FERTILITY AND STERILITY®
VOL. 81, NO. 2, FEBRUARY 2004

Published by Elsevier Inc.
Printed on acid-free paper in U.S.A.

Varicocele: a bilateral disease

Yigal Gat, M.D.,[a] *Gil N. Bachar, M.D.,*[b] *Zvi Zukerman, M.D.,*[a] *Alexander Belenky, M.D., Ph.D.,*[b] *and Michael Gornish, M.D.*[b]

Rabin Medical Center, Beilinson Campus, Petah Tiqva (affiliated with the Sackler Faculty of Medicine), Tel Aviv University, Tel Aviv, Israel

Objective: To evaluate the prevalence of varicocele in the left and right spermatic veins in infertile men by several methods of examination.

Design: Prospective study.

Setting: Andrology unit of a department of obstetrics and gynecology, and interventional radiology unit of the radiology department at a tertiary care facility.

Patient(s): Two hundred eighty-six infertile men evaluated for varicocele.

Intervention(s): Patients underwent evaluation for infertility. Physical examination was followed by contact thermography, Doppler sonography, and venography of both testes.

Main Outcome Measure(s): We measured the prevalence of varicocele in the left and right spermatic veins in infertile men, and the response of semen parameters after embolization of internal spermatic vein.

Result(s): Varicocele was detected by one of the noninvasive methods and confirmed by venography in 255 patients (89.2%): the left site in 45 (17.6%), the right side in 4 (1.5%), and bilaterally in 206 (80.8%). All patients were treated by embolization. Mean sperm concentration increased from 6.12 ± 1.02 to 21.3 ± 1.69 million/mL; mean sperm motility from 16.81 ± 1.51 to 35.90 ± 1.41%; and mean sperm morphology from 9.75 ± 0.85 to 16.92 ± 1.17%. Pregnancy rate was 43.5%.

Conclusion(s): The present study finds that what was traditionally considered a predominantly unilateral anatomical abnormality apparently has a strikingly high bilateral prevalence (80.7%). This may suggest that we should consider varicocele a bilateral disease. The second finding is the high rate of varicocele detected by venography, thermography, and sonography when compared with physical examination results. Our study may have important implications for treatment, indicating that patients with clinical evidence of unilateral left varicocele should be carefully evaluated for bilateral varicocele. (Fertil Steril® 2004;81:424–9. ©2004 by American Society for Reproductive Medicine.)

Key Words: Infertility, varicocele, contact thermography, venography

Varicocele, or venous dilatation of the pampiniform plexus, is characterized by retrograde flow in the testicular (internal spermatic) vein as a result of incompetent or absent valves. It is considered a major cause of male infertility (1–3), with a prevalence rate of about 15% in healthy men and 40% in men being treated in infertility clinics (4–6). Varicocele is believed to occur mainly on the left side (7–12). According to urologic studies in infertile men, the rate of left spermatic vein varicocele is 35% to 40% compared with 10% for bilateral varicocele (11, 12). Skoog et al. (7) found that palpable unilateral varicocele occurs on the left side in 85% to 90% of cases; a palpable right varicocele is found mostly in cases of bilateral varicocele in 10% of patients, but rarely alone.

These findings raise two major questions: why does left varicocele also affect spermatogenesis on the right? Why do men with unilateral varicocele fail to produce an adequate specimen of seminal fluid from the other testis, considering that men with a single testis are known to be fertile? Recently, a few articles have suggested that the incidence of bilateral varicocele may be underestimated (13–15). Besides physical examination, several modalities are available today for the detection of varicocele, including thermography, color flow Doppler sonography, and venography (4–6). The purpose of the present study was to evaluate the incidence of varicocele in the left and right spermatic veins in infertile men by means of several methods of examination. To the best of our knowledge, this type of comparison has never been performed.

Received June 4, 2003; revised and accepted August 27, 2003.

Reprint requests: Gil N. Bachar, M.D., Department of Radiology, Rabin Medical Center, Beilinson Campus, Petah Tiqva 49100, Israel (FAX: 972-3-9377095; E-mail: drbachar@netvision.net.il).

[a] Andrology Unit, Department of Obstetrics and Gynecology, Rabin Medical Center.

[b] Department of Radiology and the Interventional and Vascular Unit, Rabin Medical Center.

0015-0282/04/$30.00
doi:10.1016/j.fertnstert.2003.08.010

METHODS

From January 1998 to June 2001, 286 consecutive male patients aged 18 to 55 years (mean ± SD: 34.6± 7.23) with infertility of at least 12 months' duration (range: 1 to 10 years) were evaluated in a tertiary referral center. The mean age of the woman partner at presentation was 30.2 ± 6.3 years (range: 18 to 39 years). All studies were carried out in accordance with the principles of the Declaration of Helsinki. All patients gave informed consent before examination. A minimum duration of infertility was defined a failure to establish a pregnancy for at least 12 months.

Patients with cryptorchidism or testicular trauma and patients after surgery of the urogenital tract were excluded. The evaluation consisted of hormone profile (luteinizing and follicle-stimulating hormone and serum testosterone) and genetic study. Patients were instructed to abstain from sexual intercourse for 2 to 3 days before semen collection. The samples were assessed within 1 hour of collection for sperm concentration, motility, and morphology according to the World Health Organization criteria (8). Oligoasthenoteratospermia (sperm count less than 20 million/mL, sperm motility less than 40%, and less then 40% normal forms) was noted on two semen analyses in all cases before the embolization. Thereafter, all patients were assessed for varicocele by four methods: physical examination, contact scrotal thermography, Doppler ultrasound, and venography.

Physical Examination

Patients were examined in a warm room after standing for 5 minutes. The scrotal contents were examined, including volume, position, and consistency of testis and epididymis. Each spermatic cord was palpated in the standing position and during the Valsalva maneuver. Findings were graded according to the system of Dubin and Amelar (16) as follows: grade 1, varicocele palpable only during Valsalva maneuver; grade 2, varicocele palpable in standing position; grade 3, varicocele detectable by visual scrutiny alone. To prevent interobserver bias, the same experienced senior andrologist performed all the examinations.

Contact Scrotal Thermography

Contact thermography was done with the patient upright, undressed, after 5 minutes at room temperature of not less than 22°C. The penis was taped to the abdominal wall and the genital region was exposed. The investigator then brought the scrotum forward with both hands to apply the Varicoscreen, a flexible thermostrip liquid crystal film (Amsaten, De Pinte, distributed by FertiPro, Beemem, Belgium) containing heat-sensitive liquid crystals. The screen scale ranges from 31.3 to 35.3 degrees, with a color change every 0.8 degrees. In the healthy male, the temperature of the scrotal skin is symmetrically distributed and does not exceed 32.5°C, corresponding to a brown or reddish color change of the screen.

In men with varicocele or retrograde flow, the temperature is higher and the color changes to dark green, violet, or blue; the last two are diagnostic. We also compared the scrotal temperature distribution patterns of the two sides, and the intensity and extension of the hyperthermia in the standing position and during the Valsalva maneuver. A temperature differential of 0.8°C or more, encompassing at least 25% of the area of one hemiscrotum, is considered suspicious of varicocele. Bilateral varicocele can be suspected if the entire scrotum is warmer than the anterior thigh.

Ultrasound Doppler

Ultrasound Doppler study was performed with the ATL HDI 3000 or 5000 unit (Advanced Technology Laboratories, Bothell, WA), equipped with a 5–10 MHz multifrequency linear transducer. Machine settings were adjusted to optimize the detection of blood flow. The examination was done with the patient in the supine position with his scrotum supported by a towel placed over his upper thighs. The penis was placed on the abdomen and covered with a drape for minimal exposure of the patient to the proceedings and maximal access of the physician.

Each side of the scrotum was scanned from the level of the testicular hilus to the neck of the scrotum in longitudinal and transverse section, and the scrotal septum was examined in the transverse plane. Vascular channels in the spermatic cord were noted, and vessel diameters were measured by electronic clippers. The presence of testicular abnormalities, spermatocele, epididymal lesions, and hydrocele was recorded. The patient was then asked to stand erect for 5 minutes, and the examination was repeated. The Valsalva maneuver was used in the supine and erect positions. The maximum diameter of the scrotal veins was recorded, and the presence of the venous plexus was noted. The flow velocity of the main vein was measured before and after the Valsalva maneuver.

The sonographic diagnosis of varicocele was based on the detection of two to three venous channels, one of which measured >3 mm in diameter and reflux during the Valsalva maneuver. Patients without reflux or with Valsalva-induced reflux for <1 second were considered normal; patients with reflux for >1 second were considered to have varicocele. The same experienced radiologist performed all the sonographic studies. To prevent bias, the radiologist was blinded to the findings on physical examination.

Venography and Percutaneous Sclerotherapy

Venography was performed as part of percutaneous sclerotherapy of the internal spermatic vein (ISV). Written informed consent was obtained for the procedure, which was performed by an experienced interventional radiologist in an interventional radiology suite equipped with digital fluoroscopic imaging and a 45/90 degree tilt table (Polystar, Siemens, Germany). The tilt table is important for entering competent valves and is used in conjunction with various

breathing maneuvers to encourage antegrade flow in the ISV and to allow passage of the catheter.

Vascular access was obtained via the right common femoral vein using a 6F vascular sheath catheter and 3F coaxial infusion catheter (Cook, Bjaeverskov, Denmark). The guiding catheter was advanced into the inferior vena cava (IVC) and from there into the left renal vein. Injection of contrast material (Ultravist 300; Schering AG, Berlin, Germany) in the left renal vein demonstrated passive reflux along the ISV into the pampiniform testicular plexus. An attempt was then made to catheterize the ISV superselectively using the 3F catheter. If successful, the 3F catheter was advanced under fluoroscopic guidance to the pelvic fossa. If the left ISV could not be entered, the patient was placed in the 5% to 10% Trendelenburg position, and deep inspiration and mild coughing were used as maneuvers to open the main valve.

Inguinal reflux of the ISV was documented and quantified by injection of a bolus of iodinated contrast material diluted with heparinized saline solution (Ultravist 300; Schering AG). Before sclerotherapy, occlusion of the ISV in the inguinal canal was performed by the patient; a limited venographic series was used to confirm adequate occlusion. This prevented intratesticular reflux of the sclerosant and also washout of the sclerosant by incoming blood flow. Spasm of the ISV was induced by movement of the catheters to achieve occlusion of the ISV renal vein orifice, partially occluded by the indwelling guiding catheter. Thereafter, 3 to 4 mL of sclerosant (ethanolamine oleate 5%, Medeva Pharma, Lancashire, UK) was injected forcefully into the ISV in the pelvic region, with the catheter being withdrawn for the last part of the bolus. This was followed by injection of 1 to 2 mL of contrast material to flush the catheter. If there was no technical difficulty in superselective catheterization, the 3F catheter was retracted to the upper ISV.

After 5 to 10 minutes of continuous digital compression of the groin, with intermittent aspiration of the ISV after 5 minutes, the success of sclerotherapy was assessed by a repeated venographic injection. Any previously inapparent collaterals that might reestablish ISV reflux were treated with additional sclerosant, up to a maximum of 10 mL per side.

When ISV occlusion was confirmed and no collaterals remained, the catheters were withdrawn into the left renal vein, and a semi-erect (up to 60 degrees) left renal venogram was obtained to confirm the lack of reflux and additional collateral veins. For the diagnosis and treatment of right-sided varicocele, a right-sided ISV guiding catheter (a variation of the "Simmons" shape; Cook) was advanced into the IVC, and a right renal venogram was performed with the patient in the semi-erect position. When injection of contrast material (Ultravist 300; Schering AG) in the IVC demonstrated passive reflux along the ISV into the pampiniform testicular plexus, a diagnosis of right varicocele was made.

TABLE 1

Incidence of left and right varicoceles by four modalities in 255 infertile men.

Modality	Left (n = 255)	Right (n = 255)
Physical examination	228	21
Thermograpy	248	215
Doppler sonography	250	189
Venography	251	210

Gat. Varicocele: a bilateral disease. Fertil Steril 2004.

The right ISV orifice was then identified by gentle probing with a soft-tipped catheter guide or with the 3F coaxial infusion catheter. If the ISV orifice was competent, tilt-table and patient maneuvers was used to pass the valve. After sclerotherapy of the right ISV using the same technique as on the left, and confirmation of ISV occlusion and lack of collateral filling of the ISV, the catheters were withdrawn, the sheath was removed, and digital compression was applied to the puncture site for 5 minutes to assure homeostasis. The patient was observed over the next hour and discharged home with specific instructions for immediate postprocedure follow-up. These included digital compression of the puncture site whenever he was not supine, bed rest for the first 4 hours, ample fluid intake, and nonsteroidal anti-inflammatory analgesics (not aspirin).

Of the 286 patients, 255 underwent embolization. Semen analysis was obtained at 3-month intervals after embolization. Postprocedure and preprocedure semen parameters were analyzed separately and the mean values were recorded. Only semen analyses obtained 6 months or more after embolization were considered for evaluation. Patients were followed for 12 to 42 months, and any pregnancies were documented.

Statistical analyses were performed using the two-sample Student *t*-test. Values are expressed as mean ± standard deviation. Type I error $\alpha = 0.05$ and $P<.05$ were considered statistically significant.

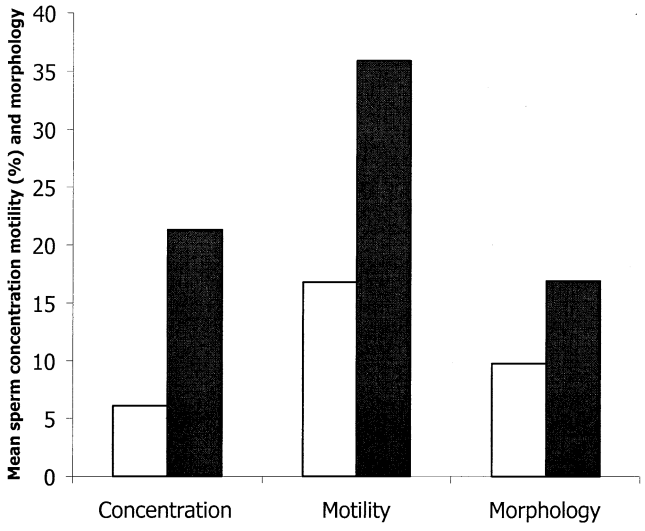
RESULTS

Varicocele was detected by one of the noninvasive methods and confirmed by venography in 255 of 286 (89.2%): 45 (17.6%) men had left-sided varicocele, 4 (1.5%) right-sided varicocele, and 206 (80.8%) bilateral varicocele. In the remaining 31 patients, varicocele was not detected by physical examination, Doppler ultrasound, or thermography, and venography was not done because of ethical considerations. When the results of the three methods were equivocal, the venography result was considered the reference strategy.

The results are summarized in Table 1. Physical examination revealed left varicocele of varying degrees in 228 patients (79.7%) and right varicocele of varying degrees in

FIGURE 1

Changes in semen parameters after embolization of varicocele in 255 infertile men. (□ = Before embolization; ■ = After embolization.)



Gat. Varicocele: a bilateral disease. Fertil Steril 2004.

21 patients (7.3%). Corresponding findings for the other methods were as follows: contact thermography, 248 patients (86.7%) left varicocele, and 215 patients (75.1%) right varicocele; Doppler sonography 250 (87.4%) left varicocele and 189 (66.0%) right varicocele; venography 251 (87.9%) left varicocele and 210 (73.4%) right varicocele. Subclinical varicocele, which is varicocele detected by scrotal thermography, ultrasound Doppler, or venography but not by clinical examination, was noted on the left side in 23 patients (9.1%) and on the right side in 189 (90.0%).

After embolization, sperm concentration, sperm motility, and sperm morphology increased in 209 patients (81.9%) (Fig. 1). Mean sperm concentration increased from 6.12 ± 1.02 to 21.3 ± 1.69 million/mL ($P<.001$); mean sperm motility from 16.81 ± 1.51 to 35.90 ± 1.41% ($P<.001$); and mean sperm morphology from 9.75 ± 0.85 to 16.92 ± 1.17% ($P<.001$). The pregnancy rate was 43.5% (111 patients); 10 patients had two pregnancies. Eight-four of the pregnancies (76%) were unassisted and 21 (19%) were achieved with in vitro fertilization (IVF), and in 6 (5%) with intrauterine insemination (IUI). The mean and median intervals to pregnancy after ISV embolization for the 84 unassisted pregnancies were 10.9 ± 2.1 and 8 months, respectively.

DISCUSSION

In 1952, Tulloch recognized that varicocele is a reversible cause of male infertility, and the early detection and treatment of varicocele in adolescents as a preventive measure of infertility was introduced. Early studies reported that the size of the varicocele had no relationship to the testicular tissue damage, the semen pathology, or the improvement in semen quality after varicocelectomy (11, 15–19). Today, clinicians recognize that small, even subclinical varicoceles in adolescents have significant pathophysiologic potential and can cause alterations in the testicular parenchyma (3).

The gold standard of small varicocele detection is testicular venography, which is based on the finding that retrograde flow can be provoked only in patients with varicocele (4). In the present study, we used it as the reference method. Contact thermography is also reliable, with high sensitivity and specificity (4). In our study, both these modalities detected varicocele in 255 infertile patients (89.1%); on the left in 45 (17.6%), on the right in 4 (1.5%), and bilaterally in 206 (80.8%).

By contrast many of the early reports on the prevalence of varicocele in the urologic literature (3, 5) were based only on physical examination, which has several disadvantages: limited capacity to detect blood flow changes, subjectivity, and risk of significant interphysician variability. Furthermore, physical examination alone may be inadequate to diagnose small or subclinical varicocele. In our study, physical examination yielded a rate of 90.8% for left varicocele and only 8.2% for right varicocele, meaning that 10% of cases on the left side and more than 91% on the right were undiagnosed. Therefore, more sensitive diagnostic modalities are necessary to evaluate varicocele. This explains the difference between our findings for right varicocele and publications in the urologic literature (4–6).

We defined subclinical varicocele as varicocele detected by scrotal thermography, ultrasound Doppler, or venography, but not by clinical examination. Subclinical varicocele was noted on the left side in 23 patients (9.1%) and on the right side in 189 (90.0%). Several studies support our findings. In 1986, McClure and Hricak (13) used ultrasound to detect subclinical varicocele in 50 infertile men. Twenty-five had palpable left-sided varicocele and 3 had palpable right-sided varicocele; all were confirmed by sonographic examination. Additional subclinical varicoceles were detected in 9 men on the left side and 21 men on the right side. Bilateral varicoceles were present in 70% of the patients. Using thermography, Chatel et al. (17) noted evidence of bilateral varicocele in 60% of 178 patients; using venography, Gonzalez et al. (14) reported a 61% incidence in 39 patients.

Bigot and Chatel (15) found spermatic venous insufficiency to be almost as frequent on the right side as on the left (60% vs. 76%). In another large study of 870 varicocelectomies performed between 1980 and 1981, Cockett et al. (18) noted bilateral varicoceles in 57%. The investigators suggested that this high incidence could explain the failure of left varicocelectomy to restore spermatogenesis and improve fertility in some patients. More recently, Abdul-

maaboud et al. (20) reported bilateral varicocele in 42% of 301 infertile patients.

We believe that our use of color flow Doppler and thermography together with the more invasive and accurate technique of venography may account for the high incidence of right-sided and bilateral retrograde flow in our sample. Moreover, our venography technique is more aggressive than that reported by others (1, 6, 14, 15). We place the patient in the 10% Trendelenburg and ask him to take deep breaths and cough. This maneuver helps to open the main valve so that we can detect any incompetent or absent of valves in the ISV.

Our findings are also supported by the autopsy data of Ahlberg et al. (21), who documented an absence of valves in 40% of left and 23% of right spermatic veins, favoring a mechanical explanation for the predominance of left-sided varicocele. Accordingly, the cadaver study of Wishahi (22) showed the absence of valves in both spermatic veins in 40 men.

Several theories have been advanced to explain the pathophysiologic effect of ISV dilatation on spermatogenesis and to explain how a unilateral anatomic anomaly can produce a bilateral testicular dysfunction.

Animal and human studies have revealed an elevation of intratesticular temperature in association with varicocele (23, 24). The increase in testicular temperature apparently interferes with the production of chromatin by DNA polymerase, leading to an abnormal morphology and motility of sperm (25). Our study documented bilateral elevation of contact scrotal temperature in 84% of the patients.

Another theory claims that venous reflux into the ISV with testicular exposure to adrenal or renal metabolites could affect spermatogenesis (7, 24). The presence of vascular anastomoses between the right and left spermatic veins has been demonstrated by venography and suggested by scrotal sonography. This may account for both the bilateral affect of unilateral varicocele as well as the high recurrence or persistence rate of varicocele after left varicocelectomy and the high incidence of bilateral varicoceles observed in our study.

One of the more common explanations for the high incidence of left varicocele is the "nutcracker phenomenon." According to this theory, compression of the left renal vein by the superior mesenteric artery increases the pressure in the vein, with consequent dilatation of the spermatic vein. We believe, however, that this accounts for only part of the difference in the incidence left and right varicocele. Another possibility is that left spermatic vein is longer than the right, so the hydrostatic pressure in the distal region of the left spermatic vein is usually high (26).

In a recent study of Scherr and Goldstein (19), bilateral varicocelectomy resulted in significantly greater improvement in semen parameters than unilateral repair. The investigators stated that even small, unrepaired varicoceles continue to have a detrimental effect on bilateral testes function. Indeed, 65% of new patients presenting with left varicocele are also found to have right varicocele (18). Our results demonstrated that in 209 of the 255 patients (81.9%) who underwent ISV embolization the sperm concentration, motility, and morphology improve by 348%, 213%, and 173%, respectively. Steckel et al. (27) reported that in a series of 86 men with unilateral left varicocele who underwent unilateral varicolectomy, sperm concentration improved from 33 ± 5 to 41 ± 7 million/mL (124%) in patients with grade 2 varicocele, and from 18 ± 5 to 32 ± 7 million/mL (177%) in those with grade 3. Pregnancy rates 2 years postoperatively were 40% for grade 1, 46% for grade 2, and 37% for grade 3. In a more recent study Su Li-Ming et al. (28) found that sperm concentration increased in 39 of 53 patients (73%) after varicocelectomy from 34 to 45 million/mL (132%), and mean sperm motility increased from 34% to 39% (114%). In a study of 78 infertile patients, sperm concentration increased after microsurgical inguinal varicocelectomy from 17.66 to 20.7 million/mL (117%) and sperm motility increased from 30.9% to 37.5% (121%) (29). Although the increment in sperm concentration and motility after bilateral ISV embolization was greater in our patients, the pregnancy rate was similar to that of Steckel et al. (27).

Male fertility is preserved with only one healthy testis. Therefore, oligoteratoasthenospermia (OTA) indicates a bilateral testicular dysfunction. This poses an enigma to clinicians: How can left varicocele cause bilateral testicular dysfunction? As such, in patients with OTA, how can treatment only of the left side also heal the right one?

This solution may lie in the present study, wherein venographic examination indicated that varicocele is in fact a bilateral vascular disease with bypasses. Our findings shed further light on the reasons why unilateral varicocelectomy has failed to effectively improve varicocele male fertility and why a relatively large number of men continue to sustain significant semen and infertility abnormalities after unilateral varicocelectomy. The failure to date to recognize varicocele as a bilateral disease may explain the conclusion of Evers (30), that "varicocele repair does not seem to be an effective treatment for male subfertility." These findings are not surprising considering that the vast majority of the patients in this meta-analysis were treated according to the usual practice, on the left side only. Thus, only those who did not have right varicocele or bypasses, received complete treatment. This assumption is supported by a recent study of our group showing that adolescent varicocele is a bilateral disease in 85% of cases (31).

Varicocele is the main cause of male infertility, and its treatment is, so far, the only one (except in rare cases) that can significantly improve sperm production. Complete treatment (bilateral and bypasses) will decrease the high temperature and high hydrostatic pressure (which causes hypoxia) in the testicular microcirculatory system, stop the stasis,

thereby normalizing the drainage with resumption of the normal oxygen supply. Therefore, in order to restore fertility potential in affected patients, it is essential that clinicians be alerted to the bilateral nature of varicocele.

In summary, the present study has two major findings. First, what was traditionally considered a predominantly unilateral anatomical abnormality apparently has a strikingly high bilateral incidence (80.7%). A high incidence of bilateral ISV reflux could explain the high rates of bilateral testicular dysfunction. The second finding was the high rate of nonpalpable varicocele detected by venography, thermography, and sonography when compared with physical examination. Our study may have important implications for treatment, suggesting that patients with clinical evidence of unilateral left varicocele should be carefully evaluated for bilateral varicocele.

References

1. Lenz M, Hof N, Kersting-Sommerhoff B, Bautz W. Anatomic variants of the spermatic vein: importance of percutaneous sclerotherapy of idiopathic varicocele. Radiology 1996;198:425–31.
2. Hoekstra T, Witt MA. The correlation of the internal spermatic vein palpability with ultrasonographic diameter and reversal of venous flow. J Urol 1995;153:82–4.
3. Paduch D, Niedzielski J. Repair versus observation in adolescent varicocele: a prospective study. J Urol 1997;158:1128–32.
4. Hamm B, Fobbe F, Sorensen R, Felsenberg D. Varicoceles: combined sonography and thermography in diagnosis and post therapeutic evaluation. Radiology 1986;160:419–24.
5. Chiou KR, Anderson JC, Wobig RK, Rosinsky DE, Matamoros A, Chen WS, et al. Color Doppler ultrasound criteria to diagnose varicoceles: correlation of a new scoring system with physical examination. Urology 1997;50:953–6.
6. Morag B, Rubinstein ZJ, Madgar I, Lunnenfeld B. The role of spermatic venography after surgical high ligation of the left spermatic veins: diagnosis and percutaneous occlusion. Urol Radiol 1985;7:32–4.
7. Skoog SJ, Roberts KP, Goldstein M, Pryor JL. The adolescent varicocele: what's new with an old problem in young patients? Pediatrics 1997;100:112–22.
8. World Health Organization. Laboratory manual for the examination of human and semen and sperm-cervical mucus interaction, 3rd ed. New York: Cambridge University Press, 1993.
9. Jones MA, Sharp GH, Trainer TD. The adolescent varicocele—a histopathologic study of 13 testicular biopsies. Am J Clin Pathol 1988;89: 321–8.
10. Hadziselimovic F, Herzog B, Liebundgut B, Jenny P, Buser M. Testicular and vascular changes in children and adults with varicocele. J Urol 1989;142:583–5.
11. Dubin L, Amelar RD. Etiologic factors in 1294 consecutive cases of male infertility. Fertil Steril 1971;22:469–74.
12. Kursh ED. What is the incidence of varicocele in a fertile population? Fertil Steril 1987;48:510–11.
13. McClure RD, Hricak H. Scrotal ultrasound of infertile man: detection of subclinical unilateral and bilateral varicoceles. J Urol 1986;135:711–15.
14. Gonzalez R, Reddy P, Kaye KW, Narayan P. Comparison of Doppler examination and retrograde spermatic venography in the diagnosis of varicocele. Fertil Steril 1983;40:96–9.
15. Bigot JM, Chatel A. The value of retrograde spermatic phlebography in varicocele. Eur Urol 1980;6:301–6.
16. Dubin L, Amelar RD. Varicocele size and results of varicolectomy in selected subfertile men with varicocele. Fertil Steril 1970;21:606–9.
17. Chatel A, Bigot JM, Helenon C, Dectot H, Rotman J, Salat-Baroux J. Interet de la phlebographie spermatique dans le diagnostic das sterilites d'origine circulatorie comparasion avec les donnes cliniques, thermographiques et anatomiques. Ann Radiol 1978;21:565–70.
18. Cockett ATK, Harrison RM, Comhaire F, Dubin L. The varicocele and its effect on fertility. Contemp Surg 1984;24:111–14.
19. Scherr D, Goldstein M. Comparison of bilateral versus unilateral varicolectomy in men with palpable bilateral varicoceles. J Urol 1999;162: 85–8.
20. Abdulmaaboud MR, Shokeir AA, Farage Y, Abd El-Rahman A, El-Rakhawy MM, Mutabagani H. Treatment of varicocele: a comparative study of conventional open surgery, percutaneous retrograde sclerotherapy, and laparoscopy. Urology 1998;52:294–300.
21. Ahlberg NE, Bartley O, Chidekel N. Right and left gonadal veins. An anatomical and statistical study. Acta Radiol Diagn (Stockh) 1966;4: 593–601.
22. Wishahi MM. Detailed anatomy of the internal spermatic vein and the ovarian vein. Human cadaver study and operative spermatic venography: clinical aspects. J Urol 1991;145:780–4.
23. Zorgniotti AW, MacLeod J. Studies in temperature, human semen quality, and varicocele. Fertil Steril 1973;24:854–63.
24. Goldstein M, Eid JF. Elevation of intratesticular and scrotal skin surface temperature in men with varicocele. J Urol 1989;142:743–5.
25. Fujisawa M, Yoshida S, Kojima K, Kamidimi S. Biochemical changes in testicular varicocele. Arch Androl 1989;22:149–52.
26. Comhaire F, Kunnen M, Nahum C. Radiological anatomy of the internal spermatic veins in 200 retrograde venogram. Int J Androl 1981;4: 379–87.
27. Steckel J, Dicker AP, Goldstein M. Relationship between varicocele size and response to varicolectomy. J Urol 1993;149:769–71.
28. Su LM, Goldstein M, Schlegel PN. The effect of varicocelectomy on serum testosterone levels in infertile men with varicocele. J Urol 1995;154:1752–5.
29. Cayan S, Kadioglu A, Orhan I, et al. The effect of microsurgical varicolectomy on serum follicle stimulating hormone, testosterone and free testosterone levels in infertile men with varicocele. BJU International 1999;84:1046–9.
30. Evers J, Collins A. Assessment of efficacy of varicocele repair for male subfertility: a systematic review. Lancet 2003;361:1849–52.
31. Gat Y, Zukerman Z, Bachar GN, Feldberg D, Gornish M. Adolescent varicocele: is it a unilateral disease? J Urol 2003;62:742–7. Discussion, 746; Reply by the authors, 746–7.