Cardiovasc Intervent Radiol (2019) 42:396–404
https://doi.org/10.1007/s00270-018-2136-4



# Effects of Varicocele Treatment on Sperm Conventional Parameters: Surgical Varicocelectomy Versus Sclerotherapy

**Laura Maria Mongioì[1] · Luca Mammino[2] · Michele Compagnone[1] · Rosita Angela Condorelli[1] · Antonio Basile[2] · Angela Alamo[1] · Sandro La Vignera[1] · Giuseppe Morgia[3] · Giorgio Ivan Russo[3] · Aldo Eugenio Calogero[1]**

Received: 25 September 2018 / Accepted: 28 November 2018 / Published online: 5 December 2018
© Springer Science+Business Media, LLC, part of Springer Nature and the Cardiovascular and Interventional Radiological Society of Europe (CIRSE) 2018

## Abstract

*Introduction* Varicocele is often associated with impaired sperm parameters. Different procedures have been developed for varicocele treatment. The aim of this study was to evaluate the effects of varicocele treatment on conventional sperm parameters.

*Materials and Methods* We compared two different techniques of intervention: surgical varicocelectomy and sclerotherapy. We also evaluated the number of varicocele recurrences and the pregnancy rate. We included 102 patients (mean age 29.8 ± 0.8 years) with ultrasound diagnosis of varicocele. We excluded patients whose ultrasound evaluation and/or sperm parameters were not known before and after varicocele correction. We divided the patients (excluding 8 with azoospermia) into two subgroups: surgical varicocelectomy ($n$ = 44) and sclerotherapy ($n$ = 50). For each patient, we compared conventional sperm parameters before and after varicocele correction.

*Results* After varicocele correction, we found a significant improvement in sperm concentration, total count and total motility. Considering the two subgroups, baseline sperm parameters did not differ significantly. Sperm concentration and total count increased significantly after varicocele correction by varicocelectomy. Varicocele correction by sclerotherapy resulted in a significant increase in sperm concentration, progressive and total motility. We found varicocele recurrence in 32% of patients who underwent varicocelectomy and in 19.7% of patients undergoing sclerotherapy. The pregnancy rate was higher after sclerotherapy (28%) than after surgical varicocelectomy (13%).

*Conclusion* Varicocele treatment must be recommended when other causes of infertility have been treated. Our results suggest the use of sclerotherapy for varicocele repair.

*Level of Evidence* 2 b

**Keywords** Varicocele · Conventional sperm parameters · Surgical varicocelectomy · Sclerotherapy

## Introduction

The relationship between varicocele and male fertility is known for many years [1]. Many studies have shown that varicocele is associated with sperm parameter alteration and infertility. In 1992, a study conducted by the World Health Organization (WHO) on 9034 patients with varicocele showed that sperm concentration and total motility were lower than in men without varicocele [2]. The exact mechanism of spermatogenesis damage is not known, but a lot of potential harmful conditions have been suggested. These include hyperthermia, oxidative stress, testicular

✉ Laura Maria Mongioì
lauramongioi@hotmail.it

[1] Department of Clinical and Experimental Medicine, University of Catania, Via S. Sofia 78, 95123 Catania, Italy

[2] Department of Medical and Surgical Sciences and Advanced Technologies "G.F. Ingrassia", University of Catania, Via S. Sofia 78, 95123 Catania, Italy

[3] Department of Surgery, Urology Section, University of Catania, Via S. Sofia 78, 95123 Catania, Italy

perfusion alterations, testicular hypoxia, hormonal anomalies and backflow of toxic metabolites [3].

Several procedures for varicocele treatment have been developed, such as surgical ligation, percutaneous embolization, microsurgery, laparoscopy and robotics [4]. In percutaneous approach, authors have reported the use of different types of materials such as glue [5], spirals [6] or sclerosing agents [7]. In a recent review, Makris and colleagues showed that the lowest rate of recurrence after treatment is obtained by using glue, followed by spirals; although the difference between spirals and sclerosing agents was minimal (9.1% vs. 11.03%) [8].

Varicocele correction still represents sometimes an empirical therapeutic approach to male infertility [9], and many authors investigated its effects on sperm parameters, live birth and pregnancy rate, both spontaneous and after assisted reproductive techniques [10–14]. Nevertheless, nowadays there is not conclusive evidence about the recommendation for varicocele treatment [13].

The aim of this study was to evaluate the effects of varicocele treatment on conventional sperm parameters, assessed according to the WHO 2010 criteria (Table 1) [15]. We also compared two different techniques of intervention: surgical varicocelectomy (ligation) and sclerotherapy. As a secondary outcome, we evaluated the number of varicocele recurrences and the pregnancy rate.

## Patients and Methods

We conducted a retrospective study on 102 patients (mean age 29.8 ± 0.8 years) with ultrasound diagnosis of varicocele, attending the Division of Andrology and Endocrinology, Teaching Hospital "Policlinico-Vittorio Emanuele", University of Catania. We excluded from the study patients whose ultrasound evaluation and/or sperm parameters were not known before and after varicocele correction. We also excluded patients with systemic disease, male accessory glands infection (prostatitis, vesiculitis, epididymitis and/or orchitis) or undergoing to treatments that could clearly influence sperm parameters (i.e., antibiotics, follicle-stimulating hormone, antioxidants, etc.).

**Table 1** Sperm parameter values according to WHO 2010 criteria

| Parameter | 5th centile | 50th centile |
|---|---|---|
| Volume (ml) | 1.5 | 3.7 |
| Concentration (mil/ml) | 15 | 73 |
| Total sperm count (mil/ejaculate) | 39 | 255 |
| Progressive motility (%) | 32 | 55 |
| Total motility (%) | 40 | 61 |
| Normal forms (%) | 4 | 15 |

The ultrasound (US) evaluation of the varicocele degree was performed according to Sarteschi's classification, which includes 5 stages and it is based on assessment of the lesion when the patient is standing and lying down [16].

Among the 102 patients, 92 had left varicocele, 2 had right varicocele and 8 were affected from bilateral varicocele. As for sperm parameters, 15 (14.7%) men were normozoospermics, 87 (85.3%) were oligo-, astheno and/or teratozoospermics and 8 (0.7%) were azoospermics with normal FSH values. We considered separately the patients with azoospermia and divided the remaining 94 patients into two subgroups, according to the technique of varicocele correction: surgical varicocelectomy ($n = 44$) and sclerotherapy ($n = 50$). For each patient, we compared conventional sperm parameters before and after varicocele correction (semen analysis post-varicocele repair: mean 5.15 ± 0.57 months, range 3–13 months). Table 1 shows the breakdown of varicocele grading between the surgical group and the sclerotherapy group.

Varicocelectomy was conducted according to Ivanissevich technique. This approach involves opening the external oblique fascia above the inguinal ring and delivering the spermatic cord into the operative field [17].

Sclerotherapy was performed using an ultrasound-guided percutaneous access in the right common femoral vein (Fig. 1) or basilic vein (Fig. 2); then, a 5 Fr valved introducer was positioned by using a 21-gauge micropuncture set (Prelude EASE, Merit medical system, South Jordan, Utah, USA). The distal portion of the left spermatic vein (LSV) was reached with a 0.035 hydrophilic guidewire (Terumo corp., Tokyo, Japan) and catheterized with a C2 or C1 5 Fr Cobra-shaped angiographic diagnostic catheter (Terumo corp., Tokyo, Japan), through a femoral access and MPA shaped diagnostic catheter (Impress merit medical system, South Jordan, Utah, USA) through basilic vein access. Once distal catheterization was obtained, diagnostic phlebography was performed to study venous circulation, searching for any collateral branch in venous gonadal drainage according to the Bähren classification [18].

After phlebography, an angioplastic compliant balloon (Rival, Bard Peripheal Vascular, Tempe, USA; size between 4 and 8 mm according to vein diameter) was coaxially advanced distal to the upper margin of left iliac bone and inflated in order to stop the retrograde flow. A second phlebography was performed to show collaterals not previously seen with free flow. In all patients, a rubber band was applied at the highest level of the scrotum, to avoid reflux of the sclerosant into the scrotal vein, preventing phlebitis. Thus, one or two vials (according to LSV diameter) of atoxisclerol 3% (lauromacrogol 400 polidocanol) were injected to perform sclerotherapy, with no Valsalva maneuver and with stopped flow (proximal and distal barrages) for 10 min [19]. If systemic collaterals

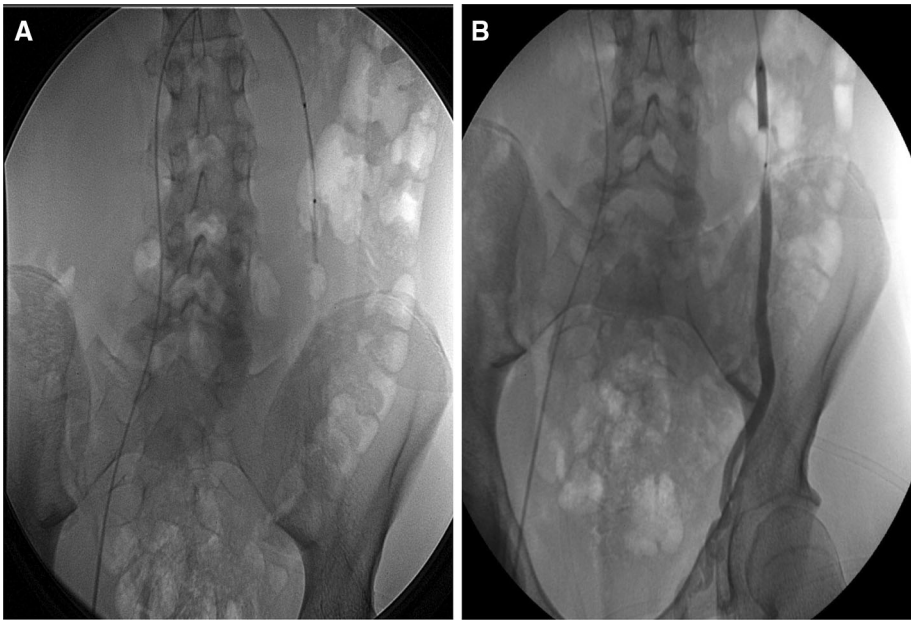


**Fig. 1** Image showing angioplastic compliant balloon inside internal spermatic vein before (**A**) and after (**B**) inflation (phlebographic check, before sclerosing agent injection; femoral access)

were observed at phlebography, a mixture of contrast agent and sclerosant was injected, checking and stopping the injection once the proximal part of collateral was seen (comment n, reviewer n). The occluding ballon was then deflated and a phlebographic control was performed [19].

The number of varicocele recurrences was carefully recorded from the two subgroups by ecocolor Doppler which patients underwent after varicocele repair.

Finally, we evaluated the pregnancy rate after varicocele correction.

## Statistical Analysis

The results are reported as mean ± SEM throughout the study. Statistical analysis of the data was performed using Student's *t* test in the entire cohort. Subsequently, patients were divided into two groups according to the technique of varicocele correction. The data resulting from this classification were analyzed by one-way analysis of variance (ANOVA) followed by the Duncan's Multiple Range test. Finally, we used Chi-square test for evaluation of different varicocele grades, number of varicocele recurrences and pregnancy rate in both groups. SPSS 22.0 for Windows was used for statistical analysis (SPSS Inc., Chicago, USA). The results with a $p$ value less than 0.05 were considered statistically significant.

## Results

In both surgical varicocelectomy and sclerotherapy groups, the most frequent varicocele grade was the III (72.7% and 66%, respectively), which did not differ significantly between the two groups. On the contrary, the number of patients with II grade varicocele was significantly higher in surgical varicocelectomy group ($p < 0.05$), instead the number of patients with IV grade varicocele was significantly higher in sclerotherapy group ($p < 0.05$) (Table 2).

Considering the entire cohort, after varicocele correction, a significant improvement of sperm concentration ($p < 0.01$), total count ($p < 0.01$) and total motility ($p < 0.05$) was found (Fig. 3). Leukocytes also increased in a statistically significant manner after varicocele repair (Fig. 4), but only 22 patients (23.4%) showed leukocytospermia according to the WHO 2010 definition. The analysis of the two subgroups (surgical varicocelectomy vs. sclerotherapy) showed that three patients from the group of surgical varicocelectomy and six from the group of sclerotherapy underwent varicocele repair for recurrence. All these latter had previously been surgically varicocelectomized. Pretreatment sperm parameters did not differ significantly between the two groups.

Among the patients undergoing surgical varicocelectomy, before surgery 44 men (91%) had oligo-, astheno and/or teratozoospermia and 4 (9%) were normozoospermics. After varicocele correction, 28 patients (63.6%) had sperm parameters in the normal range. Sperm concentration and total count improved significantly ($p < 0.05$ and $p < 0.01$ respectively; Fig. 4), while progressive and total motility did not change significantly from baseline values.

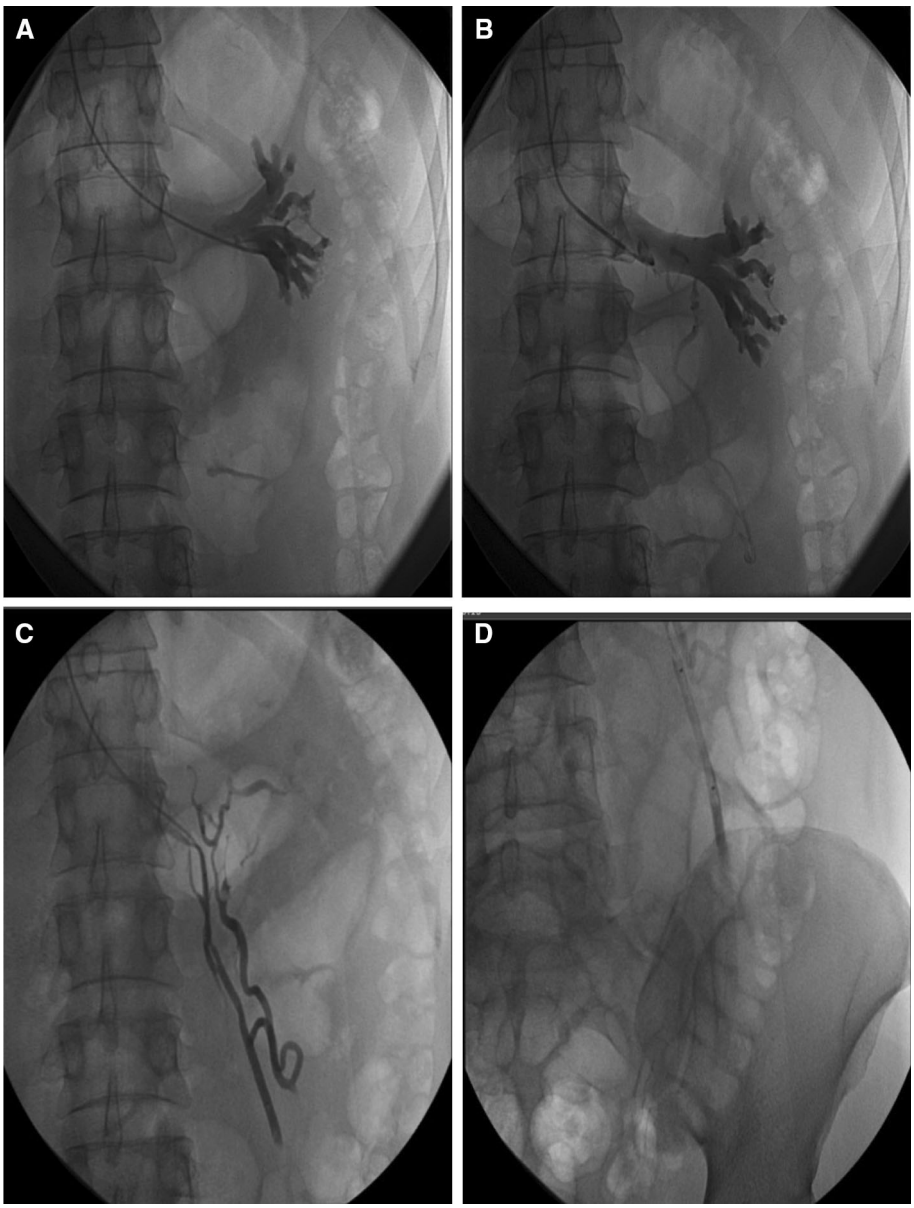


**Fig. 2** Basilic vein access: phlebographic check of left renal vein (**A**, **B**) that shows contrast agent reflux into left spermatic vein (**C**); sclerosing agent injection through occluding balloon (**D**)

**Table 2** Number of patients for each varicocele degree according to the Sarteschi's classification in both surgical varicocelectomy and sclerotherapy groups

| Sarteschi's classification | Surgical varicocelectomy | Sclerotherapy |
|---|---|---|
| I | 0 | 0 |
| II | 9/44 (20.4%)* | 1/50 (2%) |
| III | 32/44 (72.7%) | 33/50 (66%) |
| IV | 3/44 (6.8%) | 15/50 (30%)* |
| V | 0 | 1/50 (2%) |

*$p < 0.05$

As far as the group of sclerotherapy, at baseline 4 (8%) patients had a normal sperm number, instead 46 (92%) had oligo-, astheno and/or teratozoospermia. Subsequently sclerotherapy, sperm concentration ($p < 0.01$) and progressive ($p < 0.05$) and total motility ($p < 0.01$) increased significantly. Leukocytes also significantly increased ($p < 0.01$; Fig. 5) and postoperative sperm analysis showed 27 patients (54%) with normozoospermia. Moreover, comparing the two subgroups, we found a statistically significant increase in progressive and total motility after sclerotherapy than after surgical varicocelectomy ($p < 0.01$).

All the eight azoospermic patients underwent sclerotherapy. Among them, 3 (37.5%) became oligozoospermic after the procedure.

Finally, after $44.97 \pm 11.44$ months from varicocele repair, we found recurrence in 32% of patients in the group of surgical varicocelectomy and in 22.6% of men

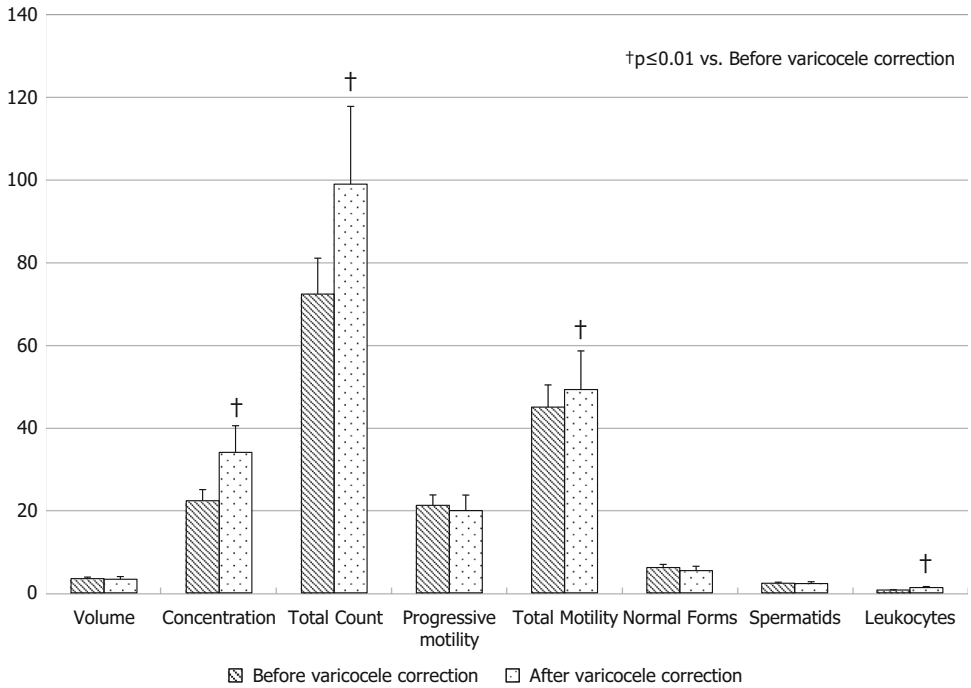


**Fig. 3** Number of patients for each varicocele degree according to the Sarteschi's classification

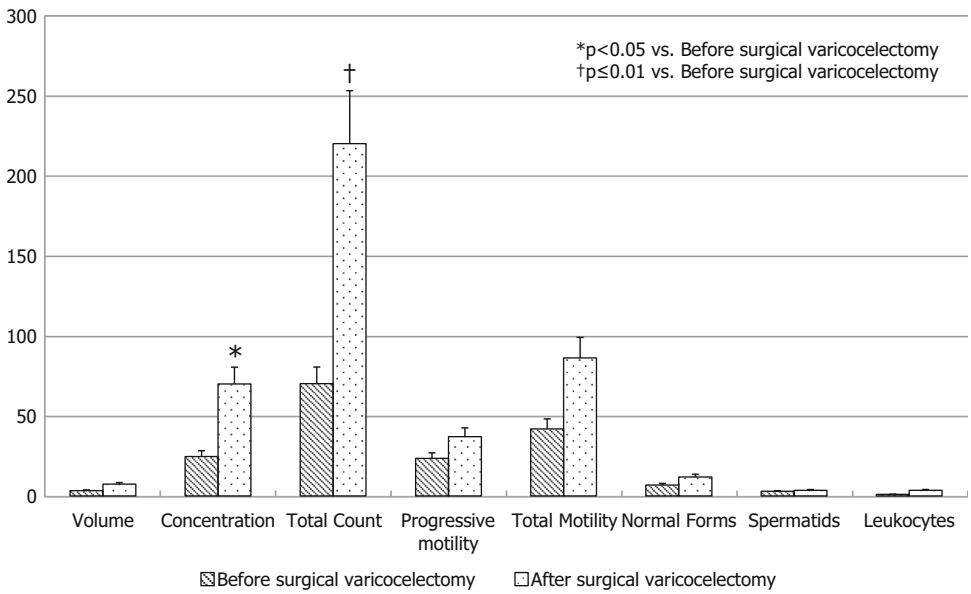


**Fig. 4** Conventional sperm parameters before and after varicocele treatment

undergoing sclerotherapy. Considering that all the azoospermic patients have undergone sclerotherapy, the percentage of recurrence after this procedure was 19.7%. The number of recurrences did not statistically differ between the two groups.

No patient reported serious adverse events and/or complications after both procedures. Patients undergoing varicocelectomy were hospitalized for about 2 days, while patients undergoing sclerotherapy needed only 2-hour post-op observation.

As for pregnancy rate, in the group of surgical varicocelectomy, six patients were not looking for pregnancy in the immediacy. Among the remaining 38 patients, four achieved a spontaneous pregnancy and a couple had a pregnancy after assisted reproductive technique (ART). The overall pregnancy rate was 13%. In the group of sclerotherapy, five patients were not looking for pregnancy in the immediacy, two interrupted the couple relationship and a patient had his wife with major health problems. Among the remaining 42 patients, 11 achieved a spontaneous pregnancy and a couple had a pregnancy after ART.

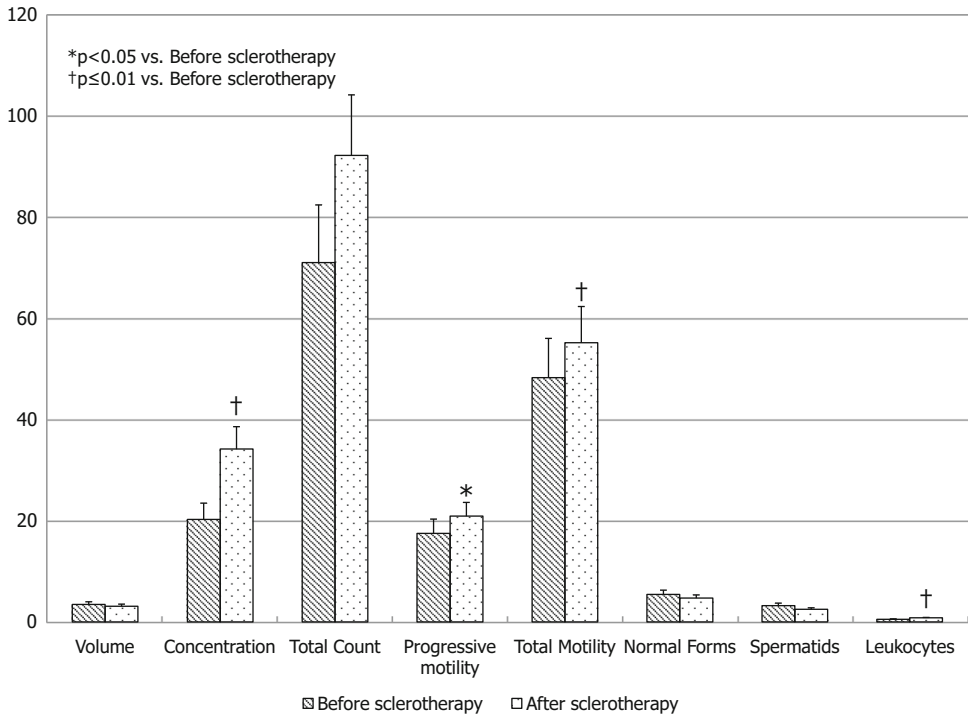


**Fig. 5** Conventional sperm parameters before and after varicocele treatment: surgical varicocelectomy (upper panel) versus sclerotherapy (lower panel)

The overall pregnancy rate was 28%. The pregnancy rate was not statistically different between the two groups.

## Discussion

Varicocele is a common male condition, affecting about 15–20% of general adult population, and it is one of the most frequent causes of infertility, as it is diagnosed in about 30–40% of men with primary infertility [3, 20]. Many authors studied the effects of varicocele treatment on sperm parameters, but the results are not yet conclusive.

In this study, we evaluated the conventional sperm parameters according to the WHO 2010 criteria before and after varicocele correction in 102 patients. Among these, we considered separately data regarding eight patients with azoospermia. Moreover, we evaluated the effects on these parameters of two different treatment techniques: surgical varicocelectomy and sclerotherapy of spermatic vein. Finally, we analyzed the percentage of varicocele recurrences and the pregnancy rate after both procedures.

After varicocele treatment, we found that sperm concentration, total count and total motility increased significantly. Leukocytes also were higher than baseline, but this increase resulted in leukocytospermia only in a small percentage of patients. These results agree with those of a recent meta-analysis and systematic review which showed that the main sperm parameters, evaluated according to WHO 2010 criteria, were worse in patients with varicocele compared to controls [3]. Some studies have also shown that patients with varicocele have worse bio-functional sperm parameters and in particular increased sperm DNA fragmentation, abnormal chromatin compactness, low sperm mitochondrial membrane potential and increased oxidative stress [21–25].

As for the effectiveness of varicocele treatment on sperm parameters, there is no agreement in the literature. Some studies affirmed that varicocele repair is not an effective treatment for male infertility [26–28], but these studies included patients with non-palpable varicocele and/or normal semen parameters. On the contrary, other authors found that varicocele repair has a beneficial effect in couples with unexplained infertility, since varicocelectomy improved sperm parameters and the pregnancy rate [29, 30]. A Cochrane Database Systematic Review and Meta-analysis, conducted on 894 men, suggests that correction of clinical varicocele in patients with poor semen quality improved pregnancy rate. Nevertheless, the available evidences are still not conclusive and they are not of high quality [13]. Moreover, varicocele is often associated with other venous abnormalities, as dilation of the periprostatic venous plexus (DPVP) and these patients did not take advantage from varicocele repair since only DPVP-varicocele patients showed a significant improvement of sperm progressive motility and seminal fluid viscosity [31]. Concomitant abacterial prostatovesiculitis (PV) also negatively affects sperm parameters after varicocele correction. Thus, the identification through ultrasound scans of a possible DPVP and/or PV may be mandatory before varicocele treatment [32].

In this study, we included eight patients with azoospermia. After varicocele treatment (sclerotherapy), three men (37.5%) became oligozoospermics. Some studies have proposed varicocele repair as a therapeutic strategy in patients with non-obstructive azoospermia, since in up to one out of three patients, spermatozoa could be found in the ejaculate. Moreover, in patients who remain azoospermic, after varicocele treatment, the probability of subsequent testicular sperm retrieval seems to be increased [33, 34].

Regarding the method of varicocele treatment, we found that sperm concentration significantly improved with both varicocelectomy and sclerotherapy, but only in patients undergoing sclerotherapy there was a statistically significant increase in progressive and total sperm motility. Furthermore, although we found no statistically significant differences between the two groups, in patients treated by sclerotherapy, the percentage of recurrences was lower than in patients undergoing surgical varicocelectomy.

Nowadays, different techniques of varicocele repair have been developed, such as surgical and microsurgical varicocelectomy, laparoscopic varicocelectomy, percutaneous sclerotherapy. These approaches are aimed at eliminating venous reflux, preserving vascular and lymphatic testicular structure and, at the same time, improving sperm parameters. Some studies suggest that microsurgical varicocelectomy is the first line varicocele treatment, resulting in better sperm parameters, decrease in sperm DNA fragmentation and higher spontaneous pregnancy rate [21]. According to some authors, this technique is also associated with lower complications and recurrence rates than other approaches [35–37]. Nevertheless, other studies showed that percutaneous embolization of internal spermatic vein for varicocele treatment and surgical ligation of varicocele are equally effective on sperm parameters [11]. Moreover, sclerotherapy allows the patients to quickly recover and it reduces the pain procedure-related and postoperative complications. Finally, this method seems to be superior to surgery in postsurgical recurrent varicocele treatment [38]. Left spermatic vein sclerotherapy achieved with the injection of sclerosant through an occluding balloon seems to be more effective in achieving total vein embolisation than the injection through a diagnostic catheter [19].

A recent prospective study compared microsurgical varicocelectomy and sclerotherapy and it showed that the two procedures are similar in terms of sperm parameters improvement and pregnancy rate. The authors also found a reduced postoperative morbidity after percutaneous embolization [39]. However, data on sclerotherapy in literature are not yet enough and currently there are not clear evidences showing the superiority of one methods of varicocele repair on the other [30].

Regarding the number of recurrences, the rates of recurrent varicocele may be different and depend to which technique has been used. Recurrence after retroperitoneal high ligation (Palomo) technique was estimated to be between 7 and 35%, between 0 and 3.57% after microsurgical approach, between 0 and 37% when considering macroscopic inguinal (Ivanissevich) or sub-inguinal approach, while between 2 and 24% after radiologic embolization [40]. The higher rates of failure seen with macroscopic inguinal or sub-inguinal varicocelectomy are theorized to be secondary to missed smaller internal spermatic veins that later dilate and cause recurrence. The higher recurrence rate seen with the open retroperitoneal or laparoscopic approaches is often attributed to the inability to ligate external gonadal (cremasteric) vessels or the external spermatic vein in these procedures [40].

Finally, as for pregnancy rate, a recent meta-analysis highlighted that the overall spontaneous pregnancy rate was 37.69% after Palomo technique series, 41.97% after microsurgical varicocelectomy techniques, 30.07% after laparoscopic varicocelectomy techniques, 33.2% after radiologic embolization approach, and 36% after macroscopic inguinal varicocelectomy, revealing significant difference among the techniques [41]. Differently from these results, we found a higher pregnancy rate after sclerotherapy (28%) than after surgical varicocelectomy (13%).

## Conclusion

Varicocele repair should be suggested to patients with impaired sperm parameters and/or otherwise unexplained infertility. In this study, we found that after varicocele treatment sperm concentration significantly improved in both surgical varicocelectomy and sclerotherapy groups. On the other hand, for the first time we clearly showed that sperm total and progressive motility increased significantly only in patients undergoing percutaneous embolization. Moreover, in the last group, we found a lower percentage of varicocele recurrences and a higher pregnancy rate. Another point to consider is the hospitalization time which is significantly shorter after sclerotherapy than after surgical varicocelectomy. Thus, according to our results, sclerotherapy should be the technique of choice for varicocele repair.

**Author's Contributions** LMM and LM are the principal investigators. MC, RAC, AB, AA, SLV, GM and GIR have contributed in methodological and statistical aspects. AEC is the coordinator of the study.

**Compliance with Ethical Standards**

**Conflict of interest** The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

## References


1. Belker AM. The varicocele and male infertility. Urol Clin North Am. 1981;8:41–51.
2. World Health Organization. The influence of varicocele on parameters of fertility in a large group of men presenting to infertility clinics. Fertil Steril. 1992;57:1289–93.
3. Agarwal A, Sharma R, Harlev A, Esteves SC. Effect of varicocele on semen characteristics according to the new 2010 World Health Organization criteria: a systematic review and meta-analysis. Asian J Androl. 2016;18:163–70. https://doi.org/10.4103/1008-682X.172638 **(Review)**.
4. Marte A. The history of varicocele: from antiquity to the modern ERA. Int Braz J Urol. 2018;23:44. https://doi.org/10.1590/s1677-5538.ibju.2017.0386.
5. Urbano J, Cabrera M, Alonso-Burgos A. Sclerosis and varicocele embolization with N-butyl cyanoacrylate: experience in 41 patients. Acta Radiol. 2014;55:179–85.
6. Reyes BL, Trerotola SO, Venbrux AC, Savader SJ, Lund GB, Peppas DS, Mitchell SE, Gearhart JP, White RI Jr, Osterman FA. Percutaneous embolotherapy of adolescent varicocele: results and long-term follow-up. Jr J Vasc Interv Radiol. 1994;5:131–4.
7. Gandini R, Konda D, Reale CA, et al. Male varicocele: transcatheter foam sclerotherapy with sodium tetradecyl sulfate—outcome in 244 patients. Radiology. 2008;246:612–8.
8. Makris GC, Efthymiou E, Little M, Boardman P, Anthony S, Uberoi R, Tapping C. Safety and effectiveness of the different types of embolic materials for the treatment of testicular varicoceles: a systematic review. Br J Radiol. 2018;91:20170445. https://doi.org/10.1259/bjr.20170445.
9. Kamischke A, Nieschlag E. Varicocele treatment in the light of evidence-based andrology. Hum Reprod Update. 2001;7:65–9 **(Review)**.
10. Yavetz H, Levy R, Papo J, Yogev L, Paz G, Jaffa AJ, Homonnai ZT. Efficacy of varicocele embolization versus ligation of the left internal spermatic vein for improvement of sperm quality. Int J Androl. 1992;15:338–44.
11. Dewire DM, Thomas AJ Jr, Falk RM, Geisinger MA, Lammert GK. Clinical outcome and cost comparison of percutaneous embolization and surgical ligation of varicocele. J Androl. 1994;15(Suppl):38S–42S.
12. Austoni E, Cazzaniga A, Gatti G, Baroni P, Gentilini O, Levorato CA. Varicocele and its repercussion on infertility. Indications and limitations of surgical intervention. Arch Ital Urol Androl. 1998;70:103–7.
13. Kroese AC, de Lange NM, Collins J, Evers JL. Surgery or embolization for varicoceles in subfertile men. Cochrane Database Syst Rev. 2012;10:CD000479. https://doi.org/10.1002/14651858.cd000479.pub5 **(Review)**.
14. Kohn TP, Kohn JR, Pastuszak AW. Varicocelectomy before assisted reproductive technology: are outcomes improved? Fertil Steril. 2017;108:385–91. https://doi.org/10.1016/j.fertnstert.2017.06.033 **(Review)**.
15. WHO Laboratory Manual for the Examination and Processing of Human Semen. 5th ed. World Health Organization, 2010.
16. Sarteschi LM. Lo studio del varicocele con eco-color-Doppler. G Ital Ultrasonologia. 1993;4:43–9.
17. Ivanissevich O. Left varicocele due to reflux; experience with 4,470 operative cases in forty-two years. J Int Coll Surg. 1960;34:742–55.
18. Bähren W, Biehl C, Danz B. Failed sclerotherapy trials with the V. spermatica interna. A retrospective analysis in 1141 patients with idiopathic varicocele. Rofo. 1992;157:355–60.
19. Basile A, Failla G, La Vignera S, Condorelli RA, Calogero A, Vicari E, Granata A, Mundo E, Caltabiano G, Pizzarelli M, Messina M, Scavone G, Lanzafame F, Iezzi R, Tsetis D. Left spermatic vein retrograde sclerosis: comparison between sclerosant agent injection through a diagnostic catheter versus through an occluding balloon catheter. Radiol Med. 2015;120:483–8. https://doi.org/10.1007/s11547-014-0478-9.
20. Tatem AJ, Brannigan RE. The role of microsurgical varicocelectomy in treating male infertility. Transl Androl Urol. 2017;6:722–9. https://doi.org/10.21037/tau.2017.07.16.
21. Baazeem A, Belzile E, Ciampi A, Dohle G, Jarvi K, Salonia A, Weidner W, Zini A. Varicocele and male factor infertility treatment: a new meta-analysis and review of the role of varicocele repair. EurUrol. 2011;60:796–808. https://doi.org/10.1016/j.eururo.2011.06.018.
22. La Vignera S, Condorelli R, Vicari E, D'Agata R, Calogero AE. Effects of varicocelectomy on sperm DNA fragmentation, mitochondrial function, chromatin condensation, and apoptosis. J Androl. 2012;33:389–96. https://doi.org/10.2164/jandrol.111.013433.
23. Wang YJ, Zhang RQ, Lin YJ, Zhang RG, Zhang WL. Relationship between varicocele and sperm DNA damage and the effect of varicocele repair: a meta-analysis. Reprod Biomed Online. 2012;25:307–14. https://doi.org/10.1016/j.rbmo.2012.05.002.
24. Dieamant F, Petersen CG, Mauri AL, Conmar V, Mattila M, Vagnini LD, Renzi A, Costa BP, Zamara C, Oliveira JBA, Baruffi RLR, Franco JG Jr. Semen parameters in men with varicocele: DNA fragmentation, chromatin packaging, mitochondrial membrane potential, and apoptosis. JBRA Assist Reprod. 2017;21:295–301. https://doi.org/10.5935/1518-0557.20170053.
25. Roque M, Esteves SC. Effect of varicocele repair on sperm DNA fragmentation: a review. Int Urol Nephrol. 2018;50:583–603. https://doi.org/10.1007/s11255-018-1839-4 **(Review)**.
26. Evers JL, Collins JA. Assessment of efficacy of varicocele repair for male subfertility: a systematic review. Lancet. 2003;361:1849–52 **(Review)**.
27. Evers JL, Collins JA. Surgery or embolisation for varicocele in subfertile men. Cochrane Database Syst Rev. 2004;3:CD000479.
28. Evers JH, Collins J, Clarke J. Surgery or embolisation for varicoceles in subfertile men. Cochrane Database Syst Rev 2008;(3):CD000479. https://doi.org/10.1002/14651858.cd000479.pub3. **(Review)**. Update in: Cochrane Database Syst Rev. 2009;(1):CD000479.
29. Marmar JL, Agarwal A, Prabakaran S, Agarwal R, Short RA, Benoff S, Thomas AJ Jr. Reassessing the value of varicocelectomy as a treatment for male subfertility with a new meta-analysis. Fertil Steril. 2007;88:639–48. https://doi.org/10.1016/j.fertnstert.2006.12.008.
30. Jensen CFS, Østergren P, Dupree JM, Ohl DA, Sønksen J, Fode M. Varicocele and male infertility. Nat Rev Urol. 2017;14:523–33. https://doi.org/10.1038/nrurol.2017.98.
31. Condorelli RA, Calogero AE, Mongioi' L, Vicari E, Russo GI, Lanzafame F, La Vignera S. Varicocele and concomitant dilation of the periprostatic venous plexus: effects on semen viscosity sperm parameters. J Endocrinol Invest. 2016;39:543–7. https://doi.org/10.1007/s40618-015-0401-9.
32. Vicari E, La Vignera S, Tracia A, Cardì F, Donati A. Varicocele and coincidental abacterial prostato-vesiculitis: negative role about the sperm output. Arch Ital Urol Androl. 2003;75:35–9.

33. Esteves SC, Miyaoka R, Roque M, Agarwal A. Outcome of varicocele repair in men with nonobstructive azoospermia: systematic review and meta-analysis. Asian J Androl. 2016;18:246–53. https://doi.org/10.4103/1008-682X.169562.
34. Shabbir M, Shukla C, Brown G, Dorkin T, Lucky M, Pearcy R, Rees R, Summerton D, Muneer A, on behalf the BAUS Section of Andrology and Genitourethral Surgery. Surgical management of azoospermia: can the NHS England Clinical Commissioning Policy reduce geographical inequality of services? BJU Int. 2018;121:172–5. https://doi.org/10.1111/bju.14068.
35. Cayan S, Shavakhabov S, Kadioğlu A. Treatment of palpable varicocele in infertile men: a meta-analysis to define the best technique. J Androl. 2009;30:33–40. https://doi.org/10.2164/jandrol.108.005967.
36. Diegidio P, Jhaveri JK, Ghannam S, Pinkhasov R, Shabsigh R, Fisch H. Review of current varicocelectomy techniques and their outcomes. BJU Int. 2011;108:1157–72. https://doi.org/10.1111/j.1464-410X.2010.09959.x.
37. Wang J, Xia SJ, Liu ZH, Tao L, Ge JF, Xu CM, Qiu JX. Inguinal and subinguinal micro-varicocelectomy, the optimal surgical management of varicocele: a meta-analysis. Asian J Androl. 2015;17:74–80. https://doi.org/10.4103/1008-682X.136443.
38. Jargiello T, Drelich-Zbroja A, Falkowski A, Sojka M, Pyra K, Szczerbo-Trojanowska M. Endovascular transcatheter embolization of recurrent postsurgical varicocele: anatomic reasons for surgical failure. Acta Radiol. 2015;56:63–9. https://doi.org/10.1177/0284185113519624.
39. Bou Nasr E, Binhazzaa M, Almont T, Rischmann P, Soulie M, Huyghe E. Subinguinal microsurgical varicocelectomy vs. percutaneous embolization in infertile men: Prospective comparison of reproductive and functional outcomes. Basic ClinAndrol 2017; 27:11. https://doi.org/10.1186/s12610-017-0055-x. eCollection 2017.
40. Rotker K, Sigman M. Recurrent varicocele. Asian J Androl. 2016;18:229–33. https://doi.org/10.4103/1008-682X.171578.
41. Cayan S, Shavakhabov S, Kadioğlu A. Treatment of palpable varicocele in infertile men: a meta-analysis to define the best technique. J Androl. 2009;30:33–40. https://doi.org/10.2164/jandrol.108.005967.