Varicocele and Adolescents: Semen Quality After 2 Different Laparoscopic Procedures

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ABSTRACT: The aim of this prospective study was to assess long-term functional results (spermiograms) in subjects who underwent laparoscopic varicocelectomy via either of 2 procedures (ligation or preservation of testicular artery). A total of 122 patients underwent laparoscopic varicocelectomy performed via either of the 2 different procedures: complete ligation of the spermatic vessels or preservation of the spermatic artery. After surgery when patients achieved 18 years, they were asked to undergo semen analysis. Spermiogram results were divided into 2 subgroups: "normal" and "abnormal." We analyzed volume, sperm count per mL, percentage of motile spermatozoa, percentage of normal spermatozoa, and percentage of vitality for each group. Both groups showed the same results in terms of "normal" and "abnormal" spermiograms (World Health Organization criteria), but analysis showed higher sperm concentration per mL, sperm motility, volume, vitality, and rate of morphologically normal sperm for the group with arteries preserved and "normal" spermiograms ($P < .01$). Analysis of data from the spermiograms showed that preservation of the testicular artery was the best possible option in terms of semen quality. Therefore, we believe that surgical treatment of varicocele should be carried out using procedures involving artery preservation.

Key words: Semen analysis, fertility, childhood.

J Androl 2007;28:727–733

Idiopathic varicocele is one of the most common andrologic diseases in hypofertile males, influencing male reproductive capacity (Zini et al, 1997) by affecting sperm quality and quantity (Pryor and Howards, 1987; Hargreave, 1993). The most important semen alterations observed in subjects with varicoceles are reduced motility, increased number of atypical forms, presence of immature cells, and decreased sperm concentration (Chehval and Purcell, 1992). Clinical observations showed that 20% of subjects with varicoceles had abnormal spermatogenesis (Comhaire, 1983), whereas no seminal abnormalities were observed in 14% of hypofertile subjects affected by this disease.

It has been discussed whether varicoceles should be treated during childhood (Witt and Lipschultz, 1993) because there are no specific tests to assess subjects' fertility (Lyon et al, 1982) and subsequently determine suitable treatment timing. At present, reduced testicular volume on the affected side (Kass and Reitelman, 1995) is one of the clinical indications for varicocelectomy, independent of its grade (Paduch and Niedzielski, 1977). Although there are different options (eg, percutaneous sclerosis, laparoscopy, retroperitoneoscopy, open surgery) for the treatment of varicoceles, there is not currently a gold standard for its treatment.

Many physicians do not know whether it is best to preserve the spermatic artery during ligation of the spermatic vessels, a laparoscopic procedure we use frequently. However, ligation of the testicular artery at the internal inguinal ring apparently does not affect the vascularization of the testes and quality of spermiograms (Ulker et al, 1997; Student et al, 1998). A prospective study was carried out to assess long-term functional results (spermiograms) in terms of "normal" vs "abnormal" and individual semen quality in subjects affected by varicoceles undergoing laparoscopic varicocelectomy with either ligation or preservation of the testicular artery.

Materials and Methods

Between April 1999 and July 2003 we performed 122 surgeries to treat left idiopathic varicocele in patients aged 12 to 16 years (mean, 14.3 years). All patients had a body mass index between 18 and 23, with weight:age and height:age ratios within normal ranges. They were all nonsmokers and exercised more than twice per week.

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Received for publication February 1, 2007; accepted for publication May 3, 2007.

DOI: 10.2164/jandrol.107.002600

Clinical and instrumental tests were performed on all subjects before surgery, including objective examination of the genitals (pubertal development according to the Tanner classification [Tanner, 1962]) and grading of varicocele according to the Dubin and Amelar classification (Dubin and Amelar, 1970). After clinical examination, Doppler velocimetry of the genital venous system and testicular ultrasound were performed. The Doppler velocimetry was used to find the origin of the venous spermatic reflux following the Coolsaet classification (Coolsaet, 1980), and the different types of venous reflux were grouped according to the Hirsch classification (Hirsh et al, 1980). Testicular ultrasound, which was performed by a radiologist, allowed the measurement of the 3 dimensions of the gonad to assess its overall volume. The testes were scanned with a Siemens Sonoline Elegra ultrasound imaging system with a 7.5-MHz probe (Siemens, Erlangen, Germany). Measurements of testicular length, width, and height were obtained by using electronic calipers (Rivkees et al, 1987; Behre et al, 1989; Diamond et al, 2000). The values obtained were then input into the formula of a prolate ellipsoid to evaluate the testicular volume (volume [mL] = 0.523 × length × width × height [cm]) (Costabile et al, 1992; Chipkevitch et al, 1996; Taskien et al, 1996).

A testis homolateral to the varicocele with a 20% reduced volume with respect to its contralateral was defined as hypotrophic (Kass and Belman, 1987; Reitelmann et al, 1987). Informed consent was obtained from the patients' parents, and then patients were randomized into group A or B according to their day of birth: even (group A) or odd (group B). All patients underwent laparoscopic varicocelectomy performed using 1 of the 2 different procedures: 3 trocars and complete ligation of the spermatic vessels (group A) or 3 trocars and preservation of the spermatic artery (group B).

The complications involved with both procedures—persistence, recurrence, and hydrocele—were observed during clinical and instrumental tests performed 1 day and 3, 6, and 18 months after surgery. Postoperatively and according to the time schedule above, testicular volume was assessed together with the presence or absence of venous reflux by Doppler velocimetry and presence or absence of homolateral hydrocele. Persistence (presence of venous reflux 1 day after surgery) and recurrence (presence of venous reflux ≥3 months after surgery) of varicocele were evaluated by Doppler velocimetry. Venous reflux in the spermatic cord, with or without Valsalva maneuver, was considered pathologic. The instrument used for all patients was the same as described before, with 5- to 10-MHz probes. After the postoperative tests when patients attained 18 years, they were asked to undergo semen analysis. The evaluation criteria for semen quality followed World Health Organization (WHO; 1999) indications.

Spermiogram results were divided into 2 subgroups: "normal," if the results met all evaluation criteria and "abnormal" for the remaining cases. Two semen samples, collected ≥3 weeks apart after 4 days of abstinence, were collected immediately after masturbation in clean plastic containers supplied by the laboratory and analyzed within 1 hour of collection. All spermiograms were analyzed by the same laboratory.

Semen Analysis

Semen specimens were collected at the Department of Laboratory Medicine, University of Verona, and then transferred immediately to the diagnostic semen laboratory, where they were kept at 37°C until liquefied. Sperm concentration was determined by counting 2 sides of a hemocytometer. Semen volume was measured by drawing up the entire sample into a graduated pipette. Motility was defined as the proportion of sperm that was progressively motile at 37°C measured with a Makler chamber. Sperm morphology was evaluated by a single examiner using strict criteria (Menkveld et al, 1990).

Evaluation Criteria

After the analysis of spermiograms, we also considered: 1) the relationship between "normal" and "abnormal" spermiograms and surgical procedures (artery preservation vs artery ligation), 2) if a preserved artery is correlated with better semen quality, and 3) the correlation between surgical procedure and surgical complications.

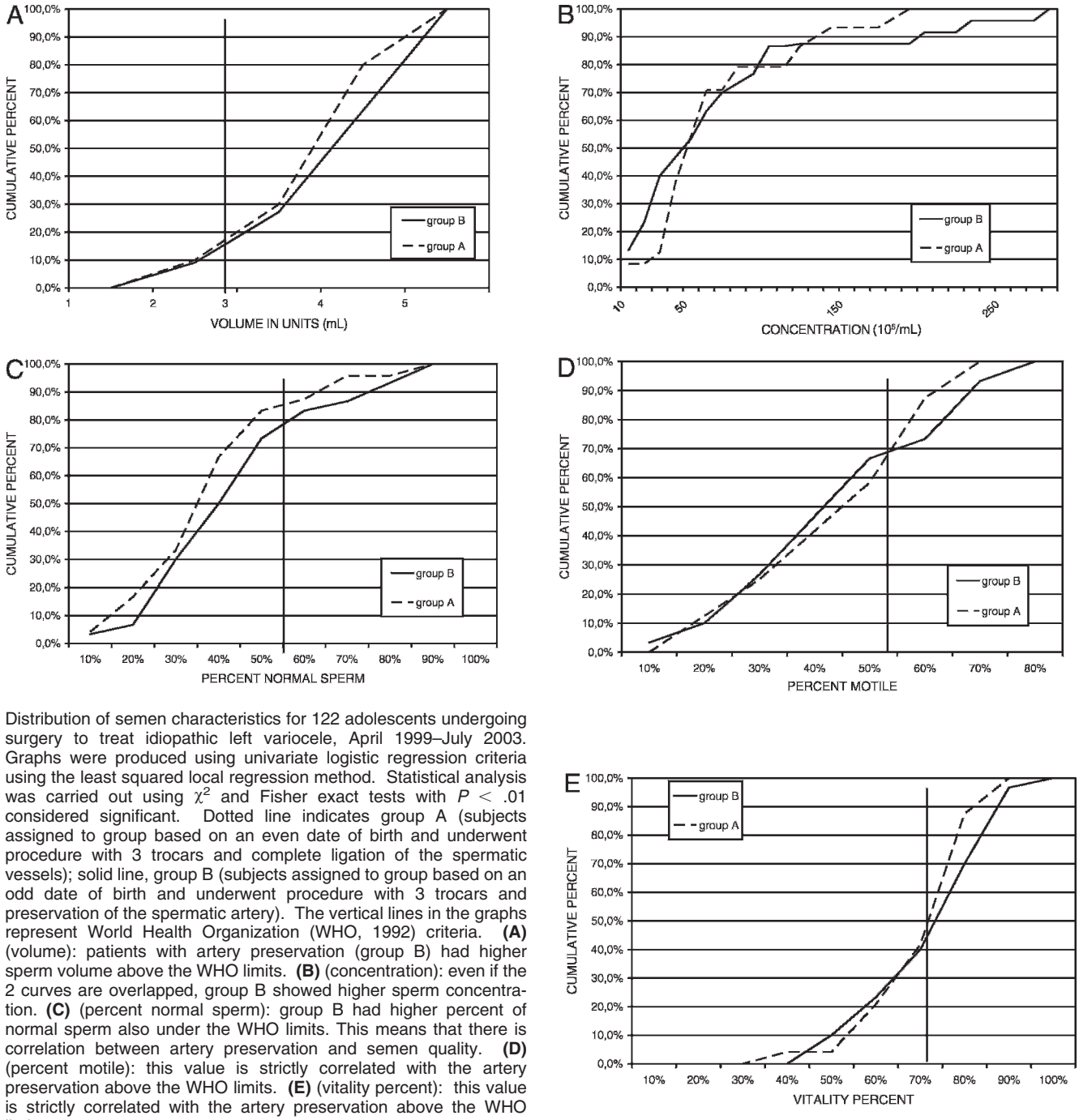
Statistical Methods

Univariate and multivariate analyses of the relationship between these variables were evaluated by linear regression. The graphs (Figure) demonstrating the relationship between the variables (semen quality measures) were produced with a univariate logistic regression model using the least squared local regression method. Statistical analysis was carried out using χ^2 and Fisher exact tests, with $P < .01$ considered significant.

Results

All patients undergoing surgery showed testicular hypotrophy homolateral to varicocele. Eighty-two patients had grade II varicoceles, whereas 40 patients had grade III varicoceles. Groups A and B were similar in terms of number and age of patients and grade of varicocele.

All surgical procedures were performed by videolaparoscopy with the use of 3 laparoscopic ports (5-mm trocars). In 63 cases (45 grade II and 18 grade III varicoceles), complete ligation (using clips) and resection of the whole vascular spermatic vessels were performed approximately 10 cm above the internal inguinal ring (group A). In 59 cases (37 grade II and 22 grade III varicoceles), the testicular artery was identified but not ligated (group B). The operating times were 20 to 40 minutes for complete ligation and 35 to 60 minutes when the spermatic artery was preserved. All procedures were performed by Dr Camoglio. No complications were reported during surgery (Parrott and Hewatt, 1994; Ng et al, 1995; Esposito et al, 2000; Cohen, 2001). All patients completed the postsurgical follow-ups; there were no study dropouts.



Distribution of semen characteristics for 122 adolescents undergoing surgery to treat idiopathic left variocele, April 1999–July 2003. Graphs were produced using univariate logistic regression criteria using the least squared local regression method. Statistical analysis was carried out using χ^2 and Fisher exact tests with $P < .01$ considered significant. Dotted line indicates group A (subjects assigned to group based on an even date of birth and underwent procedure with 3 trocars and complete ligation of the spermatic vessels); solid line, group B (subjects assigned to group based on an odd date of birth and underwent procedure with 3 trocars and preservation of the spermatic artery). The vertical lines in the graphs represent World Health Organization (WHO, 1992) criteria. **(A)** (volume): patients with artery preservation (group B) had higher sperm volume above the WHO limits. **(B)** (concentration): even if the 2 curves are overlapped, group B showed higher sperm concentration. **(C)** (percent normal sperm): group B had higher percent of normal sperm also under the WHO limits. This means that there is correlation between artery preservation and semen quality. **(D)** (percent motile): this value is strictly correlated with the artery preservation above the WHO limits. **(E)** (vitality percent): this value is strictly correlated with the artery preservation above the WHO limits.

Clinical and Doppler velocimetry follow-up for all patients at 1 day and 3, 6, and 18 months after surgery showed good results in 116 patients (95%). However, there were 5 cases of varicocele recurrence (observed 6 months after surgery) and 1 case of varicocele persistence (observed 1 day after surgery). All of these patients belonged to group B (artery preservation), with a statistically significant relationship between persistence/recurrence and surgical procedure used (artery preservation); $P < .01$. Homolateral hydrocele developed in 9 patients (7%) 3 to 6 months after surgery. Six patients showed spontaneous resolution after 1 year, and ultrasound-guided puncture of the hydrocele proved to be successful in the remaining 3 cases. There was a statistically significant relationship between the onset of hydrocele and surgical procedure used (artery ligation) with $P < .01$ (Table 1).

One hundred and ten patients out of 122 treated for varicocele who were at least 18 years underwent semen

Table 1. *Complications observed at 1 day and 3, 6, and 18 months*

	Group A (n = 63) Artery ligation			Group B (n = 59) Artery preservation		
	1 day/3 months	6 months	18 months	1 day/3 months	6 months	18 months
Persistence	...	...	...	1*	...	...
Recurrence	...	...	...	...	5*	...
Hydrocele	1	7*	...	...	1	...

* $P < .01$; χ^2 test and Fisher's exact test were used.

analysis to assess their fertility potential rather than actual fertility. The remaining 12 patients were not 18 years during the time of the study. After patients were grouped based on the results of the spermiograms (compliant or noncompliant with WHO criteria), each parameter was considered individually to obtain an overall qualitative comparison of the semen. To compare the patients, the following semen parameters were analyzed: volume, sperm count per mL, percentage of motile spermatozoa, percentage of normal spermatozoa, and percentage of vitality.

Semen Characteristics and Analysis

One hundred and ten patients, 36 with grade III and 74 with grade II varicoceles, underwent spermiograms. Of these patients, 60 were from group A (20 with grade III and 40 with grade II varicoceles) and 50 were from group B (16 with grade III and 34 with grade II varicoceles). The WHO lower limit values (1992) for the normal range of human semen are 2.0 mL for volume, 20×10^6 sperm per mL for concentration, 50% for progressive motility, 30% for normal morphology, and 70% for vitality (Eosina test). Spermiogram analysis showed that 41 patients from group A and 35 from group B met WHO criteria, whereas 19 patients from group A and 15 from group B had abnormal spermiograms. There was not a statistically significant difference between the 2 groups—both showed the same results in terms of normal and abnormal spermiograms ($P > .01$).

Even though all samples studied were similar and there was not a statistically significant relationship between the surgical procedure used and results of the spermiograms (''normal'' vs ''abnormal''), the analysis of qualitative semen characteristics showed some interesting results. Semen characteristics of groups A and B were compared. Semen volume ranged from 1.5 to 5 mL (mean, 2.8 mL) for group A and 0.5 to 4.6 mL (mean, 4.02 mL) for group B; sperm concentration per mL ranged from 3.5×10^6 to 182×10^6 (mean, 58.85×10^6) for group A and 0.2×10^6 to 250×10^6 (mean, 73.81×10^6) for group B; sperm motility ranged from 11% to 68% (mean, 39.04%) for group A and from 0% to 75% (mean, 45.73%) for group B; the proportion of sperm cells with normal morphology ranged from 6% to 85 % (mean, 38%) for group A and 9% to 89% (mean, 45.13%) for group B; and sperm vitality ranged from 40% to 90% (mean, 71.2%) for group A and 47% to 92% (mean, 76.83%) for group B ($P < .01$ in patients with ''normal'' spermiograms; Table 2).

The cumulative percentage graphs (Figure) show differences in distributions of measures of semen quality for adolescent patients in the group with artery ligation (A) vs artery conservation (B). Considering WHO criteria of normalcy as the reference, the distribution for group B was shifted to the right with respect to group A in all parameters of semen quality, showing higher sperm concentration per mL, sperm motility, sperm volume, sperm vitality, and rates of morphologically normal sperm. The 2 curves largely overlap below the WHO lower limit of normalcy. However, above this limit, there is a clear difference between the quality of semen taken from the 2 groups: the patients with artery preservation showed better results for all parameters ($P < .01$).

Table 2. *Semen characteristics per group*

	Group A	Group B*	P †
Volume, mL (mean)	1.5–5 (2.8)	0.5–4.6 (4.02)	<.01
Sperm concentration per mL (mean)	$3.5–182 \times 10^6$ (58.85×10^6)	$0.2–250 \times 10^6$ (73.81×10^6)	<.01
Motility (mean)	11%–68% (39.04%)	0%–75% (45.73%)	<.01
Normal morphology (mean)	6%–85% (38%)	9%–89% (45.13%)	<.01
Vitality (mean)	40%–90% (71.2%)	47%–92% (76.83%)	<.01

*$P < .01$; qualitative parameters of ''normal'' spermiograms in the 2 groups; χ^2 test and Fisher's exact test were used.
† World Health Organization criteria.

It was not possible to establish a statistically significant relationship between patient's age and semen quality ($P > .01$).

Discussion

Although the efficacy of surgery in the treatment of this condition can be shown only through an accurate prospective, randomized, controlled study to assess the impact of varicocelectomy on patients' semen parameters and low pregnancy rates, the majority of cases analyzed in the literature show a positive trend toward this treatment. However, the different outcomes may be due to both clinical selection criteria and success criteria.

Until pubertal development is fully reached, it is not possible to perform spermiograms. For this reason, it is difficult to opt for early treatment of varicoceles during childhood; the need for surgical correction is especially clear considering that the testicular lesions caused by this affliction are nonreversible (Sigman and Jarow, 1997; Camoglio et al, 2004). Testicular growth retardation currently presents a surgical case especially among adolescent patients, who are very likely to obtain a full volumetric and functional recovery of the testis after surgery. Although there are different options (percutaneous sclerosis, laparoscopy, retroperitoneoscopy, open surgery, etc) for the treatment of varicoceles, at present there is not a gold standard for its treatment during childhood. However, among clinicians there is concern regarding the timing of treatment: when and how to perform surgical treatment of varicoceles? Is it possible to predict a patient's fertility? Will surgical correction improve semen quality? Since fertility is usually a difficult parameter to assess (clinically it is more common to talk in terms of fertility potential), varicoceles are usually treated during childhood to remove a possible cause of future hypofertility.

From a strictly surgical point of view, apart from percutaneous procedures, the surgeon has 2 options to correct a varicocele—with or without preservation of the testicular artery. These 2 options have been discussed at length for many years (Parrott et al, 1994; Cohen, 2001). We believe that artery preservation is necessary not only because this condition is related to the efficacy of the venous system but also because it seems more appropriate to preserve the normal arterial blood supply to prevent testicular damage and testicular dysfunction. Cohen (2001) points out the importance of preserving testicular arteries during varicocelectomies for patients' fertility potential. At the same time, following data reported in the literature, he also indicates that there is still considerable controversy regarding the need to preserve testicular arteries; this would imply a large number of varicocelectomies in adolescents, with long-term follow-up and assessment of fertility before it is possible to determine if ligation of the testicular artery adversely affects testicular growth and development during puberty. Many cases in the literature show the real advantages of varicocelectomy in terms of semen quality by using and comparing different surgical techniques. The ideal treatment for primary varicocele is still under discussion: many procedures, such as open spermatic vein ligation, retrograde sclerotherapy, and more recent methods such as laparoscopy, microsurgery, and antegrade sclerotherapy have been used to treat the condition. All clinical studies carried out so far have considered semen analysis and have reported the results obtained after treatment with the same technique. Retrospective or prospective studies considering spermiogram analysis after the conservation or ligation of the testicular artery in children are not currently available; in all of these studies, preoperative semen analysis is the reference parameter to be compared with postoperative spermiograms. Because spermiograms cannot be obtained from pediatric patients, both for legal reasons and because patients' hormonal profiles are not fully developed, the efficacy of varicocelectomy in these patients is difficult to assess. Also, it is well known that not all patients, either adolescents or adults, benefit from varicocelectomy in terms of testicular function.

As previously described, in our experience, artery preservation during correction of varicocele is associated with a higher number of recurrences and persistences compared with patients treated with artery ligation (this is probably due to a wrong diagnosis or type III varicocele with multiple reflux). On the other hand, artery ligation may increase the risk for the onset of hydrocele (the complete closure of spermatic and lymphatic vessels creates blood stasis in the scrotum), clearly showing that no procedure is free from complications. Spermiogram analysis of these patients, either with recurrence or persistence of varicocele and hydrocele, does not show any differences from other patients. Although the number of patients observed is relatively small, surgical complications do not seem to be a negative prognostic factor on semen quality or testicular function. As for patients showing complications, all subjects had "normal" spermiograms when compared with WHO criteria. This could be the key element to understanding the role of varicocelectomy in pediatric patients.

From the data collected in the study, it is possible to say that not all patients benefit from varicocelectomy, independent from the procedure used (artery preservation or ligation). This is especially clear if we consider that the number of "normal" and "abnormal" sper-

miograms does not indicate statistically significant differences. This confirms that not all patients need surgical treatment and that the gonadal damage, which is not limited to decreased testicular volume, is probably irreversible. The study also showed that conservation of the testicular artery improves semen quality, although only subjects with ''normal'' spermiograms show a statistically significant difference between the 2 groups: patients with ''abnormal'' spermiograms do not show statistically significant differences between the 2 groups and semen quality overlaps in the 2 different groups, as shown by the graphs following WHO criteria. There is not a correlation among the age of patients at surgery, varicocele grade at surgery, and semen quality at 18 years. This confirms that varicocele is a disease with heterogeneous characteristics that have clinical aspects still under close study. For all of these reasons, it is possible to say that early treatment of varicoceles may not be enough to obtain full recovery of testicular function, especially in terms of fertility potential. Also, at present it is not yet possible to predict whether a pediatric patient may benefit from varicocelectomy.

Conclusions

The analysis of all spermiograms performed showed that subjects with preserved arteries had better quality semen. This is significant when the individual parameters of both groups are compared with the lower values of the normal range determined by WHO. We believe that it is necessary to carry out multicenter trials to assess the role of surgical procedures in the treatment of varicoceles in pediatric patients. The analysis of data collected from the spermiograms showed that preservation of testicular arteries is the best possible option. Therefore, we believe that surgical treatment of varicocele should be carried out using those procedures involving artery preservation.

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