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Clinical Outcome and Cost Comparison of Percutaneous Embolization and Surgical Ligation of Varicocele

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ABSTRACT: We reviewed the records of 81 consecutive subfertile men with oligospermia and/or asthenospermia, treated for varicocele with either percutaneous embolization or surgical ligation between 1987 and 1991, and compared the outcomes and costs of the two procedures. All men had presented with infertility of at least 6 months duration, and in most cases female factors had been previously evaluated and treated. Patients were offered a choice of embolization or ligation of the internal spermatic vein. Forty-five men (56%) underwent ligation, and 36 men (44%) opted for embolization. The mean age, serum follicle-stimulating hormone, pretreatment sperm density, motility, and concentration of motile sperm were similar for the two groups. Seminal quality improved in 65% of all patients after varicocele ablation (46 of 71). Improvements were seen in postoperative sperm density ($P < 0.01$), motility ($P < 0.002$), and concentration of motile sperm ($P < 0.001$). Thirty-nine percent of the assessable patients established pregnancies during the study interval (26 of 66). The two treatment groups did not differ significantly with regard to the likelihood of postoperative improvement in sperm density ($P = 0.64$), motility ($P = 0.33$), concentration of motile sperm ($P = 0.11$), or pregnancy rate ($P = 0.83$). Percutaneous embolization and surgical ligation of varicocele are equally effective in improving male infertility and cost about the same. Embolization offers the potential advantage of shorter recovery to full activity as compared to surgical ligation. Where experienced interventional radiologists are available, percutaneous embolization should be offered as an alternative to open ligation.

Key words: Male infertility, etiology, therapy, veins.
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Since Tulloch (1952) described improvement in seminal parameters and fertility in a subset of patients after ligation of the internal spermatic vein, varicocelectomy has been widely accepted in the treatment of subfertile men (Okuyama et al, 1988; Mordel et al, 1990). Over the past two decades, a number of approaches to varicocele ablation have evolved, including inguinal and retroperitoneal ligation (Dubin and Amelar, 1975; Brown, 1976; Kass and Bogdan, 1992), percutaneous transvenous embolization (Sigmund et al, 1987), and, more recently, laparoscopic ligation of the internal spermatic veins (Hagwood et al, 1992; Donovan and Winfield, 1992). Proponents of each technique have reported improved fertility with treatment.

Since 1987, we have offered our subfertile patients with varicocele a choice of percutaneous embolization or open surgical ligation. Herein, we compare the results and costs of these two treatments.

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Materials and Methods

We reviewed the records of 81 consecutive men who underwent varicocele ablation at our institution between January 1987 and September 1991. These dates were chosen to reflect an approximate time interval during which patients have been offered a choice of percutaneous transvenous embolization or open surgical ligation of the internal spermatic vein as therapy for male infertility. In addition, all patients were followed for at least 1 year after treatment. During the study interval, 45 men (56%) were treated with ligation via an inguinal or retroperitoneal approach. A varicocele was present on the left side in 41 of these men, on the right side in 1, and bilateral in 3. All surgical procedures were performed under general or regional anesthesia by one of the authors (A.J.T.). Thirty-six men (44%) chose treatment by percutaneous embolization using sclerosing agents, balloons, or coils. Varicoceles were present on the left side in 34 of these patients, and bilateral in 2. Embolization procedures were performed under local anesthesia with mild sedation by one of two of the authors (M.A.G., G.K.L.). All treatments were scheduled as outpatient procedures.

Age, pretreatment serum follicle-stimulating hormone (FSH), pre-/ and posttreatment computer-assisted semen analysis (Motion Analysis Corp., Santa Rosa, California), number of previous treatments, complications requiring admission, and establishment of pregnancy were determined from the patients' medical records. In all cases, at least two semen samples were analyzed

Table 1. *Pretreatment characteristics of 81 men undergoing embolization or ligation of varicocele*

Characteristic	Embolization ($N = 36$) (mean ± SD)	Surgical ligation ($N = 45$) (mean ± SD)	P-value*
Age (years)	32.28 ± 4.74	31.00 ± 4.27	0.21
FSH (ng/dl)	6.94 ± 3.12	6.55 ± 3.51	0.60
Density†	27.87 ± 31.88	16.41 ± 16.21	0.03
Motility (%)	23.69 ± 12.45	22.02 ± 14.22	0.58
Concentration of motile sperm†	7.99 ± 13.51	3.91 ± 4.48	0.06

* Unpaired *t*-test.
† Million sperm/ml.

before treatment, and the means were used for statistical comparison. After treatment, semen samples were collected at 3-, 6-, and 9-month intervals after at least 2 days of abstinence, except in cases where pregnancy occurred within 3 months or the patient was lost to follow-up. All men had sperm counts less than 20 million per milliliter and/or motility less than 50%. Recurrences were determined by physical examination by one of the authors (A.J.T.). When pregnancy data could not be discerned from the record, patients were contacted by telephone to determine accurate pregnancy rates through September 1992. Because of the chosen inclusion dates, all patients contacted by telephone were at least 12 months posttreatment.

To compare the relative costs of ligation versus embolization, the average procedure-related charges for the five most recently treated embolization patients (four unilateral, one bilateral) and the four most recent surgically treated patients (three unilateral, one bilateral) were considered. Because historical data in this regard were beyond the scope of our intent, bills for patients treated in 1992 were chosen to reflect the most up-to-date cost information available. Because these men were treated in 1992, they were not included in semen quality and pregnancy rate calculations.

Statistical Analysis

Chi-square analyses were used to determine whether or not semen parameters improved after treatment and to compare pregnancy rates for the embolization and ligation groups. We defined "improvement in semen quality" as a 20% or greater increase in mean sperm count, and/or a 10% or greater increase in mean percent motility after treatment. Because some men with counts as low as 1 million sperm per milliliter established pregnancies, "threshold" values of minimal semen quality were not used. Overall improvement in semen quality was assessed with a paired *t*-test and with nonparametric tests. Because the levels of significance were the same for these two measures, only *t*-test results are presented. Paired *t*-tests were also used to compare pre-/ and posttreatment semen parameters for patients who established pregnancies versus those who did not establish pregnancies. Alpha levels of <0.05 were considered significant.

Table 2. *Results of varicocele treatment by percutaneous embolization or surgical ligation in 81 men*

Parameter	Pretreatment (mean ± SD)	Posttreatment (mean ± SD)	P-value*
Sperm density†	21.5 ± 23.2	30.2 ± 36.8	0.01
Motility (%)	22.8 ± 13.4	28.9 ± 18.1	0.002
Concentration of motile sperm†	4.7 ± 8.5	10.2 ± 14.2	0.001

* Paired *t*-test.
† Million sperm/ml.

Results

Age and pretreatment serum FSH levels did not differ for the embolization ($N = 36$) and ligation ($N = 45$) groups. Pretreatment sperm density was statistically significantly lower in the ligation group, although the clinical significance of this finding is unknown. Percent motility and concentration of motile sperm were similar for the two treatment groups (Table 1).

Two of the patients treated surgically had been referred after unsuccessful treatment with percutaneous embolization at other institutions. Eight men in the embolization group were referred after unsuccessful surgical treatment elsewhere. Among the men who received their initial treatment at our institution, there were three reported recurrences after surgical ligation, and one recurrence after embolization. Eleven patients treated surgically required overnight hospitalization. Reasons for admission on the day of surgery included: "routine" (three patients), EKG changes (two patients), urinary retention (two patients), dizziness (two patients), atelectasis (one patient), and pain requiring parenteral narcotics (one patient). One patient in the surgery group experienced a wound infection several days postoperatively that required hospitalization. No complications requiring admission occurred in the embolization group.

Posttreatment semen analysis was available for 71 of 81 patients (88%). Two of the 10 men who did not have a posttreatment semen analysis established pregnancies prior to their first follow-up visit; the remaining 8 patients did not return for follow-up. Overall, 65% (46 of 71) of men had improved seminal parameters following treatment. Statistically significant improvement was seen in mean sperm density (from 21.5 million/ml to 30.2 million/ml, $P = 0.01$), mean motility (from 22.8 to 28.9%, $P = 0.002$), and mean concentration of motile sperm (from 5.7 million/ml to 10.2 million/ml, $P = 0.001$). These results are presented in Table 2. Interestingly, only 8% of patients (6 of 71) had "normal" posttreatment semen parameters according to World Health Organization standards (density >20 million/ml, motility >50%).

Pregnancy data were available for 66 of 81 men (81%). Of the remaining 15 patients, 1 man was divorced shortly after treatment and had not tried to establish pregnancy.

Table 3. *Pre- and posttreatment semen parameters for 81 men undergoing embolization or ligation of varicocele, by pregnancy outcome*

Parameter	Pretreatment means			Posttreatment means		
	+Pregnancy	−Pregnancy	*P*-value*	+Pregnancy	−Pregnancy	*P*-value*
Density†	23.0	18.8	0.51	42.3	20.0	0.04
Motility (%)	26.1	21.8	0.23	36.9	25.1	0.02
Concentration of motile sperm†	7.2	4.7	0.39	15.2	6.3	0.03

* Paired *t*-test.
† Million sperm/ml.

Table 4. *Changes in semen quality in 81 men undergoing embolization or ligation of varicocele*

Parameter	Embolization (*N* = 36)	Surgical ligation (*N* = 45)	*P*-value*
Increased density	20/32 (63%)	23/39 (59%)	0.64
Increased motility	16/32 (50%)	24/39 (62%)	0.33
Increased concentration of motile sperm	18/32 (56%)	29/39 (74%)	0.11
Pregnancy	11/29 (38%)	15/37 (41%)	0.83

* Chi-square analysis.

and 14 patients were lost to follow-up. Of the 66 men for whom pregnancy data were available, 26 (39.4%) fathered children during the study interval.

The mean pre-/ and posttreatment semen parameters for patients who established pregnancies were compared to those of men not establishing pregnancy (Table 3). While the pretreatment semen quality was similar, mean posttreatment parameters were significantly better for the men who established pregnancies.

Outcomes for the embolization and surgically treated groups were compared with chi-square analyses (Table 4). The two groups did not differ with respect to the likelihood of improvement in posttreatment sperm density, motility, or concentration of motile sperm. Furthermore, the pregnancy rate for the two treatment groups was not statistically different ($P = 0.83$, $\chi^2 = 0.046$, df = 1). Thirty-eight percent of the assessable embolization patients produced pregnancies, while 41% of the assessable surgically treated men fathered children.

The procedure-related costs for nine patients treated with surgical ligation or embolization in 1992 are presented in Table 5. Total costs for the two procedures were comparable.

Discussion

Our intent in this study was to compare outcomes for two different methods available for the treatment of varicocele in subfertile men. Although the retrospective design of the study precludes us from definitively arguing in favor of varicocele ablation in all men presenting with infertility, certain observations from this review do merit further comment.

A particular strength of the current review is the excellent patient follow-up, with 88% of men returning for at least one posttreatment semen analysis, and pregnancy data for 81% of the patients. Because the majority of subfertile couples are 20–40 years old, not surprisingly, they are somewhat "mobile." Thus, they can be difficult patients to follow long term.

Our overall results of improved seminal quality in 65% of men and a pregnancy rate of 39.4% after varicocele ablation are consistent with other investigators' findings. Dubin and Amelar (1975) found improvement in seminal quality in 71% of patients along with a 55% pregnancy

Table 5. *Cost comparison for nine men treated with surgical ligation or percutaneous embolization in 1992*

Item	Surgical ligation		Embolization	
	Unilateral	Bilateral	Unilateral	Bilateral
Preoperative laboratory	$ 130	$ 130	$ 130	$ 130
Anesthesia	1,187	1,696	0	0
Pathology	46	112	0	0
OR/angio suite	910	1,663	814	814
Surgeon/angiographer	1,086	2,172	1,703	3,530
Medications	43	36	71	140
Coils/wires/contrast media	0	0	778	1,397
Recovery	374	374	200	200
Total	$3,776	$6,183	$3,696	$6,211

rate, while Brown (1976) reported seminal improvement in 58% of men, with a pregnancy rate of 41%.

Our finding of a significant difference in the posttreatment semen quality of men establishing pregnancies compared to those who did not father children deserves mention. This further supports our belief that varicocele impairs fertility in at least a subset of men, although how to identify this subset before treatment remains an enigma.

A review of the literature on percutaneous varicocele embolization shows improved semen quality in 41–59% of patients (Marsman, 1985; Bach et al, 1988; Salgarello et al, 1990). Pregnancy rates have ranged from 24 to 41% (Marsman, 1985; Smith et al, 1988). In a retrospective study comparing results of surgical ligation versus embolization, Parsh et al (1989) reported 1-year posttreatment pregnancy rates of 14% and 25%, respectively, although this difference was not statistically significant.

Bach et al (1988) has suggested that percutaneous embolization is less expensive than surgical ligation of varicocele. Our results indicate that the costs of the two procedures are comparable. The potential financial advantage for patients undergoing percutaneous embolization as compared to those treated surgically lies in the shorter recovery time to full activity for the former group. The majority of patients treated with embolization return to work in 48 hours. We have generally asked patients treated surgically to avoid strenuous activity for at least 3 weeks. Marmar et al (1985) have reported that patients treated with their technique of spermatic vein ligation at the external inguinal ring often return to work in 2 days. With more extensive procedures, men with vigorous job requirements may be off work for 7 or more days, depending on their comfort level.

With an increasing emphasis on cost reduction in medicine, other less invasive methods of varicocele therapy have recently received attention. These include varicocele ligation under local anesthesia and laparoscopic ablation. Marmar et al (1985) use only local anesthesia and thus avoid anesthesia-related charges. This would result in a 31% or 27% cost reduction for unilateral or bilateral varicocele ligations, respectively, at our institution. Ross and Ruppman (1993) have also reported the efficacy of varicocelectomy under local anesthesia. However, 89.9% of their patients also received intravenous sedation administered by an anesthesiologist. At our institution, this would result in little or no cost reduction, since the professional fee for "monitored care" cases is essentially the same as that for general anesthetic cases. Furthermore, while eliminating the anesthesiologist from the procedure would reduce costs, this could come at the expense of patient comfort and safety.

To date, we have not offered laparoscopic spermatic vein ligation as an alternative for our subfertile patients with varicocele. The reported advantages of this procedure over conventional open techniques include reduced postoperative discomfort and a more rapid recovery time to full activity. Hagwood et al (1992) reported that patients treated with laparoscopic varicocelectomy returned to work an average of 2 days postoperatively. Donovan and Winfield (1992) have reported that laparoscopically treated patients return to work an average of 3.4 days after varicocelectomy and consumed an average total of 8.4 acetaminophen with codeine tablets. Neither group of investigators identified significant morbidity associated with laparoscopy. The question of whether laparoscopy offers these same advantages over embolization remains to be answered.

In summary, percutaneous embolization and surgical ligation of varicocele are equally effective in improving male fertility. The total costs for the procedures themselves are comparable, although the potential advantage of an earlier return to work after embolization is recognized. Where experienced interventional radiologists are available, percutaneous varicocele embolization should be offered as an alternative to open surgical ligation.

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