the vas. The vas incision and then the scrotal incision are closed with Prolene ligatures (see Fig. 15).

Thus far, the R–IVD has not proven effective enough for general use. It has a 20 percent failure rate. In some experiments, the device caused excessive scarring or eroded through the vas wall. Reversibility has also not been adequately tested. However, a modified R–IVD or similar device may hold promise.

![Fig 15. The Scored Dilating Probe (upper figure) is used to dilate the vas prior to insertion of the Reversible Intravas Device (lower figure). The R-IVD is 2.5 cm in length. Contact: Nathan Brodie, M.D., 1103 Albemarle Road, Brooklyn, New York 11218 USA. Cost: The dilator together with three R-IVD devices costs about $25.00 (US). Four refill packages, each containing three devices, cost $20.00 (US).](image-url)

Phaser (Bionyx Control)

The Phaser, a device made of two stainless steel and gold T-shaped microvalves, is now undergoing clinical tests which will determine its effectiveness in obstructing the passage of sperm. Developed by Louis Bucalo of the Bionyx...
Corporation in New York City, the "valve", which is still considered experimental, has been used successfully in laboratory animals. A modification of this valve, designed to stay firmly in place without sutures, is currently being tested in humans.

To insert the Phaser, the surgeon transects the vas and reams out the mucosa from the vas end. The arm of the valve is threaded into each cut end and then tied in place. Approximately 1/4 inch long and with a gold mesh to promote tissue ingrowth, the valve is usually inserted under general anesthesia because investigators have found that procaine (local anesthesia) may destroy vas contractility (119). Most patients remain in the hospital overnight and are discharged the following day.

Valves, unlike other mechanical devices, can be used to turn the flow of sperm on or off as desired throughout a man's lifespan. Silicone, rubber, and dacron are now being tested as possible materials for future valves. Obvious disadvantages at present are the high cost of valves, the considerable surgical skill required for insertion, and the still unproved reversibility.

Nonsurgical Sterilization
For more than a decade, investigators have been searching for nonsurgical methods of male sterilization, but so far experience with chemicals has not been satisfactory either as a temporary or permanent method of male sterilization. Basically, physicians hesitate to inject chemicals into the body which may interfere with normal physiological functions. Without direct vision, moreover, the vas is difficult to identify through the scrotal sack, and after the procedure, occlusion cannot be determined easily.

Five potential ways to use chemicals for male sterilization were suggested by Dr. Emil Steinberger, University of Texas Medical School, USA, and Dr. Harold Jackson, University of Manchester, England:
- preventing sperm maturation by influencing the rate at which they pass through the reproductive tract;
- interrupting spermatogenesis by exerting a cytotoxic effect on the seminiferous epithelium or germinal cells;
- reducing sperm motility;
- blocking pituitary action, thus reducing testosterone secretion and spermatogenesis;
- producing an antifertility agent in the semen which could cause infertility in the female (66,111,130).

Percutaneous Fulguration
Theoretically, percutaneous fulguration (cauterization by a needle inserted through the scrotal skin and into the vas) should destroy the vasal mucosa (71,103,114), but to date investigators have had difficulty judging the exact amount of cautery needed for effective occlusion. Although the bipolar concentric electrode currently being developed by Battelle (see Fig. 13) may one day be used for percutaneous fulguration in human males, it has not yet been tested clinically.

Chemicals
Most investigations of chemical methods of sterilization deal with sclerosing agents such as ethanol, quinacrine, silver nitrate, sodium tetradecyl sulfate, sodium morrhuate, acetic acid, and hydrogen peroxide, all of which might be used on a temporary or permanent basis (8). Theoretically, precise control of these chemicals may pose a problem, as Dr. Stanford Schmidt has pointed out:

...even one drop of chemical agent will fill three to four inches of the vas deferens. If the lumen of the vas is sclerosed for that distance, anastomosis of the vas would be difficult or impossible. If the sclerosing agent were to inadvertently enter the circulation, the possibility of a dangerous reaction exists. If an excess of the sclerosing agent were used, this could lead to severe inflammation of the entire length of the vas, the seminal vesicles and the ejaculatory ducts (102).

Contrary to Dr. Schmidt's fears, however, Drs. Coy Freeman and Donald Coffey at the Johns Hopkins University in Baltimore, Maryland, have encountered no difficulties in controlling chemicals. In their current investigations, they have been injecting into the lumen of the vas 250 microliters of a solution containing mostly ethanol in order to bring about permanent occlusion. There is minimum toxicity because ethanol (chemical formula: \( \text{CH}_3\text{CH}_2\text{OH} \)) diffuses evenly in body fluid, tissues, and cells. Preliminary assessments indicate that this procedure is quicker and less expensive than surgical methods. Also, it is unlikely that either infection or hematoma will result.*

Research
The challenge in vasectomy research is to identify a procedure that will 100 percent effective, simple to perform, and free of complication, but at the same time readily reversible if desired. So far, these goals seem to be basically incompatible because the more extensive and effective the action on the vas, the less likely is later reversibility.

At the Second International Conference on Voluntary Sterilization held in Geneva in 1973, Dr. Joseph Speidel, Director of Research, Office of Population, US Agency for International Development, urged specific research on:
- safety and side effects of current vasectomy techniques;
- semen reservation;
- simplified surgical techniques;
- techniques for reversing vas occlusion;

**Personal interview, D. Coffey and C. Freeman, July 1973.
easily administered and reversible chemosterilants which could be used without medical supervision.

Current knowledge on the physiology and functioning of the vas deferens is still inadequate. "With an increased understanding of the mechanisms controlling vas motility and of the effects of vasectomy on the enervation of the vas," Dr. Speidel concluded, "a scientific basis may be provided for the development of a standard vasectomy operation and for an improvement in the vasovasostomy success rate" (III).

Research proposals along these lines from investigators in developing countries may be directed to:

Program for Applied Research in Fertility Regulation
University of Minnesota
Suite 226, University Park Plaza
2829 University Avenue S.E.
Minneapolis, Minnesota 55414 USA

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