History of Vasectomy

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KEYWORDS

• Vasectomy • History • Techniques • Indications

Vasectomy as a medical term is a misnomer because only part of the vas deferens is excised during the procedure. It has been used in the literature to describe a wide range of procedures including partial vasectomy, vasal transection, vasoligation, and vasal occlusion. Vas deferens as an anatomic structure was not a subject of significant clinical and research interest until the nineteenth century. It is difficult, however, to find another surgical procedure as simple as vasectomy that has sparked so much medical and social controversies for more than a century. Vasectomy is a historical, social, philosophic, medical, demographic, and legal phenomenon. It is not surprising that the history of this procedure combines not only a constant quest for ideal technique and better results but also misconceptions, false beliefs, and erroneous indications.

EARLY EXPERIMENTAL AND CLINICAL WORKS ON VASECTOMY

Herophilus (335 BC–280 BC) provided the first account of the testicles, epididymis, vas deferens, seminal vesicles, spermatic artery, and spermatic vein.[1] The vas deferens was first mentioned much later by another ancient physician, Rufus of Ephesus (late first century AD), in one of the first known books on anatomic nomenclature "De nominatione partium hominis" ("On the naming of the parts of the body"), where it was called Πόροί σπερματίκοί.[2] For the following centuries, the amount of neologisms in anatomy was unprecedented because it was necessary to describe and name new things. Thus, vas deferens as a structure in the ancient literature was called "*evacuatorium"* or "*expulsorium seminis*," "*vas nervosum*," "*canales"* or "*pori*," even "*itinera seminaria"* or "*venae genitals*," all of these being different versions of the Greek translation of "*poroi spermatikoi*."[3]

Vas deferens (vās, duct + in dēferēns, present participle of dēferre, to carry away) was supposedly named by Mondino dei Liuzzi or Mundinus (1275–1327), anatomist from Bologna.[4,5] His book "De Anatome" (Anothomia) was published in 1316 and widely used in European medical schools for more than 300 years. In the chapter "De anothomia vasorum spermaticorum et testiculorum," he described vasa spermatica praeparantia (semen-preparing vessels that carry semen to the testes) and vasa spermatica deferentia (semen-delivering vessels), that carried semen away from the testes (**Fig. 1**). In his books "Commentary on the Anatomy of Mundinus" (1521) and the famous "Isagogae Brevis" ("A Short Introduction to Anatomy," 1522), another famous Italian anatomist, Berengario da Carpi (1460–1530), mentioned the presence of descending vessels carrying sperm down to the testes and contiguous with them ascending vessels, vasa deferentia (vasa spermatica), which carry sperm away. "Their substance is white and harder than that of the other vessels. These vasa deferentia in the male ascend from the testes to the pubic bone… These vessels bent back within the belly descend between the rectum and the bladder, and there they dilate into many caverns…"[6]

Regnier de Graaf (1641–1673) must be credited for the detailed description and the first experimental work on the vas deferens. In his book "De Vivorum Organis Generationi Inservientibus" (1668), he described vas semen deferens as a "body like large nerve, round white, rather hard and with manifest cavity. So that the cavity may be seen better, a vas deferens should be opened the breadth of 6 or 7 fingers above the testicle and air pumped in the direction of the testicle, or better a coloured liquid injected by means of syringe. The vessel will distend" (**Fig. 2**). In his animal experiments, De Graaf "firmly bound the vas deferens of one testicle in a dog or some other

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Urol Clin N Am 36 (2009) 285–294
doi:10.1016/j.ucl.2009.05.007

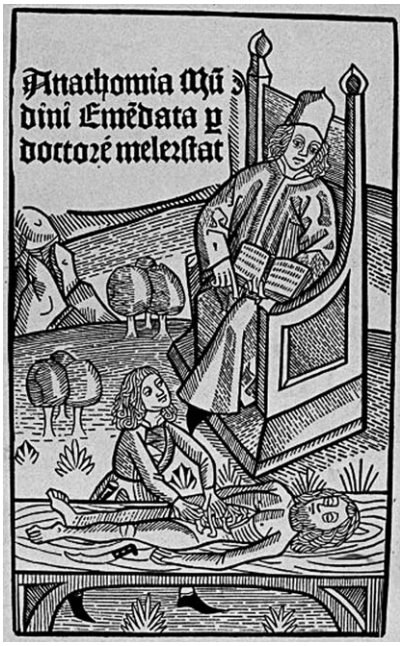

Fig. 1. Mondino dei Liuzzi (1275–1327). Line block after a woodcut, c. 1493. (*Courtesy of* Wellcome Trust, London, UK.)

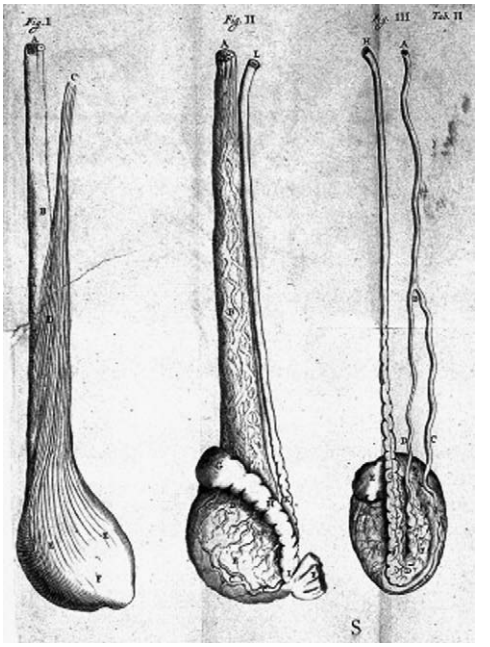

Fig. 2. From Regnier de Graaf "De virorum organis generationi inservientibus, de clysteribus et de usu siphonis in anatomia," 1668. (*Courtesy of* Wellcome Trust, London, UK.)

animal before coitus'' and then observed ''the tubules of the testicle fill with seminal matter in such way that anyone at all can perceive them.[7]''

John Hunter[8] first described absence of the vas deferens in a cadaver in 1737. More advanced experimental work on the vas deferens was performed by Sir Astley Cooper[9] in the beginning of the nineteenth century. He found that ligation of the dog's vas deferens, unlike ligation of the testicular artery and vein, does not produce a ''gangrened and sloughed'' testicle. Complete occlusion of the vas deferens caused enlargement of the testis and epididymis, which was also filled with spermatozoa. After 6 years of observation, spermatozoa were found in the epididymis, which confirmed intact sperm production after vasal occlusion.

The effect of vasectomy or vasal occlusion on spermatogenesis was studied later by many researchers with initially controversial reports. Working on dogs and rabbits, Gosselin and Brissaud noted normal spermatogenesis after ligation or resection of the vas deferens.[10–12] Gosselin also dissected human cadavers and observed that entirely blocked vas deferens was associated with an enlarged epididymis that contained quantities of spermatozoa. These observations were confirmed by Curling in 1866.[13] Bouin and Ancel (1903) declared that closing the outlet from the testis invariably leads to degeneration of the germinal tissue, however.[14] This opinion was supported by works of Tiedje and Sand,[15,16] who also used vasoligation in clinical practice. In 1924, Moore and Quick and then Oslund[17,18] studied the effect of vasectomy on rabbits, rats, and guinea pigs. They concluded that vasectomy alone does not cause degeneration of germ cells. Clinical evidence of preserved spermatogenesis was provided by Posner, who reported that ''by puncture of the testis he had withdrawn living spermatozoa 10–17 years after occlusion of the epididymis by gonorrheal invasion.'' William Belfield, on making an anastomosis of epididymis and vas for cure of sterility, found spermatozoa present 14 years after the occlusion of the epididymis had occurred.[19] By the first quarter of the twentieth century, research and clinical observation revealed no bad effects after vasectomy/vasal occlusion.

VASECTOMY IN CLINICAL PRACTICE: THE BEGINNING

Clinical use of vasectomy can be traced back to the 1880s. Since the first orchiectomy was performed by Louis Auguste Mercier in 1857 for the treatment of enlarged prostate, castration has been used to reduce obstructive symptoms of prostatic hypertrophy and improve micturition.[20] The earliest reference to section of vasa deferentia

as an alternative procedure to castration to achieve prostatic atrophy was made by Felix Guyon in 1885 (**Fig. 3**).[21] Five years later, in 1890, James Ewing Mears also suggested vasectomy for the same reasons. Karl Gustav Lennander from Uppsala University (Sweden) advocated vasectomy as a substitute for castration ''as a means of relieving ills consecutive to prostatic hypertrophy in 1894.[22] Pavone and Isnardi described prostatic atrophy as a result of vasectomy.[23] Reginald Harrison performed more than 100 vasectomies between 1893 and 1900 (**Fig. 4**). He found that ''the usual effect of vasectomy is to induce shrinkage of the hypertrophied prostate'' and restore natural micturition. Harrison performed vasectomy by excision of the portion of the vas deferens but later substituted it with torsion of the vas deferens for vasal obliteration ''with the pair of Spencer Wells forceps, through a small incision over the duct.'' In this way, the vas is seized and bared and a small portion of it is torsed out, no ligature being required. A 7- or or 10-day interval in dealing with the two vasa is advised.''[24] Harrison was probably the first physician who also noticed reconnection of the divided portion of the vas deferens. ''It was found six months after a portion of one of the vasa had been excised and the ends ligatured in a loop that the divided ends had reunited and the continuity and use of the duct has been reestablished.''[25] Vasectomy enjoyed popularity for a short time because it was considered a method of minimal harm and high efficacy.

Fig. 3. Felix Guyon (1831–1920). (*Courtesy of* Wellcome Trust, London, UK.)

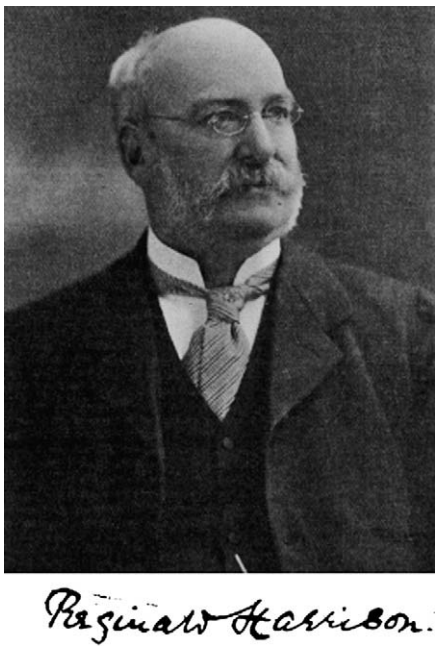

Fig. 4. Reginald Harrison (1837–1908). (*From* Obituary. Reginald Harrison, FRSCEng. BMJ 1908;1(2462):601; with permission.)

Further experience, however, lowered the expectation of micturition improvement after vasectomy. In 1895, Guyon failed to obtain any substantial loss of the bulk of the prostate in four different experiments. Wood[26] reviewed 192 cases of vasectomies and reported improvement in urination in 15%, no changes in 15%, and deaths in 6.7%. Wallace[27] concluded that ''a single or double vasectomy is useless as a means of producing prostatic atrophy.'' Shortly afterwards, this method had lost its recognition as a treatment for prostatic hypertrophy, especially with further developments of surgical treatment of enlarged prostate.

Wood[26] noticed that vasectomy was successfully performed for the relief of painful recurrent orchitis, which ''quite justified this operation apart from any intention to affect the prostate.'' Although prostatectomy has become a more commonly performed procedure, epididymitis was recognized as a far too frequent surgical complication. Vasectomy was recommended for prevention of postoperative epididymitis at the beginning of the twentieth century. In 1904, Robert Proust,[28] a French urologist and brother of famous writer Marcel Proust, mentioned vasectomy at the time of prostatectomy. It was also recommended by Jose Albarran in 1909.[29] Allea described a temporary through-the-skin vasoligation technique.[21]

This technique was discouraged because of difficulties feeling and isolating the vas, however. Meltzer (1928)[30] recommended bilateral vasectomy, rather than vasoligation, as ''a definitive prophylactic measure against the painful complication of epididymitis.'' Scrotal vasectomy had been a popular—albeit controversial—procedure before, during, or after open prostatectomy and even transurethral resection of the prostate (TURP) for almost 80 years. With improved surgical techniques and new effective antibiotics, the incidence of epididymitis diminished drastically. One of the last prospective studies conducted in 1975 showed that vasectomy does not reduce the incidence of epididymitis and its routine use in prostatic surgery is not indicated.[31]

THE FOUNTAIN OF YOUTH

In the nineteenth century, Charles-Edouard Brown Sequard (1817–1894) coined the word ''rejuvenation,'' and the interest of defeating old age flourished in the early twentieth century. After 20 years of sophisticated animal research on testicular function, Eugen Steinach (1861–1944),[32] an Austrian physiologist, professor of biology at the University of Vienna, and director of the city's Biologic Institute of the Academy of Science, published his famous book ''Rejuvenation Through the Experimental Revitalization of the Aging Puberty Gland''(1920). He reported degeneration of the germinal epithelium and hypertrophy of the interstitial (Leydig) cells after unilateral vasectomy or vasoligation. This, in turn, stimulates the production of germ cells by the opposite testis and returns old animals to a functional condition. Steinach announced that he had rejuvenated a senile male rat with vasoligation and that the technique can be used on humans. Surgery of the vas deferens (vasectomy or vasoligation) was termed a Steinach I procedure; introduced later was the less popular ligation of the efferent ductules between testis and epididymis, known as a Steinach II operation (**Fig. 5**).

On November 1, 1918, Dr. Robert Lichtenstern performed the Steinach procedure on Anton W., a 43-year-old coachman who suffered from chronic fatigue. ''The patient presented with the appearance of an exhausted and prematurely old man,'' Steinach reported in his book.[32] The procedure resulted in long-lasting improvement. It brought Steinach world fame. In April 1923, the *New York Times* wrote about the ''exodus to Vienna'' of doctors who hoped to learn the secret of the Steinach operation.

Thousands of Steinach operations were performed in the United States and around the world. Before his planned visit to America, the *New York Times* wrote: ''Dr. Steinach Coming to Make Old Young.'' He was so famous that his name became a verb: men were ''Steinached.''[33] Eugen Steinach was nominated unsuccessfully for a Nobel Prize in physiology six times between 1921 and 1938.

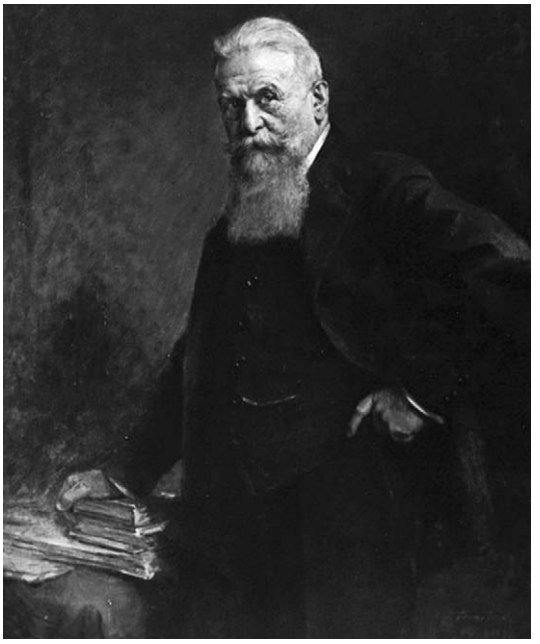

Fig. 5. Eugen Steinach (1861–1944). (*Courtesy of* Wellcome Trust, London, UK.)

On November 17,1923, the Viennese urologist Victor Blum performed a Steinach operation on Sigmund Freud, who ''hoped that it might bar the recurrence of his jaw cancer and might even improved his sexuality, general condition and his capacity to work.'' After the procedure, Freud was ambiguous about its effect. Another famous person, the Nobel Prize winner in literature W.B. Yeats, underwent a vasectomy on April 6, 1934, at the age of 69. ''It revived my creative power and…sexual desire,'' he wrote in 1937.[34]

Medical views on the rejuvenation vasectomy procedure ranged from those of devotees, such as Robert Lichtenstern and Peter Schmidt in Germany, Harry Benjamin in America, and Norman Haire in England, to scoffers such as Morris Fishbein (1889–1976) the editor of *JAMA*. Fishbein denounced the Steinach procedure as early as 1927 with the lack of scientifically controlled studies.[34] The procedure was in use until the late 1940s, however. Popularity of rejuvenation by vasectomy gradually declined after isolation of testosterone in 1935. In 1951, the most well-known proponent of the Steinach procedure, Norman Haire, accepted that his belief about rejuvenating consequence of vasectomy was faulty.

The Simon Population Trust, a UK voluntary sterilization organization, declared that the Trust did not recommend vasectomy for rejuvenation only in 1969.[35]

VASECTOMY FOR EUGENIC STERILIZATION

Why not ligate the vas deferens to promote Malthusian ideas? This rhetorical question from editorial comments in 1891 defined a new direction in the vasectomy history for the next half-century.[36] In 1897, Van Meter suggested vasectomy for male sterilization to eradicate hereditary disease from the human family. ''Furthermore…we can easily have enacted a law that will provide for the sterilization of all criminals; and thus will crime be wiped out, or, at least, greatly lessened.''[37] A.J. Ochsner, surgeon in chief of Augustana Hospital and St. Mary's Hospital in Chicago and the future president of American College of Surgeons, reported two vasectomies performed in 1897 to relieve urinary retention secondary to enlarged prostate. The procedure consisted of the resection of the vasa deferentia on both sides through an incision less than 1 in long just below the external inguinal ring. Both patients had no harmful effect or impairment of sexual desire. Ochsner concluded that vasectomy can substitute for castration, which has been recommended as a punishment for certain crimes and had been practiced without legal sanction in many cases. He suggested vasectomy for sterilizing habitual criminals and ''chronic inebriates, imbeciles, perverts and paupers'' to protect the community at large without harming the criminals.[38] Dr. Daniel Brown of Chicago also recommended vasectomy for eugenic purposes in his address ''Medical Aspects of Crime,'' which was read before the American Medical Association in 1899.[39]

The first eugenic sterilization was performed by Dr. Harry Sharp, chief physician of the Indiana State Reformatory (**Fig. 6**). The inmate named Clawson insisted on castration to stop excessive masturbation. Sharp offered him a vasectomy which he performed on October 12, 1899. A semen sample was examined later under the microscope and ''found to be sterile.'' The inmate reportedly ''stopped masturbating, his mind was better.'' Although the first vasectomies were performed via low inguinal incision, later Sharp used the English method, ''which selects the scrotal region as the site of the operation.'' The vas deferens was clasped between thumb and index finger and severed via the short longitudinal skin incision which was left open at the end of the operation. Both Ochsner and Sharp practiced open-end vasectomy. Dr. Sharp presented his first paper on the subject at the Mississippi Valley Medical Association meeting at Put-In-Bay in the fall of 1901.[39]

Fig. 6. Harry C. Sharp. (*From* Popenoe P. The progress of eugenic sterilization. J Hered 1934;25:19–26; with permission.)

Forty-two similar operations were performed by 1902; 176 were performed by 1907.[40] During the next few years, several articles by physicians claimed that vasectomy offers a solution to the problem of limiting the birth of defective persons. In 1907, the governor of Indiana signed the nation's first sterilization law to initiate the involuntary sterilization of any habitual criminal, rapist, idiot, or imbecile committed to the state institution and diagnosed by physicians as ''unimprovable.''[41] By 1909, Sharp performed 280 such procedures and quickly emerged as the national authority on eugenic sterilization. He published a pamphlet, ''Vasectomy,'' with an affixed tear-out postcard with a preprinted message supporting sterilization law. In 1910, Sharp demonstrated vasectomy to a doctor from Russia who attended an international conference under the auspices of the American Prison Association.[39] By 1917, 15 of the United States successfully passed laws authorizing vasectomy for various conditions and crimes. By 1937, it had increased to 32 states. The first European Sterilization Law was passed in Switzerland in 1928 followed by Denmark, Germany, Sweden, Norway, and Finland in 1936.[35] The practice of involuntary sterilization gradually ceased and virtually stopped by the 1960s.

POPULATION CONTROL AND FAMILY PLANNING

In 1909, William Belfield, professor of surgery at Rush Medical College, wrote about married men who chose vasectomy rather than criminal abortion to prevent the transmission to offspring of their own hereditary taints, such as insanity and syphilis.[42] Vincent O'Connor[43] summarized the reasons for surgical sterilization of men: (1) prevention of the insane, the criminal, or the perverse from producing offspring, (2) precarious health of the wife, which increased the risk of bearing children, and the wife being unable or refusing to undergo tubal ligation, (3) agreement between husband and wife to prevent pregnancy, (4) prevention of the occurrence of epididymitis, a routine procedure in many clinics in the treatment of prostatism, (5) rejuvenation (Steinach), a false physiologic assumption and clinical failure, and (6) mass sterilization for the purpose of racial limitation, as evidenced by recent Nazi treatment of persons of Jewish, Polish, and other nationalities. It was the first time voluntary vasectomy was clearly mentioned for family planning. Vasectomy for voluntary sterilization was not widely performed, however. ''The person who seeks to have himself sterilized…does it so secretly and for what he considers strong personal reasons. The patient frequently encounters difficulty in persuading a competent surgeon to perform this procedure because in most states there is question as to its legality and the surgeon exposed himself to a possible suit for malpractice.''[43] In 1953, the British Family Planning Association recommended that couples who request sterilization on the ground that it is easier and more reliable than birth control should receive a lesson in social responsibility.[44] Before 1969, the American College of Obstetricians and Gynecologists recommended restricting voluntary sterilization to men or women whose age multiplied by number of children equaled or exceeded 120.

Although vasectomy as a contraceptive procedure for family planning was not commonly used in the developed countries, the procedure was successfully introduced to control rapidly growing population in certain developing Asian countries. India launched a massive program and became the first country in the world to make it an official government policy in 1952.[45] The approaches to encourage men to be sterilized included outreach to men at workplaces or in rural communities using mobile units, vasectomy ''camps'' and ''festivals,'' special clinic hours, and settings that were considered more appealing to men. In India, the Ernakulam camps achieved 78,000 male sterilizations annually, whereas in Gujarat camps sterilization was performed on more than 200,000 men in 2 months.[46] In Thailand, large numbers of men receive vasectomies during special festivals held on the King's birthday.[47] Quality of care has been a problem in many of the mass camps.

One of the most important and controversial elements of vasectomy promotion in Asia historically has been incentive payments to providers and acceptors, however. In some countries, major incentive payments were used that bordered on coercion because the money offered for sterilization equaled or surpassed monthly salaries. These aggressive programs were focused on mostly poor and less informed social groups. This approach to vasectomy reached a new level during India's Emergency period (1975–1977). Over these 2 years, during which the government made an extraordinary effort toward the goal of reducing the population, almost 7% of all Indian couples were sterilized.[44] A total of 6.2 million vasectomies were performed in 1976, almost 5 million more than in 1975.[48] This task was accomplished through undeniably coercive means. In some Indian states, police, school teachers, and other government employees participated in recruiting men to have vasectomy. When the Emergency ended in 1977, the government was preparing laws to make small families compulsory. Reaction against the coercive vasectomy program and population control helped bring down the Gandhi government in March 1977.[49]

In the ensuing years, the entire family planning program was toned down, and vasectomy in particular ''lost its credibility and never regained its popularity.'' Vasectomy, the dominant family planning method in India for 20 years, was almost entirely replaced by female sterilization.[49] Ironically, the worldwide discussion about the importance of male participation in family planning had started after the decline in vasectomy programs. The First International Conference on Vasectomy was conducted in October 1982 in Colombo, Sri Lanka. Seventy leading professionals from 25 countries reviewed vasectomy efforts, examined the main barriers to accessibility, and reported ways to overcome these barriers.[50]

In the United States, the Association for Voluntary Sterilization promoted the benefits of voluntary sterilization as a means of family planning. Its predecessor, the Sterilization League of New Jersey, was formed in 1937 to support the eugenic sterilization of the physically and developmentally disabled and persons with mental illness. Between 1943 and 1964, the organization changed its name several times. It was known successively as Birthright (1943–1950), the Human Betterment Association of America (1950–1962), and the Human

Betterment Association for Voluntary Sterilization (1962–1964) before becoming the Association for Voluntary Sterilization in 1965. The Association for Voluntary Sterilization changed its name to the Association for Voluntary Surgical Contraception during the 1980s, was renamed the Association for Voluntary Surgical Contraception International in 1994, and became Engender Health in 2001.[51]

The data on vasectomy as a contraceptive method in the 1950s are limited. In California, Poffenberger published his report on 2000 voluntary vasectomies performed between 1956 and 1961. He reported that ''not only were men pleased with the result of the operation but they talked about its advantages freely and attempted, often with success, to convince others to have it done. In some cases, men came several hundred miles to have the operation. Of the total sample, only 14.5% reported one or more physical reasons motivating them to seek a vasectomy. The rest gave no medical reason for desiring the operation.''[52] The largest single objection for performing voluntary elective vasectomy was a legal one from a misunderstanding of the law. In 1963, the American Medical Association legal counsel advised that ''outside of the two states where nontherapeutic sterilization is expressly prohibited by law (Connecticut and Utah), the physician who performs these procedures does not expose himself unduly to civil or criminal liability.''[53] Between 1963 and 1967, already 40,000 vasectomies had been performed annually in the United States.[54] By 1991, the number of vasectomies performed annually increased to 493,487 and reached 526,501 in 2002 (approximately 10/1000 men aged 25–49 years).[55,56]

Vasectomy use worldwide is different from country to country. Marie Stopes International family planning services in the United Kingdom has advertised contraceptive vasectomy since 1958.[57] In the 1970s and 1980s, new statutory provisions in several Western European countries made voluntary sterilization legal. In England and Wales, vasectomy was incorporated into the National Health Service in 1972. A short time later, Scandinavian statutes introduced the right to obtain voluntary sterilization upon request for all men over 25 years of age in Denmark, Sweden, Norway, and Iceland. The lower limit of 25 was also enacted in Austria. In 1978, Italy legalized voluntary sterilization; in that year the operation became legal, by implication, in Luxembourg. In 1983, Spain and Turkey repealed their antisterilization laws. In 1975, the high degree of consensus of European countries on full liberalization of voluntary sterilization was expressed by an international act. The Council of Ministers of the Council of Europe unanimously voted in Resolution No. 75 on November 14, 1975.[29] By this resolution, the Committee recommended the 21 member countries to ''make sterilization (for family planning purposes) available as a medical service.''[58] In France, vasectomy was considered an illicit procedure under the nineteenth century ''Napoleon code,'' which proscribed acts of so called ''self mutilation.'' The birth control charity Marie Stopes International even offered a ''vasectomy tourist service ''to the United Kingdom on its Web site.[59] The procedure became legal in France in 2001.

Although data on vasectomy worldwide are incomplete, the countries with the highest prevalence of this sterilization method are New Zealand, United Kingdom, Canada, United States, South Korea, Australia, Switzerland, China, and Denmark.

TECHNICAL EVOLUTION OF VASECTOMY

From the early days of vasectomy use in clinical practice, surgeons throughout the world have tried to find a better way to perform this procedure. The driving forces behind the multiple modifications of vasectomy were simplification and shortening the procedure, concerns over the recanalization, and, later, possibility of vasectomy reversal. More than 30 different techniques of surgical approach, section, and occlusion of the vas deferens have been described in the literature.[60]

Early vasectomies were performed via an inguinal approach. One of the first modifications, the ''English method,'' selects the scrotal region as the site of the operation.[24] Harrison excised the portion of the vas deferens via two incisions over the vas on each side of the scrotum and ligated the ends in a loop.[25] Alternatively, a loop of the vas was gently drawn out through the wound with a blunt hook. ''The loop is then encircled below the hook with a silk ligature…which is tightly knotted. The …extraneous portion of the vas removed with scissors and the pedicle dropped into its place.''[61] Van Meter in 1897 and Sharp 1909 recommended an open-end procedure with ligation of the abdominal end and leaving open the testicular end ''in order that the secretion of the testicle may be emptied around the vessels of pampiniform plexus and there be absorbed.''[37,40]

In 1955, Jhaver introduced the single incision approach for bilateral vasectomy. After performing a large series of vasectomy operations by this method, he published this technique in 1958.[62,63] This approach was later questioned by Schmidt,

who thought it could lead to operating twice on the same vas deferens, missing the other completely.

The possibility of spontaneous vasal reanastomosis, which was clinically observed by Harrison in 1900, was confirmed by Rolnick,[64] who reported in 1924 that the canine vas can regenerate over long distances by endothelialization of its sheath. Since then, many methods of the occlusion of the vasal ends have been introduced to avoid recanalization. Besides ligation of the cut vasal ends, Strode (1937) first attempted a fascial interposition between the ligated end of the vas deferens. He buried the proximal (testicular) end within the surrounding fascia distal (abdominal) end outside the fascia.[65] In 1966, Schmidt introduced fulguration of the vasal lumen with electrocautery and later with red-hot wire cautery to effectively and quickly seal the vas deferens without additional occlusion and removal of portion of the vas. He also closed the vasal sheath over the distal cut end to prevent recanalization.[66,67]

Jhaver[68] started to use one tantalum medium clip instead of ligatures on each divided vasal end, whereas Moss[69] advocated two tantalum clips across each divided end for occlusion. The vasectomy failure rate was 1.2% with one clip and 0% with two clips. Craft[70] suggested irrigation of the distal cut end of the vas with sterile water to facilitate azoospermia.

By 1972, the surgical modifications seemed to have been exhausted. In 1973, the no-scalpel vasectomy technique was developed by Dr. Shunqiang Li and associates.[71] The procedure was done without a skin incision using two instruments: a ring forceps to hold the vas deferens without piercing the skin (similar to vas clamp designed by Allea in 1928) and a sharp hemostat. Since then, no-scalpel vasectomy has been widely promulgated and practiced in China as a routine sterilization method, with 8 million no-scalpel vasectomy procedures performed on Chinese men between 1974 and 1988. In June 1985, an expert group of physicians sponsored by the Association for Voluntary Surgical Contraception visited the Chongqing Family Planning Scientific Research Institute in China to learn the new vasectomy technique.[72,73] The first no-scalpel vasectomy performed in the United States was by Dr. Mark Goldstein, who was a member of that international team, at the New York Hospital– Cornell Medical Center in 1985. In November 1986, the 1st International Training Course on no-scalpel vasectomy was conducted in Bangkok, Thailand.[72] The no-scalpel vasectomy technique has rapidly gained popularity among surgeons and patients because of shorter operative time, less tissue injury, less postoperative swelling and pain, and a lower complication rate.

Vasal occlusion without division of the vas deferens has been an attractive concept for many years because of its simplicity. Allea recommended temporary percutaneous ligation of the vas deferens with silk ligature before prostate surgery to prevent epididymitis. The ligature was removed in 15 days. Microscopic studies in four patients revealed complete obstruction of the vas after removal of the ligature.[21] The idea of reversible vasal occlusion was popular in the 1960s. Procedures using the new techniques of vasal occlusion, including a ''plug'' of plastic materials, the intravas device, vas clip, and vas valve, have been attempted.[74] In 2002, the VasClip, a small implantable biocompatible lock made of a medical-grade polymer, was approved by the US Food and Drug Administration in 2002 with an indication for ligation of the vas deferens. The VasClip was found to fail at an unexpectedly high rate and has since been taken off the market, however.[75]

Recently the feasibility of thermal occlusion of the vas deferens with noninvasive, transcutaneous high intensity focused ultrasound has been demonstrated on animal models.[76] After more than a century of controversies, improvements and technical innovations, modern vasectomy has become a safe, effective, and permanent male contraceptive procedure. However, the ideal technique has yet to be found. Predictably, minimally invasive methods of permanent vasal occlusion will continue to evolve.

REFERENCES

1. Libby W. The history of medicine in its salient features. Boston (MA): Houghton Mifflin Company; 1922. p. 50–1.
2. Rufus of Ephesus. Names of the parts of the body. In: Daremberg C, Ruelle CE, editors. Oeuvres de Rufus d'Ephese [transl]. Amsterdam: Adolf M.Hakkert; 1963. p. 67–8. (reprint of the Paris, J.B Bailliere, 1879 edition).
3. Ivanova A, Holomanova A. The anatomic nomenclature by Vesalius. Bratisl Lek Listy 2001;102(3): 169–73.
4. The American heritage dictionary of the English language. 4th edition. Houghton Mifflin Harcourt; 2000.
5. Bresadola M, Fezzi P. Mondino dei Liuzzi: Anothomia a cura di Piero Giorgi. International Centre for the History of Universities and Science. Available at: http://cis.alma.unibo.it/Mondino/auctor.htm. Accessed June 2, 2009. [Latin].
6. da Carpi JB. A short introduction to anatomy (Isagogae Breves). Translated by L.R. Lind, with

Anatomical Notes by Paul G. Roofe. Chicago: University of Chicago Press; 1959 [Latin].
7. Jocelyn HD, Setchell BP. Regnier de Graaf on the human reproductive organs: an annotated translation of Tractatus de Virorum Organis Generationi Inservientibus (1668) and De Mulierub Organis Generationi Inservientibus Tractatus Novus (1672). J Reprod Fertil Suppl 1972;17:1–76 [Latin].
8. Hunter J. Observation on the glands situated between the rectum and bladder, called vesiculae seminales. In: Palmer JF, editor. Complete Works. London: Longman, Reese, Orm, Brown, Green & Longman; 1737. p. 20–34.
9. Cooper A. Observation on the structure and diseases of the testis. London: Longman; 1830.
10. Jhaver PS, Ohri BB. The history of experimental and clinical work on vasectomy. J Int Coll Surg 1960;33: 482–6.
11. Gosselin P. Nouvelles etudes sur l'obliteration des voies spermatique et sur sterilite consecutive a l'epididymite bilaterale. Arch Gen de Med 1847; Serie 5, vol II, p. 257–70 [French].
12. Brissaud E. Les effects de la ligature du canal deferent. Arch D Physiol 1880;S2:769–89 [French].
13. Curling TB. A practical treatise on diseases of the testis and of the spermatic cord and scrotum, 2nd edition. Philadelphia: Blanchard and Lea; 1856.
14. Bouin F, Ancel P. Recheres sur les cellules interstitielles du testicule des mammiferes. Arch d Zool Exper 1903;S4(1):437–523 [French].
15. Tiedje P. Changes in testes after ligation. Deutsch med Wchnschr 1921;47:352–63 [German].
16. Sand K. Experiences sur la resection du vas deferens. J dePhysiol et de Path Gen 1921;19:494–503 [French].
17. Oslund R. Vasectomy on rats and guinea pigs. Am J Physiol 1924;67:422–43.
18. Moore CR, Quick WMJ. Vasectomy in rabbits. Am J Anat 1924;34:317–36.
19. After-effects of vasectomy. [editorial comments]. JAMA 1909;24:1348.
20. Ricketts BM. Surgery of the prostate, pancreas, diaphragm, spleen, thyroid and hydrocephalus: a historical review. Cincinnati: Lancet Clin; 1904.
21. Alyea EP. Vaso-ligation: a preventive of epididymitis before and after prostatectomy. J Urol 1928;19:65–80.
22. Gallant AE. Sterilization of the unfit by vasectomy. Med Times 1915;43:39.
23. Harrison R. Diseases of genito-urinary system: the year-book for treatment for physicians. Philadelphia: Cassell and Company Limited; 1896. p. 267.
24. Harrison R. Remarks on vasectomy relative to enlarged prostate and bladder atony. Lancet 1900; 155:1275–6.
25. Harrison R. Illustration of vasectomy or obliteration of the seminal ducts relative to hypertrophy of the prostate and bladder atony. Lancet 1900;156:96–7.
26. Wood AC. The results of castration and vasectomy in hypertrophy of prostate gland. Ann Surg 1900; 32:309–50.
27. Wallace CS. The results of castration and vasectomy upon the prostate gland in the enlarged and normal condition. Trans Path Soc Lond 1905;56:80–106.
28. Proust R. La prostatectomie dans l'hypertrophie de la prostate. Paris: Mason et Cie; 1904 [French].
29. Albarran J. Medicine operatoire de voies urinaires. Paris: 1909 [French].
30. Meltzer M. Bilateral vasectomy for prevention of epididymitis in prostatism. NY State J Med 1928; 28:1290–2.
31. Wagenaar J. Vasectomy in prostatic surgery. Eur Urol 1975;1(6):275–7.
32. Steinach Eugen. Verjüngung durch experimentelle neubelebung der alternden pubertätsdrüse. [Rejuvenation by experimental revitalization of the ageing puberty gland]. Archiv für Entwicklungsmechanik der Organismen 1920;46:557–610 [German].
33. Sengoopta C. Tales from the Vienna labs: the Eugen Steinach–Harry Benjamin correspondence. Newsletter of the rare book room. New York: The New York Academy of Medicine; 2000;2:5–7.
34. Wyndham D. Versemaking and lovemaking: W.B. Yeats "strange second puberty." Norman Haire and Steinach rejuvenation operation. J Hist Behav Sci 2003;39:25–50.
35. Wolfers D, Wolfers H. Vasectomania. Fam Plann Perspect 1973;5:196–9.
36. Why not ligate the vas deferens? Med Rec 1891;39: 266.
37. Van Meter ME. Some new methods in surgery. Transaction of the National Eclectic Medical Association 1898;25:69–75.
38. Ochsner AJ. Surgical treatment of habitual criminals. JAMA 1899;32:867–8.
39. Kantor WM. Beginning of sterilization in America. J Hered 1937;28:374–6.
40. Sharp HC. Vasectomy as a means of preventing procreation in defectives. JAMA 1909;53:1897–902.
41. Reilly P. Involuntary sterilization in the United States: a surgical solution. Q Rev Biol 1987;62:153–70.
42. Gallant AE. Sterilization of the unfit by vasectomy. Med Times 1915;43:38–40.
43. O'Connor VJ. Anastomosis of vas deferens after purposeful division for sterility. JAMA 1948;3: 162–3.
44. Stallworthy J, Walker K, Malleson J, et al. Problems of fertility in general practice. London: Cassell and Co; 1953.
45. Kashyap KN. Effects of vasectomy on population control and problems of reanastomosis. Proc R Soc Med 1973;66:51–2.
46. Ross JA, Hong S, Huber D. Voluntary sterilization: an international fact book association for voluntary sterilization. New York, 1985.

47. Nirapathpongporn A, Huber DH, Krieger JN. No-scalpel vasectomy at the King's birthday vasectomy festival. Lancet 1990;335(8694):894–5.
48. Liskin L, Pile JM, Quillin WF. Vasectomy: safe and simple. Population Reports Series D 1983;4:61–100.
49. Srinivasan K. Regulating reproduction in India's population: efforts, results and recommendations. New Delhi: Sage Publications; 1995.
50. Atkins BS, Jezowski TW. Report on the first international conference on vasectomy. Stud Fam Plann 1983;14:89–95.
51. Blouin F, Jessee WS. The Association for Voluntary Sterilization Records, 1929–1981. Minneapolis: Social Welfare History Archives, University of Minnesota Libraries. Available at: http://special.lib.umn.edu. Accessed June 3, 2009.
52. Poffenberger T. Two thousand voluntary sterilizations performed in California: background factors and comments. Marriage Fam Living 1963;25:469–74.
53. Landis J. Attitudes of individual California physicians and policies of state medical societies on vasectomy for birth control. J Marriage Fam 1966;28:277–83.
54. Davis JE, Hulka JF. Elective vasectomy by American urologists in 1967. Fertil Steril 1970;21:615–21.
55. Mangani R, Haws J, Morgan G. Vasectomy in the United States, 1991 and 1995. Am J Public Health 1999;89:92–4.
56. Barone MA, Hutchinson PL, Johnson CH, et al. Vasectomy in the United States, 2002. J Urol 2006;176:232–6.
57. Vasectomy: follow-up of thousand vasectomies. Cambridge: The Simon Population Trust; 1969.
58. Stepan J. Sterilization: the quiet revolution. People 1985;12(4):30–1.
59. Mayor S. French men invited to become "vasectomy tourists." BMJ 2000;321:470.
60. Klapproth HJ, Young IS. Vasectomy, vas ligation and vas occlusion. Urology 1973;1:292–300.
61. Division of the vas deferens in prostatic hypertrophy. Med Rec 1896;49:696–7.
62. Jhaver PS. Vasectomy after effects, modern techniques, complications, repair. Indian J Med Sci 1973;27:411–6.
63. Ohri BB, Jhaver PS. Single incision single stitch technique for vasectomy. Indian J Surg 1968;20:480–4.
64. Rolnick HC. Regeneration of the vas deferens. Arch Surg 1924;9:188–203.
65. Strode JE. A technique of vasectomy for sterilization. J Urol 1937;37:733–6.
66. Schmidt SS. Prevention of failure in vasectomy. J Urol 1973;109:296–7.
67. Schmidt SS. Techniques and complications of elective vasectomy: the role of spermatic granuloma in spontaneous recanalization. Fertil Steril 1966;17:467–82.
68. Jhaver PS, Davis JE, Lee H, et al. Reversibility of sterilization produced by vas-occlusion clip. Fertil Steril 1971;22:263–9.
69. Moss WM. A sutureless technique for bilateral partial vasectomy. Fertil Steril 1972;23:33–7.
70. Craft I, MCQueen J. Effect of irrigation of the vas on post-vasectomy semen counts. Lancet 1972;1:515–6.
71. Cutting out the scalpel: a unique approach to vasectomies. Interview with Dr. Li Shunqiang, the originator of no-scalpel vasectomy. China Popul Today 1995;12(5–6):25–7.
72. Bing XU, Huang WD. No-scalpel vasectomy outside China. Asian J Androl 2000;2:21–4.
73. Huber D. No-scalpel vasectomy: the transfer of a refined surgical technique from China to other countries. Adv Contracept 1989;5:217–8.
74. Hulka JF, Davis JE. Vasectomy and reversible vaso-occlusion. Fertil Steril 1972;23:683–96.
75. Levine L, Abern M, Lux M. Persistent motile sperm after ligation band vasectomy. J Urol 2006;176:2146–8.
76. Roberts WW, Chan DY, Fried NM, et al. High intensity focused ultrasound ablation of the vas deferens in canine model. J Urol 2002;167:2613–7.