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Preservation of Testicular Arteries During Subinguinal Microsurgical Varicocelectomy: Clinical Considerations

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ABSTRACT: Microsurgical varicocelectomy with intentional preservation of the testicular artery(ies) is regarded as the gold standard approach to varicocele repair. We sought to determine whether the number of testicular arteries preserved at the time of microsurgical varicocelectomy predicts improvement in postoperative semen parameters. We analyzed the records of 334 infertile men who underwent varicocelectomy performed by a single surgeon using a subinguinal microsurgical technique between July 1996 and January 2003. We examined the association between the number of testicular arteries preserved at the time of varicocelectomy and serum follicle-stimulating hormone (FSH), luteinizing hormone (LH), varicocele grade, testicular volume, and postoperative improvement in semen parameters. Unilateral, left-sided varicocelectomy was performed in 194 men, while bilateral varicocelectomy was performed in 140 men. Mean (±SE) sperm concentration ($20.1 \pm 1.5 \times 10^6$/mL to $26.7 \pm 1.9 \times 10^6$/mL, $P = .001$), percent motility (24.7 ± 1.0% to 30.9 ± 1.2%, $P = .001$), and percent normal morphology (35.8 ± 1.4% to 37.7 ± 1.5%, $P = .046$) improved significantly following varicocelectomy. The mean number of preserved testicular arteries was 1.5 on the left (range, 1–4) and 1.5 on the right (range, 1–4). The number of testicular arteries preserved at the time of varicocelectomy did not correlate significantly with preoperative assessment of serum FSH, LH, varicocele grade, and testicular volume or with postoperative improvement in semen parameters. Our data indicate that preoperative parameters are not predictive of the number of testicular arteries identified at the time of microsurgery. These data also suggest that the number of arteries identified and preserved with meticulous spermatic cord dissection does not correlate with improvement in semen parameters.

Key words: Varicocele, male infertility, semen.
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Knowledge of the testicular arterial anatomy is of fundamental importance during surgery of the spermatic cord and scrotal structures to ensure that testicular function and male fertility potential are preserved. Contrary to classical descriptions of testicular arterial anatomy that depict a single testicular artery branching at the level of the scrotum (Warwick and Williams, 1973; Woodburne, 1978), several investigators, using both clinical and histologic analysis, have documented the presence of multiple arterial branches within the inguinal spermatic cord as far proximally as the internal ring (Beck et al, 1992; Jarow et al, 1992; Ergun et al, 1997; Hopps et al, 2003). Using loupe magnification, Jarow et al (1992) examined the spermatic cords of 12 men who underwent inguinal varicocelectomy and reported a mean of 2 testicular arteries (range, 1–3). Histologic analysis of 17 adult spermatic cords examined at autopsy revealed a mean of 2.4 arteries at the level of the proximal inguinal canal (Jarow et al, 1992). Reporting on the intraoperative anatomy of 83 infertile men who underwent microsurgical varicocelectomy at the inguinal level, Beck et al (1992) identified 1 artery in 69% of dissections, 2 arteries in 27% of dissections, and 3 or more arteries in 4% of spermatic cords. In a follow-up report, the same group identified 2 arteries in 42% of all dissections and 3 arteries in 33% of the spermatic cords during microsurgical varicocelectomy at the subinguinal level (Hopps et al, 2003).

Varicocelectomy requires meticulous dissection of the angioarchitecture within the spermatic cord in an effort to identify and preserve the testicular arterial blood flow and lymphatic channels while ligating all internal and external spermatic veins. Although it is unverified, researchers suspect that the number of arteries identified and preserved following careful microsurgical dissection of the varicocele will have little impact on the outcome of this surgery in terms of postoperative improvement in semen parameters and fertility potential. Moreover, it is unknown whether there are any preoperative predictors of the number of arteries that can be identified and preserved following careful microsurgical varicocelectomy. As such, the objectives of the current study were to examine whether the number of testicular arteries identified and preserved at the time of varicocelectomy 1) can be predicted by preoperative parameters (serum follicle-stimulating hormone [FSH], luteinizing hormone [LH], vari-

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cocele grade, and testicular volume), and 2) can predict postoperative improvement in semen parameters.

Methods

Study Subjects

We performed a retrospective review of men who presented for infertility evaluation at the Mount Sinai Hospital Andrology Clinic between July 1996 and January 2003 and who subsequently underwent microsurgical subinguinal varicocelectomy for the treatment of clinically palpable varicoceles. A total of 346 men were identified. Patients who had undergone previous varicocele ligation and inguinal or scrotal surgery were excluded from the analysis (n = 12), leaving 334 patients who were included in the present study. All microsurgical varicocelectomies were performed by the same surgeon (A.Z.).

Preoperative evaluation included a complete medical and fertility history of the patient and his female partner, a physical examination, semen analyses, and measurements of serum hormone levels (FSH, LH, total testosterone, and estradiol). Testicular volume was measured by a single examiner on physical examination (A.Z.). Varicoceles were graded (I, II, or III) according to World Health Organization (1985) guidelines during physical examination in a warm room with the patient standing.

Nearly all of the men had at least 2 semen analyses before and 2 semen analyses after surgery. However, to be consistent, we used the semen analysis performed 1–3 months before varicocelectomy (preoperative analysis) and the semen analysis performed 6–8 months after surgery (postoperative analysis) for data analysis in this study. Semen specimens were obtained by masturbation after a minimum of 3 days of abstinence. After liquefaction of semen, standard semen parameters (volume, concentration, motility, and morphology) were obtained according to World Health Organization (1992) guidelines.

All of the men underwent a testicular artery and lymphatic-sparing subinguinal microsurgical varicocelectomy, as previously described (Goldstein et al, 1992). In brief, a 2- to 3-cm oblique incision is made over the external inguinal ring. The testicle is delivered into the operative field, and all external and gubernacular veins are ligated. Using an operating microscope at 8–10× magnification, the internal and external spermatic sheaths are opened, and the testicular arteries, lymphatics, and vas deferens and its vessels are carefully identified and preserved. No attempt was made to clearly identify the vasal artery (so as not to disturb the vasal package—vas and its vessels), although this artery was generally identified in most cases (this was not included in the analysis). Identification of the testicular artery(ies) is confirmed by visualization of clear pulsatile movement and/or evidence of antegrade, pulsatile blood flow with gentle lifting and partial occlusion of the vessel. All external and internal spermatic veins are clipped or ligated and divided. All patients were examined 6–12 weeks postoperatively to assess recovery and to rule out the development of potential complications (hydrocele, testicular atrophy, and persistent or recurrent varicocele).

Patient information for this study remained confidential and within the institution. In our institution, institutional review board (IRB) approval is not necessary for retrospective studies. IRB approval was therefore not obtained.

Statistics

Results are expressed as the mean ± 1 standard error of the mean. Differences in semen parameters before and after varicocelectomy were estimated by parametric and nonparametric tests as appropriate. The relationships between parameters (eg, number of arteries, testicular volume) were examined using linear regression techniques with the Pearson correlation coefficient. All hypothesis testing was 2-sided with a probability value of .05 deemed significant. Statistical analysis was performed using SPSS statistical software (SPSS 10.0, Chicago, Ill).

Results

Unilateral left-sided varicocelectomy was performed in 194 men, while bilateral varicocelectomy was performed in 140 patients. The mean age of the patients was 35 years (range, 21–62 years), and 79% presented with primary and 21% with secondary infertility. Overall, mean (±SE) sperm concentration ($20.1 \pm 1.5 \times 10^6$/mL to $26.7 \pm 1.9 \times 10^6$/mL, $P = .001$), percent motility (24.7 ± 1.0% to 30.9 ± 1.2%, $P = .001$), and percent normal morphology (35.8 ± 1.4% to 37.7 ± 1.5%, $P = .046$) improved significantly following varicocelectomy. Similarly, mean sperm concentration and percent motility improved significantly in the subsets of men who underwent left and bilateral varicocelectomy (Table).

The total number of testicular units was 474 (334 left units and 140 right units). Among all patients, the mean number of testicular arteries identified was 1.5 on the left (range, 1–4) and 1.5 on the right (range, 1–4). Of the 474 testicular units, 268 (57%) had 1 artery preserved, 176 (37%) had 2 arteries preserved, and 30 (6%) had 3 or more arteries preserved. Overall, we did not identify any significant correlations between the number of arteries preserved and ipsilateral varicocele grade ($r = .04$, $P = .5$) or testicular volume ($r = -.015$, $P = .7$). In the group of men who underwent a left microsurgical varicocelectomy, we found no correlation between the number of arteries per testicular unit and serum FSH, serum LH, and postoperative improvement in sperm concentration, motility, and morphology (data not shown). Similarly, in the group of men who underwent bilateral microsurgical varicocelectomy, we found no correlation between the number of arteries per testicular unit and serum FSH, serum LH, and postoperative improvement in sperm concentration, motility, and morphology (data not shown).

Follow-up examination (at 6–12 weeks postoperatively) revealed that 2 (0.6%) of the men developed a clinically significant (large and symptomatic) hydrocele and that 1 (0.3%) of the men experienced a clinical varicocele recurrence. No patient developed testicular atrophy.

*Pre- and postoperative mean (±SE) semen parameters for left and bilateral microsurgical varicocelectomy**

	Preoperative	Postoperative	*P*†
Left varicocelectomy (n = 194)			
Sperm concentration ($\times 10^6$/mL)	19.5 ± 2.2	25.5 ± 2.7	.005‡
Sperm motility (%)	24.6 ± 1.4	28.3 ± 1.4	.031‡
Bilateral varicocelectomy (n = 140)			
Sperm concentration ($\times 10^6$/mL)	20.9 ± 2.1	28.4 ± 2.8	.006‡
Sperm motility (%)	28.4 ± 2.8	34.2 ± 2.0	.001‡

* Values are the mean ± SEM.
† Comparison between pre- and postvaricocelectomy.
‡ Wilcoxon signed rank test.

Discussion

In the present study of 474 microsurgical spermatic cord dissections, we have observed that the average number of testicular (internal and external spermatic) arteries at the subinguinal level is 1.5, with a range of 1–4 arteries. We have identified and preserved 1 artery in 57% of cords, 2 arteries in 37% of cords, and 3 or more arteries in 6% of cords. These data on the intraoperative varicocele arterial anatomy are in keeping with previous reports indicating that multiple arteries are frequently encountered during inguinal and subinguinal varicocelectomy (Beck et al, 1992; Jarow et al, 1992; Ergun et al, 1997; Hopps et al, 2003). It has been shown that, in its course to the testis, the testicular artery may branch into multiple arteries and that, while the level of this branching is variable, it has occurred within the inguinal canal in 31%–88% of cases (Brooks, 2002). Indeed, Beck et al (1992) and Hopps et al (2003) have shown that in their subinguinal and inguinal dissections, 1 artery is preserved in 25% and 69% of cords, respectively, 2 arteries are preserved in 42% and 27% of cords, respectively, and 3 or more arteries are preserved in 33% and 4% of cords, respectively. In contrast, classical descriptions of testicular anatomy that illustrate a single testicular arterial may erroneously lead some surgeons to assume that it is safe to ligate all other vascular structures once a single artery has been identified (Warwick and Williams, 1973; Woodburne, 1978). Given the results of the current investigation and other supporting studies (Beck et al, 1992; Jarow et al, 1992; Ergun et al, 1997; Hopps et al, 2003), we urge surgeons to recognize that 2 or more arterial branches are frequently encountered during inguinal or subinguinal varicocelectomy. Moreover, as recommended by the American Urological Association, the surgical repair of varicoceles should be carried out with optical magnification (loupes or microscope) to maximize preservation of the arteries (Jarow et al, 2002).

The number of testicular arteries identified and preserved at the time of varicocelectomy did not correlate with preoperative parameters, including serum FSH, LH, testicular volume, and varicocele grade. These data suggest that there are no preoperative predictors of intraoperative varicocele arterial anatomy. In reviewing their subinguinal varicocelectomies, Hopps et al (2003) did not examine the possible correlations between varicocele arterial anatomy and preoperative parameters (varicocele grade and testicular volume) but reported that the size and number of testicular veins encountered during microsurgical cord dissection did not correlate with varicocele grade.

In the current study, we have observed a significant improvement in mean semen parameters (sperm concentration, percent motility, and percent normal forms) after microsurgical varicocelectomy. These results on sperm quality improvement are in keeping with previously published data on varicocelectomy (Schlesinger et al, 1994). However, most of the outcome data on varicocelectomy are based on uncontrolled or poorly designed studies; therefore, the true effect of varicocele repair on fertility potential remains controversial (Kamischke and Nieschlag, 1999; Evers and Collins, 2003).

To our knowledge, this is the first study to examine and report on the absence of a correlation between the number of arteries preserved per testicular unit during varicocelectomy and postoperative improvement in sperm concentration, motility, and morphology. These negative findings do not imply that preservation of only a single testicular artery will necessarily be sufficient to maintain or optimize testicular function and male fertility potential, since maximal preservation of the arterial blood supply to the testes is likely essential in all situations. Instead, the results (ie, absence of correlation between the number of arteries preserved and semen parameter improvement) probably simply reflect the variable intraoperative arterial anatomy of the spermatic cord. Additionally, it is possible (unreported to date) that the unintentional ligation of a small (secondary) internal spermatic artery in humans has a minimal or undetectable impact on outcome (possibly as a result of contribution from the main testicular artery and the vasal artery) (Carbone and Merhoff, 2003). Silber (1979) and Wosnitzer and Roth (1983) have reported that

the likelihood of testicular artery ligation (of the primary artery) during varicocelectomy is common, especially when no magnification is used. Although ligation of the testicular artery in adults carries with it the risk of testicular atrophy and/or impaired spermatogenesis, the actual rate of frank testicular atrophy and impaired spermatogenesis is reportedly low. Penn et al (1972) observed that testicular atrophy occurred in 14% of cases when the main testicular artery was purposely ligated at the time of renal transplantation.

Conclusions

We recommend that meticulous dissection of the spermatic cord be undertaken to identify and preserve the maximum number of testicular arteries possible. Our data indicate that preoperative parameters are not predictive of the number of testicular arteries identified at the time of microsurgery. Our findings also suggest that the number of arteries identified and preserved using careful spermatic cord dissection does not correlate with improvement in semen parameters.

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