

Comparative Risks and Costs of Male and Female Sterilization

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Abstract: Couples who are considering elective sterilization should compare the risks and costs of male and female sterilization procedures as part of the decision process. Morbidity, mortality, failure rates, and short-term costs associated with male and female sterilization procedures were estimated from data available in previous case series. Male sterilization procedures were found to have zero attributable deaths and significantly less major complica-

tions when compared to female sterilization procedures. No less than 14 deaths a year can be attributed to female sterilization procedures in the US. Male and female sterilization procedures have efficacy rates that are not significantly different from each other. The short-term costs of female sterilization are 3.0 to 4.1 times that of vasectomy. (*Am J Public Health* 1985; 75:370-374.)

Introduction

There are over 15 million surgically sterilized adults in the United States, 19 per cent of US couples with a wife 15-44 years of age.^{1,2} Each year close to one million surgical sterilizations are performed, the number of vasectomies being almost equal to the more popular tubal ligation.^{1,2} Sterilization is now the most common method of fertility control among married couples over age 30.³ When socioeconomic, family, and marital factors are looked at, those couples whose wives are undergoing tubal ligation are not significantly different from those couples whose husbands are undergoing vasectomy.⁴

The goal of this analysis is to estimate comparable efficacy, complication, and mortality rates and short-term costs associated with male and female sterilization procedures.

Previous publications^{2,5-8} have shown that sterilization is safer than using temporary contraception or no contraception.

Generally, sterilization is requested after procreation for the sexual couple or single person is deemed to be complete,^{2,3,8,9} a very different situation than that of couples or single persons choosing temporary contraception. The costs, efficacy, and risks associated with temporary versus permanent sterilization are used for a different set of decisions by different groups of individuals. The person who elects to be sterilized expects that for a given level of efficacy and cost that he or she will have the lowest rate of complications and mortality possible.

The psychological and social aspects of choosing male versus female sterilization by members of a sexual couple are not discussed in this analysis. However, we recognize that the risks, efficacy, and costs associated with the different sterilization procedures are only part of the information necessary for informed decision making by the consumer and the health care provider.

While the reversibility of the sterilization procedure is not a conceptual issue, it may be an empirical issue in the decision process. Clinical success of both male and female sterilization reversal is reported to range from 10-50 per

cent² and is dependent on the type of sterilization procedure and the skill of the surgeon. The re-anastomosis in the male would be associated with significantly less costs and risks of complications than the comparable female procedure.²

Methods

A literature search was done to capture all case series publications presenting data on deaths, complications, and failures of tubal ligation and vasectomy procedures in the US. Because of the changing nature of sterilization, including a multiplicity of techniques the increasing skill of the surgeons, and an increasing awareness of the associated risks, only case series published after 1970 were reviewed. Each case series was reviewed for consistency of the definition of attributable mortality, morbidity failure, and a minimum follow-up interval of three years. Over 50 case series were reviewed, including a variety of retrospective and prospective study designs. The numerator and denominator data from the case series were combined and averaged to produce estimates for the morbidity, failure, and mortality rates for tubal ligation and vasectomy. A Poisson distribution was assumed in calculating the 95 per cent confidence intervals of each estimated rate.

Because the case series varied in informational detail, it was not possible to calculate the rates by age, race, or socioeconomic status. Thus the estimates are for all US males and females undergoing sterilization. There is evidence in studies from lesser developed countries to suggest that for any age, race, or socioeconomic status the risk ratio among the various sterilization methods will be relatively constant even though the absolute rates will differ.¹⁰

Forty-eight per cent of tubal ligations are done within one month of an abortion or parturition, but this does not affect complication rates.⁹ Only complications and fatalities directly attributed by each author to the tubal ligation procedure are included in the risk estimates.

Procedure Costs

The procedure costs estimates are intended only to reflect the short-term costs. Costs associated with failure, complications, recuperation time, or death are not included.

Because cost information was complete and easily available for Boston and Dallas, these data were used to estimate procedure costs. It is recognized that these estimates may not be appropriate for less urbanized areas, or statistical metropolitan areas with a lower cost-of-living index.

The procedure costs include the surgeon's fee, anesthesia fee, and the facility costs for the operation and post-operative care. The maximum allowable insurance pay-

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ments* to the surgeon and anesthesiologist for tubal ligation and vasectomy were used to reflect the physician costs. The federal regional diagnosis-related group (DRG) payments for uncomplicated laparoscopy and laparotomy tubal ligation and vasectomy, for Dallas and Boston, were used to reflect all inpatient costs, excluding physician fees. An average outpatient post-operative facility fee for Dallas and Boston** for \$200 is used in the cost estimates for that proportion of tubal ligations and vasectomies done as outpatient procedures.

Only very rarely is a vasectomy done as an inpatient procedure. It may be included occasionally as an inpatient procedure when the patient was hospitalized for another indication, or when the patient is at high risk for complications.

Data are not available on the number of person admitted to the hospital for the purpose of undergoing vasectomy.*** However, so as not to underestimate the costs associated with these inpatient procedures, 5 per cent of vasectomies will be included as inpatient procedures in this cost estimation.

Data are not available on the proportion of vasectomy patients who stay in outpatient post-operative facilities.*** However, a random telephone survey of Dallas and Boston primary care physicians who regularly perform vasectomy showed outpatient post-operative facilities to be used in most instances. In order not to underestimate the costs of vasectomy, all outpatient vasectomies will be included as using post-operative facilities.

Nationally, about 25 per cent of laparoscopy tubal ligations and 2.5 per cent of laparotomy tubal ligations are done as outpatient procedures.¹¹ Those procedures done as outpatient procedures will be included as using post-operative facilities.

Table 1 shows the estimated procedure costs for inpatient and outpatient vasectomy, laparoscopy, and laparotomy tubal ligation.

Vasectomy Risks

Mortality Rate

No deaths were reported in any of the case series, and a recent review found no reported deaths in the US attributable to vasectomy.^{1,2} Potts, *et al*,¹⁰ in reviewing relative risks of sterilization in lesser developed countries quote a

*Personal Communication, representative from Health Insurance Institute of America.

**Phone survey of area hospitals, outpatient facilities, and physicians.

***Personal communication, Dr. William Pratt, National Survey of Family Growth, National Center for Health Statistics.

rate of 0.1/100,000 procedures in India, with most of the deaths attributable to tetanus or sepsis. This is the only value that exceeds zero in the available literature. A theoretical argument for a dose-related risk of death from anaphylaxis to the 3–5cc subcutaneous injection of anaesthetic has been made¹² but no estimate is available.

A mortality rate of zero will be used for later calculations.

Cumulative Failure Rate

In the case series, failure was defined as continued presence of motile sperm in the semen three months after the procedure. Close comparison with tubal sterilization failure, the occurrence of pregnancy in a previously sterilized women is not possible.³ In this analysis, the cumulative failure rate for vasectomy will be compared with that for tubal ligation, with the understanding that the vasectomy failure rate may be an overestimate of the actual number of failed vasectomies that result in pregnancy of the spouse.

Eight US studies from 1971–74 from a review by Hatcher,² where the current standard procedure was performed, found nine failures in 5,638 vasectomies. This gives a rate of 0.16/100 procedures (95 per cent confidence limits 0.07–0.28).

Long-Term Mortality Rate

The long-term mortality rate is related to sterilization failure which leads to pregnancy and its associated maternal mortality risks. The number of pregnancies which are assumed to occur from each failure is multiplied by the maternal mortality rate for US women 15–44 years of age (9.2/100,000 pregnancies). On the one hand, this overestimates mortality because not all failed vasectomies would lead to pregnancy; on the other hand, it underestimates the true mortality because the average age of wives of vasectomized men is older than that of all US pregnant women.⁷

In calculating estimates for male and female sterilization, the assumption is made that there are no elective abortions.

Complication Rate

Major complications are those associated with significant morbidity and/or large additional costs: all complications requiring intravenous antibiotics, hemorrhage requiring transfusion, operative complications or trauma requiring further repair or extended hospitalization.

Minor complications include fever or localized infection treated with oral antibiotics not requiring hospitalization, superficial hematoma, localized pain or complaints not requiring hospitalization or surgical repair.

Only those case series reporting complications that can be categorized into minor or major were used for the parameter estimation.

TABLE 1—Estimated Short-term Sterilization Procedure Costs

Procedure Type	Anesthesia & Physician Fee	Outpatient Facility	Inpatient (DRG rate)	Total
Outpatient Vasectomy	\$251	\$200	\$ 0	\$ 451
Inpatient Vasectomy	\$251	\$ 0	\$ 900	\$1151
Outpatient Laparoscopy	\$673	\$200	\$ 0	\$ 873
Inpatient Laparoscopy	\$673	\$ 0	\$ 952	\$1625
Outpatient Laparotomy	\$710	\$200	\$ 0	\$ 910
Inpatient Laparotomy	\$710	\$ 0	\$1303	\$2013

SOURCE: Health Insurance Institute of America, Blue Shield Health Insurance, *Federal Register* DRG payment schedule for Dallas and Boston, 1983–1984.

Fifteen studies in a review by Hatcher² found seven major complications out of 16,319 vasectomies, 0.43/1,000 procedures (95% confidence limits 0.17–0.81).

We have not used the minor complication rate, however, because of the considerable underreporting particularly in the case of tubal ligation, which would be expected to have a minor complication rate approaching 100 per cent if the definition were applied literally.

Sexual Dysfunction—No significant difference has been found in the rate of sexual dysfunction between couples with male and female sterilization.³

Alder, *et al.*,¹³ prospectively studied 90 matched couples undergoing surgical sterilization. He found that in the couples where the husband had undergone vasectomy there was a higher frequency of intercourse, fewer sexual problems, and more satisfactory marriage than couples where the wife had undergone tubal ligation.¹³ These differences were not felt to be secondary to the procedure but related to underlying differences in the couples.

Arteriosclerotic Cardiovascular Disease and Vasectomy—On the basis of animal studies, it has been postulated that damage to the arterial walls by deposits of circulating immune complexes may have followed vasectomy.^{3,14,15,16} Two recent reviews^{14,17} of 13 large US epidemiologic studies to evaluate this hypothesis found no increase in ASCVD in vasectomized men.

Sperm Antibodies—Thirty to 50 per cent of men who have undergone vasectomy develop antibodies to sperm.^{3,14,17} This has raised concern about the development of immunological disease in vasectomized men. Two recent reviews of a number of large US epidemiologic studies on the subject^{14,17} found that sperm antibodies had a negative effect on fertility in males who had undergone vas anastomosis procedures. No other immunological health effects were identified.

In summary, the available evidence does not support sexual dysfunction, arteriosclerotic cardiovascular disease, or immunological disease as complications of vasectomy. Therefore, they will not be included in the major complication category of this analysis.

Tubal Ligation Risks

Mortality Rate

Several reviews of tubal ligation or complications of tubal ligation present mortality rates from 2.5–10.0/100,000.^{9,11,18–24} The most common causes of death were complications of general anaesthesia (38.0 per cent), operative trauma (27.5 per cent), sepsis (24.0 per cent), and myocardial infarction (10.3 per cent).⁹ No deaths have been reported due to complications of local anaesthesia with tubal ligation procedures in the US,⁹ but tubal ligation performed under local anaesthesia would still retain the mortality risk from operative trauma, sepsis, and myocardial infarction.

Mortality rates are calculated for laparoscopy and laparotomy tubal ligation procedures, using two large US case series.^{9,21} For laparoscopy tubal ligation, there were 21 deaths attributable to 444,565 procedures, a rate of 4.72/100,000 (95 per cent confidence limits 2.70–6.74). For laparotomy, there were 13 deaths attributable to 567,000 procedures, a rate of 2.29/100,000 (95 per cent confidence limits 1.22–3.71).

Cumulative Failure Rate

The cumulative failure rate for laparoscopy tubal ligation was calculated from 21 case series, most of which were

reviewed in a paper by McCausland.²⁵ There were 154 failures among 55,877 sterilized women, a rate of 0.28/100 (95 per cent confidence limits 0.23–0.32). Five case series were used to estimate the failure rate for laparotomy tubal ligation.^{22,25–27} There were 17 failures among 5,213 sterilized women, a rate of 0.33/100 (95 per cent confidence limits 0.18–0.48).

Long-Term Mortality Rate

Unlike vasectomy, there is an increased rate of ectopic gestation with an associated increased maternal mortality among women with failed tubal ligation.^{28–31} The proportion of such women with tubal gestation ranges from 16–50 per cent, depending on the type of procedure.^{28–30} The case series by McCausland²⁵ is the only study with detailed information of ectopic pregnancy rates by type of procedure. McCausland found 49 ectopic pregnancies out of 160 failed laparoscopy tubal ligations, an ectopic pregnancy rate of 30 per cent. He also reported 13 ectopic pregnancies out of 106 failed non-laparoscopy tubal ligations, ectopic pregnancy rate of 12.3 per cent.

Rubin, *et al.*,²⁹ estimated, for all women in the US in 1978, 37 deaths attributable to 42,400 ectopic pregnancies, an estimated ectopic pregnancy mortality rate of 87/100,000 ectopic pregnancies.

To estimate the long-term mortality rate, the expected number of ectopic pregnancies is multiplied by the ectopic pregnancy mortality rate. The estimated number of non-ectopic gestations is multiplied by the non-ectopic maternal mortality rate for the US.⁷

Complication Rate

For laparoscopy tubal ligation, four case series were used.^{15,21,26,27} There were 214 major complications among 10,179 women undergoing sterilization, a rate of 2.1/100 (95 per cent confidence limits 1.8–2.4). For laparotomy tubal ligation, three case series were used.^{15,24,27} There were 102 major complications among 1,651 undergoing sterilization, a rate of 6.2/100 (95 per cent confidence limits 5.0–7.3).

Post-tubal Syndrome—The question whether tubal ligation predisposes women to menstrual disturbances has been explored in several studies.^{15,24,27} It has been concluded that the observed differences in menstrual function after tubal ligation may be attributed to the older average age, and/or previous pelvic disease and birth control methods. Therefore menstrual disturbance is not considered a complication of tubal ligation.

Results

Table 2 shows the costs, mortality, complication, and failure rates for 100,000 sexual couples or single persons undergoing sterilization. Within the confines of the variation of the available case series and the assumptions discussed in the Methods section, these data are comparable.

Table 3 shows the risk ratios (RR) for tubal ligation compared to the reference vasectomy. The attributable mortality RR and the major complication RR for tubal ligation procedures are each approximately two orders of magnitude greater than vasectomy. The short-term costs of tubal ligation are 3.0 to 4.1 times greater than vasectomy.

In Figure 1, the first section shows the estimated rates from Table 2 applied to the actual numbers of sterilizations in 1981—i.e., 400,000 vasectomies, 140,500 laparoscopy, and 299,500 laparotomy tubal ligations.

In the second section of Figure 1, the same rates and numbers of procedures are applied in a hypothetical situa-

TABLE 2—Estimated Deaths, Complications, Failures and Costs for Tubal Ligation and Vasectomy (per 100,000 procedures)

Sterilization Procedure	Laparoscopy Tubal Ligation	Laparotomy Tubal Ligation	Vasectomy
Procedure Mortality	4.72	2.29	0
Long-term Mortality	0.09	0.06	0.02
Attributable Mortality*	4.81	2.35	0.02
Major Complications	2100	6170	43
Sterilization Failures	276	326	160
Short-term Costs (Millions \$)	143.6	198.5	48.6

*Attributable = Procedure Mortality plus Long-Term Mortality

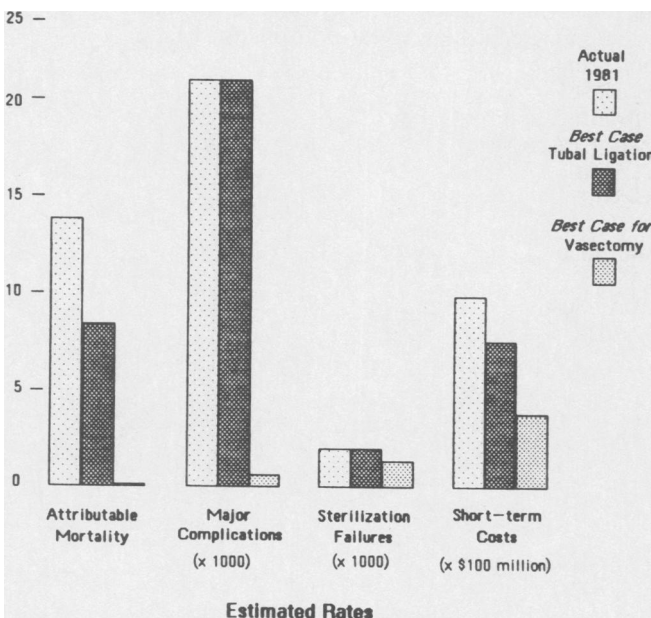
TABLE 3—Risk Ratios for Mortality, Complications, Failures and Costs for Tubal Ligation and Vasectomy (Vasectomy is reference RR = 1.0)

Sterilization Procedure	Laparoscopy Tubal Ligation	Laparotomy Tubal Ligation	Vasectomy
Long-term Mortality	5.7 *(1.1–18.1)	3.9 (0.7–13.8)	1.0
Attributable Mortality	241 (146.9–393.8)	117.5 (63.4–217.8)	1.0
Major Complications	49.0 (32.0–75.1)	143.0 (104.6–198.2)	1.0
Sterilization Failures	1.7 (0.9–3.4)	2.0 (0.9–4.5)	1.0
Short-term Costs	3.0	4.1	1.0

*95 per cent confidence limits

tion in which all of the tubal ligations are done as outpatient procedures, using only local anaesthesia. This is the “best case” situation for tubal ligation.

In the third section of Figure 1, the same rates and numbers of procedures are applied in a hypothetical situation in which all of the sterilization procedures are done as vasectomy. This is the “best case” situation for vasectomy.

**FIGURE 1—Actual and Hypothetical Risks and Costs of Sterilization Procedures (1981 data)**

This would lead to an estimated 100 per cent reduction in mortality, 85 per cent reduction in major complications, and 62 per cent decrease in costs with the same efficacy rate as the other alternatives.

Discussion

This method of analysis and rate estimation is flawed by the variability of the case series used including differences in study population, physician experience, and technique. However, by using the raw data from a large number of case series reflecting such a large variety of experience, the estimated rates may be close to the real-life situation. The actual differences among the sterilization procedures will not be adequately known until a large, well-designed prospective study is conducted among sexual couples requesting elective sterilization.

With this limitation in mind, we believe that our data suggest that vasectomy is safer and considerably less expensive than tubal ligation, with efficacy rates not significantly different from tubal ligation.

REFERENCES

1. Reproductive Impairment among Married Couples: United States, 1982. Data from National Survey of Family Growth Data, Series 23, No. 11, National Center for Health Statistics. Washington, DC: Govt Printing Office.
2. Hatcher RA, Guest F, Stewart F, *et al* (eds): Contraceptive Technology 1984–1985. New York: Irvington Publishers, 1984.
3. Vasectomy—safe and simple. *Popul Rep* 1983; 11:63–94.
4. Markman LM, Frankel HA: The choice of sterilization procedure among married couples. *J Fam Pract* 1982; 14:27–30.
5. Sachs BP, Layde PM, Rubin GL, *et al*: Reproductive mortality in the United States. *JAMA* 1982; 247:2789–2792.
6. Keeping JD, Chang A, Morrison J: Sterilization: a comparative review. *Aust NZ J Obstet Gynaecol* 1979; 19:193–202.

7. Ory HW: Mortality associated with fertility and fertility control: 1983. *Fam Plann Perspect* 1983; 15:57-63.
8. Rubin GL, Ory HW, Layde PM: The mortality risk of voluntary surgical contraception. *Biomed Bull* 1982; 3:1-5.
9. Peterson HB, DeStefano F, Rubin GL, *et al*: Deaths attributable to tubal sterilization in the United States, 1977 to 1981. *Am J Obstet Gynecol* 1983; 143:131-136.
10. Potts M, Speidel JJ, Kessel E: Relative risks of various means of fertility control when used in lesser developed countries. In: Sciarra JJ, Zatzuchni GI, Speidel JJ (eds): *Risks, Benefits, and Controversies in Fertility Control*. Hagerstown, MD: Harper And Row, 1977.
11. Peterson HB, Greenspan JR, DeStefano F, *et al*: The impact of laparoscopy on tubal sterilization in United States hospitals, 1970 to 1978. *Am J Obstet Gynecol* 1981; 140:811-814.
12. Ackman CFD, MacIsaac SG, Schual R: Vasectomy: benefits and risks. *Int J Gynaecol Obstet* 1979; 16:493-496.
13. Alder E, Cook A, Gray J, *et al*: The effects of sterilization: a comparison of sterilized women with the wives of vasectomized men. *Contraception* 1980; 23:45-53.
14. Massey FJ, Bernstein GS, O'Fallon WM, *et al*: Vasectomy and health: results from a large cohort study. *JAMA* 1984; 252:1023-1029.
15. Lipshultz LI, Benson GS: Vasectomy—1980. *Urol Clin North Am* 1980; 7:89-105.
16. Advance Report on Final Mortality Statistics, 1980. *Monthly Vital Statistics Report* 1983; 32:1-40.
17. Perrin EB, Woods JS, Namekata T, *et al*: Long-term effect of vasectomy on coronary heart disease. *Am J Public Health* 1984; 74:128-132.
18. Peterson HB, Lubell IL (eds): *Sterilization: A Worldwide Epidemiologic View*, Chicago: Year Book Medical Publishers, 1983.
19. Peterson HB, Greenspan JR, Ory HW, *et al*: Tubal sterilization mortality surveillance, United States, 1978-1979. *Adv Planned Parenthood* 1981; 16:71-76.
20. Aubert JM, Lubell I, Schima M: Mortality risk associated with female sterilization. *Int J Gynaecol Obstet* 1980; 18:406.
21. Phillips JM, Hulka J, Hulka B, *et al*: American Association of Gynecologic Laparoscopists, 1976 membership survey. *J Reprod Med* 1978; 21:3.
22. Peterson HB, DeStefano F, Greenspan JR, *et al*: Mortality risks associated with tubal sterilization in United States hospitals. *Am J Obstet Gynecol* 1982; 143:125-129.
23. Phillips J, Hulka JH, Keith D, *et al*: Laparoscopic procedures: a national survey for 1975. *J Reprod Med* 1977; 18:219-225.
24. Newton JR, Gillman S: A retrospective survey of female sterilization for the years 1968 to 1973, analysis of morbidity and post-sterilization complications for 5 years. *Contraception* 1980; 22:295-311.
25. McCausland A: High rate of ectopic pregnancy: incidence and etiology. *Am J Obstet Gynecol* 1980; 136:97-101.
26. Cunanan RG, Courey NG, Lippes J: Complications of laparoscopic tubal sterilization. *Obstet Gynecol* 1980; 55:501-506.
27. Brenner WE: Evaluation of contemporary female sterilization methods. *J Reprod Med* 1981; 26:439-453.
28. Peterson HB, Lubell I, DeStefano F, *et al*: The safety and efficacy of tubal sterilization: an international overview. *Int J Gynaecol Obstet* 1983; 21:139-144.
29. Rubin GL, Peterson HB, Dorfman SF, *et al*: Ectopic pregnancy in the United States: 1970 through 1978. *JAMA* 1983; 249:1725-1729.
30. Barnes AB, Wennberg CN, Barnes BA: Ectopic pregnancy: incidence and review of determinant factors. *Obstet Gynecol Surv* 1983; 38:345-356.
31. Qvigstad E, Jerve F: Ectopic pregnancy following tubal sterilization. *Int J Gynaecol Obstet* 1982; 20:279-281.

1985 International Study Tour to Japan: A Focus on Health and Aging

An international study tour to Japan and Hong Kong will be conducted July 20-August 4, 1985. A comprehensive view of the health care system with an emphasis on services for the older adult in Japan will include visits to the Metropolitan Tokyo Research Institute for the Aged, National Institute of Public Health, Ministry of Health, Life Planning Center, universities, hospitals, public health departments and long term care facilities. The study tour will be co-directed by Drs. Geri Marr Burdman, Margaret F. Dosch, and Kiyoka Koizumi. Continuing education credit available for health and social service professionals. For further information, contact:

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