Inguinal and subinguinal micro-varicocelectomy, the optimal surgical management of varicocele: a meta-analysis

Jun Wang, Shu-Jie Xia, Zhi-Hong Liu, Le Tao, Ji-Fu Ge, Chen-Min Xu, Jian-Xin Qiu

Conventional meta-analyses have shown inconsistent results for the efficacy of various treatments of varicoceles. Therefore, we performed a multiple-treatment meta-analysis to assess the effectiveness and safety of 10 methods of varicocelectomy and embolization/sclerotherapy. We systematically reviewed 35 randomized controlled trials and observational studies, from 1966 to August 5, 2013, which compared any of the following treatments for varicoceles: laparoscopic, retroperitoneal, open inguinal and subinguinal varicocelectomy, microsurgical subinguinal and inguinal varicocelectomy, percutaneous venous embolization, Tauber antegrade sclerotherapy, retrograde sclerotherapy and expectant therapy (no treatment). Inguinal and subinguinal microsurgery, open inguinal, laparoscopic varicocelectomy showed a significant advantage over expectant therapy in terms of pregnancy rates (odds ratio (OR): 3.48, 2.68, 2.92 and 2.90, respectively). Compared with retroperitoneal open surgery, inguinal microsurgery showed an improvement of sperm density (mean difference (MD): 10.60, 95% confidence interval (CI): 1.92–19.60) and sperm motility (MD: 9.09, 95% CI: 4.88–13.30). Subinguinal and inguinal microsurgery outperformed retroperitoneal open surgery in terms of recurrence (OR: 0.05, 0.06 respectively). Tauber antegrade sclerotherapy and subinguinal microsurgery were associated with the lowest risk of hydrocele formation. The odds of overall complication, compared with retroperitoneal open varicocelectomy, were lowest for inguinal microsurgery (OR = 0.07, 95% CI: 0.02–0.19), followed by subinguinal microsurgery (OR = 0.09, 95% CI: 0.02–0.19). Inguinal and subinguinal micro-varicocelectomy had the highest pregnancy rates, significant increases in sperm parameters, with low odds of complication. These results warrant additional properly conducted randomized controlled clinical studies with larger sample sizes.

Asian Journal of Andrology (2015) 17, 74–80; doi: 10.4103/1008-682X.136443; published online: 09 September 2014

Keywords: meta-analysis; varicocele; varicocelectomy

INTRODUCTION

A varicocele is defined as abnormal dilated and tortuous veins in the scrotum. They are present in 15%–20% of the male population, and in up to 35% of patients with male infertility. Varioceles are now recognized as the most surgically correctable cause of male infertility. The exact pathophysiological association between reduced male fertility and varicocele is still unknown. Several postulated causes include increased reactive oxidative species, sperm DNA damage, increased scrotal temperature, and reduced the supply of oxygenated blood and nutrients.

Several surgical approaches have been used for varicocele including open surgical ligation of the spermatic vein, and microsurgical and laparoscopic varicocelectomy. Each technique has its own advantages and disadvantages, and conflicting results have been reported in various studies. Until date, there is no consensus as to which technique should be considered the “gold standard.”

In recent times, new meta-analytic methods–network or mixed treatment comparisons meta-analysis have become available that allow complete assessments across various treatments. Network meta-analysis is a fairly new statistical technique that allows both direct and indirect comparisons to be undertaken, even when two of the strategies have not been directly compared.

The aim of the current study was to use a network meta-analysis on data from randomized comparative clinical trials (RCT) and nonrandomized clinical trial studies to assess the efficacy and safety of currently used treatment for varicoceles in order to provide better guidance for treatment choices.

MATERIALS AND METHODS

Criteria for study inclusion and search strategy

Systematic reviews were done according to the preferred reporting items for systematic reviews and meta-analysis statement. Inclusion criteria were similar to the analysis by Kroese et al. men with varicocele (any grade) who had semen analyses, who were part of a couple with otherwise unexplained subfertility. Subfertility is defined by 1 year of infertility and no identifiable female factors. Types of outcome measures included pregnancy rate, semen parameters, overall complications, recurrent varicocele, postoperative hydrocele. Exclusion criteria for pregnancy rates were: follow-up <9 months, patients with azoospermia, crypto-ozospermia, obstructive oligospermia or urinary infection, couples with additional fertility drugs or assisted reproduction techniques such as in vitro fertilization or intrauterine insemination. Exclusion criteria for semen parameters were: semen parameters are...
tested <3 times, patients with azoospermia, crypto-ozoospermia. Exclusion criteria for complications were: follow-up <3 months, not confirmed by proper examination, insufficient data, more than one treatment per arm. All patients with prior surgery for varicoceles or congenital diseases (e.g. Klinefelter, Y chromosome deficiency) or endocrine diseases (e.g. Kallmann syndrome, hypercorticoïdism) were excluded.

We identified RCTs and non-RCTs that evaluated the efficacy and safety of surgical ligation, therapeutic embolization and sclerotherapy treatment methods for varicocele reported from 1966 to August 5, 2013. Observational studies were pooled into the analysis only when there were complications or particular treatment. We searched PubMed, Embase, the Cochrane Collaboration's Database of Systematic Reviews, and Scopus using the MeSH terms: “varicocele,” “varicocelectomy,” “ligation,” “embolization,” “therapeutic,” “sclerotherapy,” “human.” In addition, we reviewed the reference lists of all the previous meta-analyses. Studies published in any language were eligible for inclusion.

Study selection
Study eligibility was independently determined by two authors. Titles and abstracts were used to screen for initial study inclusion. Full-text reviews were carried out on the remaining papers. Discrepancies were resolved by discussion.

Evaluation for bias
We scored these non-RCT studies using a modified Newcastle–Ottawa Quality Assessment Scale15 and assessed risk of bias for each included RCTs by Cochrane Collaboration’s tool which includes the selection, performance, attrition, detection, and reporting bias. Evaluation was done by two independent assessors to improve the validity.

Data extraction and management
Two reviewers performed data extraction independently. Disagreements were resolved by discussion and consensus. Population information and study characteristics such as the specific intervention were extracted independently using standard data extraction forms. For multiple reports of the same study, duplicated data were removed. We imputed missing standard deviations (s.d.) of mean changes for each treatment using the largest s.d. reported in the set of included studies for each outcome.

Subgroup analysis
Where data were available, we conducted a subgroup analysis with more strictly defined inclusion criteria: studies that included men with abnormal semen, clinical varicocele to determine the efficacy of various types of varicocelectomies and other modalities.

Statistical analysis
We did network meta-analyses within a Bayesian framework using Markov chain Monte Carlo (MCMC) methods in Just Another Gibbs Sampler and programming language R, version 3.0.1 (R Foundation for Statistical Computing, Vienna, Austria).16 We modeled the binary outcomes in each treatment group of every study, and specified the relationships among odds ratios (ORs) across studies making various comparisons. This method combines direct and indirect evidence for any given pair of treatments. Convergence was checked after every outcome analysis using diagnostic tools as described by Raftery and Lewis17 and diagnostic plots (trace, density, autocorrelation) from MCMC simulations. Heterogeneity was evaluated using I²-statistics. Inconsistency was estimated within each outcome analysis. We did sensitivity analyses according to age range (including only studies with patient age >14) and study designs (RCTs only).

RESULTS
A total of 157 articles were identified through the electronic and manual searches of references (Figure 1). Of these, 95 were judged to be relevant according to the review of the abstracts and titles. More studies were eliminated because of use of inadequate study designs, and lack of relevance of measured outcomes. RCTs were assessed using a risk of bias table, and non-RCT studies were scored by the Newcastle–Ottawa Quality Assessment Scale.15 After scoring, 35 studies (12 observational studies and 23 RCTs) qualified for inclusion (Figure 2 and Supplementary Table 1). The characteristics of the studies are shown in Table 1. The types of intervention were laparoscopic retroperitoneal, open inguinal varicocelectomy, microsurgical subinguinal and inguinal varicocelectomy, percutaneous venous embolization, Tauber antegrade sclerotherapy, retrograde sclerotherapy. Because subinguinal antegrade sclerotherapy was reported only in one study is not widely used clinically, this study was excluded from the analysis.

Randomization was achieved by a random number generator in five studies (Abdel-Maguid and Othman 2010, Barbalias et al. 1998, Krause et al. 2002, Nieschlag et al. 1995/1998, Pan et al. 2013), and was not stated in the other studies. Normozoospermic men from infertile couples (normal semen density, motility and morphology) were evenly distributed in different groups. Blinding is difficult to implement in surgical trials, and only one trial stated that it was double-blinded. However, blinding is not likely to have a great effect on objective outcomes such as pregnancy rates, semen parameters, recurrence and hydrocele formation rates. Although semen analysis results may be influenced by testicular volume and female age, unfortunately, the original articles did not report on these data, and that is a limitation of the current study.

Efficacy outcomes
Pregnancy rate
Seventeen studies and 2042 subjects were eligible for analyses of pregnancy rates.7,16–32 The networks are provided in the online appendix (Supplementary Figure 1). Patients who had undergone

Figure 1: A study workflow diagram.
subinguinal, inguinal microsurgery, inguinal open surgery and laparoscopic surgery had a significant advantage over those who had undergone expectant therapy in terms of pregnancy rates (OR: 3.48, 2.68, 2.92 and 2.90, respectively). However, there was no significant difference between inguinal microsurgery, inguinal open surgery, laparoscopic surgery and subinguinal varicocelectomy. The rank probability plot suggested that inguinal, subinguinal microsurgery, inguinal open surgery and laparoscopic surgery were the top four techniques (Figure 3).

**Sperm density and sperm motility**

Twelve studies with 1900 subjects, and 13 studies with 1964 subjects were included in the network meta-analysis of sperm density and sperm motility. Because Zucchi et al. reported sperm density in a median (range) form, and sperm motility in mean (s.d.) form, that study was not included in the analysis of sperm density. Figure 4 shows forest plots of each treatment assessed against expectant therapy or no treatment in terms of sperm density and sperm motility. Inguinal, subinguinal microsurgery, laparoscopic techniques ranked among the top three. Compared with retroperitoneal open surgery, inguinal microsurgery showed noticeable improvement of sperm density (mean difference (MD): 10.6, 95% confidence interval (CI): 1.92–19.6) and sperm motility (MD: 9.09, 95% CI: 4.88–13.3). Subinguinal microsurgery also improved sperm motility by 7.98% (95% CI: 2.28–11.5).

**Subgroup analysis of pregnancy rate, sperm density and sperm motility**

This subgroup analysis was restricted to men with clinical varicoceles, and abnormal semen analyses (azoospermia excluded) (Supplementary Figure 2). Patients who had undergone subinguinal and inguinal microsurgery, inguinal open surgery and laparoscopic surgery had a significant advantage over those who had undergone expectant therapy in terms of pregnancy rate. However, the precision was low. The semen parameters also demonstrated similar results. Overall, this subgroup analysis also favored inguinal and subinguinal microsurgery over other treatment, but the difference was not statistically significant due to a small number of studies.

**Adverse events outcomes**

Twenty-three studies were included in the network meta-analysis of recurrent varicocele. The odds of recurrent varicocele were significantly lower after subinguinal and inguinal microsurgery compared with retroperitoneal open surgery (OR = 0.05, 95% CI: 0.01–0.19 and OR = 0.06, 95% CI: 0.01–0.16). There were no significant differences between various other treatments and retroperitoneal varicocelectomy (Figure 5a).

Twenty-three studies with 5851 subjects were included in the network meta-analysis of overall complication (Figure 5c). The odds of overall complications, compared with retroperitoneal open varicoceletomy, were lowest for inguinal microsurgery (OR = 0.07, 95% CI: 0.02–0.19), followed by subinguinal microsurgery (OR = 0.09, 95% CI: 0.02–0.19). Inguinal open and laparoscopic surgery were associated with lower risks of overall complications. Although there was a tendency for relatively low risks of overall complications for Tauber sclerotherapy, the failure rate is not negligible.

A sensitivity analysis of the study type, and the patient age did not show any major change in recurrence, hydrocele formation, or overall complications (Supplementary Table 2). However, the difference was not statistical significant due to the small number of studies.

Overall, heterogeneity was found to be moderate, although, in the direct comparisons of overall complications, we found $I^2$ values higher than 70% for the comparisons of laparoscopic surgery and Tauber sclerotherapy ($I^2 = 79.8$%). Only three studies were included in that meta-analysis.

**DISCUSSION**

Recent meta-analyses have raised interest in the choice of treatment for varicocele. Cayan et al. reviewed pregnancy rates, recurrence and hydrocele formation rates among various techniques, and found that open microsurgical inguinal or subinguinal varicocoelectomy techniques resulted in higher pregnancy rates, and fewer recurrences and postoperative complications compared with conventional varicocoelectomy techniques in infertile men. These data are consistent with the current results.

In the current network analysis, microsurgical inguinal varicoceletomy showed a slight advantage over the subinguinal technique. Hopps et al. concluded that the anatomy using a subinguinal approach is far more complicated, and is associated with a greater number of internal spermatic veins and arteries compared with the inguinal approach. Any damage to the lymphatic drainage during the excess dissection of the cord structures may increase the possibility of hydrocele. However, the subinguinal approach still outperformed conventional open retroperitoneal surgery in terms of rates of development of hydrocele. Microsurgical inguinal surgery is technically easier, but some reports have stated that the opening of the aponeurosis of the external oblique results in more pain, and a longer recovery period.

The most important issue is whether patients with subclinical varicocele and one or more abnormal semen parameters benefit from surgical repair. A prospective randomized trial compared the effect of unilateral surgical repair of left clinical varicoceles. Subclinical varicocoelectomy had an improvement in sperm density ($P < 0.006$), and total motile sperm counts ($P < 0.008$), but had no beneficial...
Table 1: Study and patient characteristics

| Studies                        | Treatment group                                      | Sample size | Grade | Patient age (range or mean±SD) | Outcome measure                     | Design   |
|--------------------------------|------------------------------------------------------|-------------|-------|---------------------------------|-------------------------------------|----------|
| Abdel-Meguid and Othman 2010   | Subinguinal open/subinguinal micro                   | 80/82       | I–III | 34±8.5/33.7±8.77                | Complications/pregnancy rate/sperm  | RCT      |
| Abdel-Meguid et al. 2011       | Control/subinguinal micro                            | 72/73       | NA    | 20–39                           | Pregnancy rate                      | RCT      |
| Al-Kandari et al. 2007         | Laparoscopic/subinguinal open/subinguinal micro      | 40/40/40    | NA    | 14–45                           | Complications/pregnancy rate/sperm  | RCT      |
| Al-Said et al. 2008            | Laparoscopic/subinguinal micro/subinguinal open      | 94/112/92   | NA    | 20–55                           | Complications/pregnancy rate/sperm  | RCT      |
| Barbalias et al. 1998          | Retro open/Pv embolization/subinguinal open          | 20/20/20    | I–III | 22–39                           | Complications/sperm parameters      | RCT      |
| Cayan et al. 2000              | Retro open/laparoscopic                             | 232/236     | I–III | 20–35                           | Complications/pregnancy rate/sperm  | RCT      |
| Faye et al. 2010              | Tauber sclerotherapy/inguinal open/ subinguinal antegrade | 51/55/49   | NA    | Not given                       | Complications/pregnancy rate        | RCT      |
| Mansour Ghanaie et al. 2012    | Control/inguinal micro                               | 68/68/68    | I–III | 36.1±4.2/36.8±4.6               | Pregnancy rate/sperm parameters     | RCT      |
| Grasso et al. 2000             | Retro open/control                                   | 34/34/34    | I     | 30–38                           | Complications/pregnancy rate/sperm  | RCT      |
| Gontero et al. 2005            | Inguinal open/subinguinal micro                      | 50/49       | I–III | 25.4±3.6/52.8±3.6               | Complications/pregnancy rate/sperm  | RCT      |
| Madgar et al. 1995             | Control/inguinal open                                | 20/20/20    | NA    | 21–45                           | Pregnancy rate                      | RCT      |
| Nieschlag et al. 1993/1998     | Pv embolization/retro open                           | 62/62/62    | I–III | 32.8±0.5/33.1±0.4               | Complications/pregnancy rate/sperm  | RCT      |
| Nilsson et al. 1979            | Control/retro open                                   | 45/51       | NA    | 21–52                           | Pregnancy rate                      | RCT      |
| Pan et al. 2013                | Subinguinal micro/inguinal micro                     | 56/59/59    | I–III | 29.5±4.6/31.9±4.1              | Complications/pregnancy rate/sperm  | RCT      |
| Podkamenev et al. 2002         | Laparoscopic/retro open                              | 434/220     | II–III| 7–17                            | Complications                        | RCT      |
| Sautter et al. 2002            | Tauber sclerotherapy/laparoscopic                   | 35/34       | I–III | 16–45                           | Complications/pregnancy rate        | RCT      |
| Sayfan et al. 1992             | Pv embolization/retro open/inguinal open             | 36/55/55    | NA    | 23–44                           | Complications/pregnancy rate/semen  | RCT      |
| Sun et al. 2012                | Laparoscopic/retro open/inguinal open                | 51/51/51    | NA    | 13–33                           | Complications                        | RCT      |
| Telkar et al. 2012             | Control/Pv embolization                              | 15/15/15    | I–III | 18–45                           | Complications                        | RCT      |
| Yamamoto et al. 1996           | Laparoscopic/retro open                              | 45/47       | NA    | 24–37                           | Pregnancy rate                      | RCT      |
| Yavetz et al. 1992             | Retro open/Pv embolization/inguinal open             | 43/51/51    | NA    | Not given                       | Complications/pregnancy rate/sperm  | RCT      |
| Zucchi et al. 2005             | Inguinal open/Tauber sclerotherapy                  | 32/32/32    | I–III | 16–44                           | Complications/sperm parameters      | RCT      |
| Krause et al. 2002             | Tauber sclerotherapy/control/retrograde Sclerotherapy | 11/11/11    | NA    | 32.2±5.8                      | Pregnancy rate                      | RCT      |
| Ghanem et al. 2004             | Subinguinal micro/retro open                         | 304/109     | I–III | 36.7±4.9/35.8±4.3               | Complications/pregnancy rate/sperm  | Cohort   |
| Watanabe et al. 2005           | Laparoscopic/inguinal open/subinguinal micro         | 50/33/33    | I–III | 32.4±4.2/33.5±4.2/33.1±5.9      | Complications/pregnancy rate/sperm  | Cohort   |
| Shlansky-Goldberg et al. 1997  | Inguinal open/Pv embolization                        | 149/197     | NA    | 20–56                           | Complications/pregnancy rate/sperm  | Cohort   |
| Vermeulen et al. 1986          | PV embolization/control                              | 90/25/25    | I–III | 29±3.6/28.2±3.4                 | Pregnancy rate                      | Cohort   |
| Khouni et al. 2011             | Retro open/laparoscopic/Tauber sclerotherapy        | 42/41/41    | I–III | Mean age 28                     | Complications/pregnancy rate        | Cohort   |
| Abdulmaaboud et al. 1998       | Inguinal open/retrgrade Sclerotherapy/laparoscopic   | 94/120/87   | I–III | 30±7/29±5/28±5.8                | Complications/pregnancy rate        | Cohort   |
| Orhan1 et al. 2005             | Subinguinal micro/inguinal micro                     | 65/147      | NA    | 19–41                           | Complications/pregnancy rate/sperm  | Cohort   |
| Rageth et al. 1992             | Retro open/control                                  | 55/55/55    | NA    | Not given                       | Pregnancy rate                      | Cohort   |
| Beutner et al. 2007            | Laparoscopic/Tauber sclerotherapy/Pv embolization    | 122/108/126 | I–III | 9–59                            | Complications                        | Cohort   |
| May et al. 2006                | Laparoscopic/Tauber sclerotherapy                   | 122/108     | II–III| 20±8.5                         | Complications                        | Cohort   |
| Mazzoni et al. 2001            | Retro open/Tauber sclerotherapy                     | 44/44/44    | I–III | 9–18                            | Complications                        | Cohort   |
| Riccobona et al. 2003          | Laparoscopic/subinguinal open                        | 19/21/88    | II–III| 4–15                            | Complications                        | Cohort   |

Trial including male patients >30 years, demonstrated that open retroperitoneal surgery did not improve either sperm quality nor pregnancy rates. Another randomized trial compared surgical repair in infertile men with clinical left and subclinical right varicoceles. Left and bilateral repairs resulted in improvements in sperm concentration, motility, but no significant...

Retro open: retroperitoneal open; Pv embolization: percutaneous venous embolization; NA: not available; RCT: randomized clinical trial.
Surgical and radiological treatments for varicoceles

J Wang et al

Figure 3: A comparison of pregnancy rates after various surgical/radiological treatments. (a) A forest plot of pregnancy rates. (b) A rank probability plot of pregnancy rates. CI: control; emb: percutaneous venous embolization; igmi: inguinal microsurgery; igo: inguinal open; lp: laparoscopic; ro: retroperitoneal open; rScl: retrograde sclerosis; sbigm: subinguinal microsurgery; sigo: subinguinal open; Tauber. Tauber sclerotherapy; CI: confidence interval.

Figure 4: A comparison of semen parameters after various surgical/radiological treatments. (a) A forest plot of sperm density ($10^6$ ml$^{-1}$). (b) A forest plot of sperm motility (%). CI: confidence interval.

Retroperitoneal (Palomo) technique is one of the most widely used methods. However, the current study showed that it is also the least efficacious treatment, with relative high risk of recurrence and hydrolecele formation. That treatment of varicocele aims to block the internal spermatic vein. However, the external spermatic vein has been found to be dilated in 16%–74% of cases. This vein cannot be approached by retroperitoneal or laparoscopic techniques and therefore, subinguinal or inguinal approaches are preferred. In addition, varicocelectomy performed without using magnification may result in recurrence because of the difficulty in visualization of small branches of the internal spermatic vein, proven to be present radiologically.

There are several limitations to the current study. We did not investigate some important complications such as testicular atrophy, prolonged pain, epididymoorchitis. Some complications like inferior epigastric arterial bleeding, subcutaneous emphysema are only associated with laparoscopic procedures. According to Cayan et al., a pooled complication rate with laparoscopic approaches was found to be 7.45%. As for Tauber's technique, the complication rates reported were between 0% and 14%. The common complications were scrotal hematoma (1.5%–2.2%) and epididymoorchitis (0.5%–2%). Postembolization complications included contrast extravasation, vascular perforation, coil migration, and allergy to contrast agents.

Due to ethical limitations and characteristics of surgical trials, most trials were not blinded. In addition, some trials did not disclose methods of randomization. Most of RCTs included were not of good quality. With limited information, we could not evaluate the impact of the learning curve, which may have potentially biased the results. For semen parameters, many studies did not report s.d. of mean changes. We imputed missing s.d. of mean changes for each treatment using the largest s.d. reported in the set of included studies for each outcome.
As a consequence, conservative results had poor precision. Another limitation of our analysis is that the method for detecting publication bias is not well established. In one study which used a crossover design, only the data before crossover were used. The effectiveness and safety of several surgical techniques were well estimated. However, retrograde sclerotherapy was evaluated in only two trials. Thus, the result of retrograde sclerotherapy may not be as robust as that of other techniques. The studies included in the present analysis of varicocele treatment were moderately heterogeneous. Restriction to men with clinical varicoceles, an abnormal semen analysis did not lower the heterogeneity.

In patients with subfertility or abnormal sperm parameters, various surgical approaches and embolization/sclerotherapy have led to improvements in pregnancy rates, and sperm counts and motility. Inguinal and subinguinal micro-varicocelectomy had the highest pregnancy rates, and significant increases in sperm parameters. In all patients after various varicocelectomy or embolization/sclerotherapy, inguinal and subinguinal micro-varicocelectomy were associated with low odds of recurrence, hydrocele formation and overall complications. Tauber antegrade sclerotherapy was associated with lower odds of recurrence, hydrocele formation and overall complications. Larger properly conducted RCTs of varicocelectomy in men with varicocele and sperm defects are needed to confirm these results.

Figure 5: A comparison of complications after various surgical/radiological treatments. (a) A forest plot of recurrence of varicoceles. (b) A forest plot of hydrocele formation. (c) A forest plot of overall complications. CI: confidence interval.

As a consequence, conservative results had poor precision. Another limitation of our analysis is that the method for detecting publication bias is not well established. In one study which used a crossover design, only the data before crossover were used. The effectiveness and safety of several surgical techniques were well estimated. However, retrograde sclerotherapy was evaluated in only two trials. Thus, the result of retrograde sclerotherapy may not be as robust as that of other techniques. The studies included in the present analysis of varicocele treatment were moderately heterogeneous. Restriction to men with clinical varicoceles, an abnormal semen analysis did not lower the heterogeneity.

In patients with subfertility or abnormal sperm parameters, various surgical approaches and embolization/sclerotherapy have led to improvements in pregnancy rates, and sperm counts and motility. Inguinal and subinguinal micro-varicocelectomy had the highest pregnancy rates, and significant increases in sperm parameters. In all patients after various varicocelectomy or embolization/sclerotherapy, inguinal and subinguinal micro-varicocelectomy were associated with low odds of recurrence, hydrocele formation and overall complications. Tauber antegrade sclerotherapy was associated with lower odds of recurrence, hydrocele formation and overall complications. Larger properly conducted RCTs of varicocelectomy in men with varicocele and sperm defects are needed to confirm these results.
inguinal approach, scrotal sclerotherapy and subinguinal antegrade sclerotherapy in varicocele treatment: a randomized prospective study. Urol Int 2010; 85: 200–3.

22. Mansour Ghaeani M, Asgari SA, Dadrass N, Allahkhah A, Iran-Pour E, et al. Effects of varicocele repair on spontaneous first trimester miscarriage: a randomized clinical trial. Urol J 2012; 9: 505–13.

23. Grasso M, Lania C, Castelli M, Galli L, Francesco F, et al. Low-grade left varicocele in patients over 30 years old: the effect of spermatic vein ligation on fertility. BJU Int 2000; 85: 305–7.

24. Krause W, Müller HH, Schäfer W, Weidner W. Does treatment of varicocele improve male fertility? Results of the ‘Deutsche Varikolestenlehre’, a multicentre study of 14 collaborating centres. Andrologia 2002; 34: 164–71.

25. Madgar I, Weissenberg R, Lunenfeld B, Karasik A, Goldwasser B. Controlled trial of high spermatic vein ligation for varicocele in infertile men. Fertil Steril 1995; 63: 120–4.

26. Nieszchlag E, Behre HM, Schlimgheider A, Nashan D, Pohl J, et al. Surgical ligation vs angiographic embolization of the vena spermatica: a prospective randomized study for the treatment of varicocele-related infertility. Andrologia 1993; 25: 233–7.

27. Nieszchlag E, Hertle L, Fischdeck A, Abshagen K, Behre HM. Update on treatment of varicocele: counselling as effective as occlusion of the vena spermatica. Hum Reprod 1998; 13: 2147–50.

28. Pan F, Pan L, Zhang A, Liu Y, Zhang F, et al. Comparison of two approaches in microsurgical varicocelectomy in Chinese infertile males. Urol Int 2013; 90: 443–8.

29. Sayfan J, Soffer Y, Orda R. Varicocele treatment: prospective randomized trial of 3 methods. J Urol 1992; 148: 1447–9.

30. Yamamoto M, Hibi H, Hirata Y, Miyake T, Ishigaki T. Effect of varicocelectomy on sperm parameters and pregnancy rate in patients with subclinical varicocele: a randomized prospective controlled study. J Urol 1996; 155: 1636–8.

31. Yavetz H, Levy R, Papo J, Yoge V, Paz G, et al. Efficacy of varicocele embolization versus ligation of the left internal spermatic vein for improvement of sperm quality. Int J Androl 1992; 15: 338–44.

32. Nilsson S, Edvinsson A, Nilsson B. Improvement of semen and pregnancy rate after ligation and division of the internal spermatic vein: fact or fiction? Br J Urol 1979; 51: 591–6.

33. Sun HB, Liu Y, Yan MB, Li ZD, Gui XG. Comparing three different surgical techniques used in adult bilateral varicocele. Asian J Endosc Surg 2012; 5: 12–6.

34. Song T, Wang CY, Zhang L, Zhang F, Chen WZ, et al. Microscopic versus laparoscopic varicocelectomy in the treatment of varicocele: effects and complications. Zhonghua Nan Ke Xue 2012; 18: 335–8.

35. Barbálas GA, Liatsikos EN, Nikiforidis G, Siablis D. Treatment of varicocele for male infertility: a comparative study evaluating currently used approaches. Eur Urol 1998; 34: 393–9.

36. Zucchi A, Mearini L, Mearini E, Costantini E, Bini V, et al. Treatment of varicocele: randomized prospective study on open surgery versus Tauber antegrade sclerotherapy. J Androl 2005; 26: 328–32.

37. Podkamenev VV, Stalnakhovich VN, Urkov PS, Soloviev AA, Iljin VP. Laparoscopic surgery for pediatric varicoceles: randomized controlled trial. J Pediatr Surg 2002; 37: 727–9.

38. Sautter T, Sulser T, Suter T, Gretener H, Hauser D. Treatment of varicocele: a prospective randomized comparison of laparoscopy versus antegrade sclerotherapy. Eur Urol 2002; 41: 398–400.

39. Watanabe M, Nagai A, Kusunmi N, Tsuobi H, Nasu Y, et al. Minimal invasiveness and effectiveness of subinguinal microscopic varicocelectomy: a comparative study with retroperitoneal high and laparoscopic approaches. Int J Urol 2005; 12: 892–8.

40. Khouni H, Bouchiba N, Khelfa MM, Ben Ali M, Sebai A, et al. Treatment of idiopathic varicocele: comparative study of three techniques about 128 cases. Tunis Med 2011; 89: 929–34.

41. Orhan RO, Sermeciz A, Firdolas F, Ardicoglu A, Koksal I. Comparison of two different microsurgical methods in the treatment of varicocele. Syst Biol Reprod Med 2005; 51: 213–20.

42. Abdulmaaboud MR, Shokeir AA, Farage Y, Abd El-Rahman A, El-Rakhawy MM, et al. Treatment of varicocele: a comparative study of conventional open surgery, percutaneous retrograde sclerotherapy, and laparoscopy. Urol Int 1998; 52: 294–300.

43. Riccobona M, Oswald J, Keen M, Lusuardi L, Radmayr C, et al. Optimizing the operative treatment of boys with varicocele: sequential comparison of 4 techniques. J Urol 2003; 169: 666–8.

44. Ghantem H, Anis T, El-Nashar A, Shamloiu R. Subinguinal microvaricocelectomy versus retroperitoneal varicocelectomy: comparative study of complications and surgical outcome. Urology 2004; 64: 1005–9.

45. Beutner S, May M, Hoschke B, Heike C, Lein M, et al. Treatment of varicocele with reference to age: a retrospective comparison of three minimally invasive procedures. Surg Endosc 2007; 21: 61–5.

46. May M, Johannsen M, Beutner S, Heike C, Braun KP, et al. Laparoscopic surgery versus antegrade scrotal sclerotherapy: retrospective comparison of two different approaches for varicocele treatment. Eur Urol 2006; 49: 384–7.

47. Mazzoni G, Spagnoli A, Lucchetti MC, Villa M, Capitanucci ML, et al. Adolescent varicocele: Tauber antegrade sclerotherapy versus Palomo repair. J Urol 2001; 166: 1462–4.

48. Telkar S, Goudar BV, Lamani YP, Ambi U, Koppal R. Laparoscopic versus open varicocelectomy: a prospective study. J Clin Diagn Res 2012; 6: 271–3.

49. Cortero P, Pretti G, Fontana F, Zitella A, Marchioro G, et al. Inguinal versus subinguinal varicocele vein ligation using magnifying loupe under local anesthesia: which technique is preferable in clinical practice? Urol Int 2005; 66: 1075–9.

50. Cayan S, Shavakhabov S, Kadioglu A. Treatment of palpable varicocele in infertile men: a meta-analysis to define the best technique. J Androl 2009; 30: 33–40.

51. Hopp CV, Lemer ML, Schlegel PN, Goldstein M. Intraoperative varicocelectomy: a microscopic study of the inguinal versus subinguinal approach. J Urol 2003; 170: 2366–70.

52. Zheng YQ, Gao X, Li ZJ, Yu YL, Zhang ZG, et al. Efficacy of bilateral and left varicocelectomy in infertile men with left clinical and right subclinical varicoceles: a comparative study. Urology 2009; 73: 1236–40.

53. Bзаzem A, Belzile E, Ciampi A, Kohle G, Jari K, et al. Varicocele and male factor infertility treatment: a new meta-analysis and review of the role of varicocele repair. Eur Urol 2011; 60: 796–808.

54. Liang Z, Guo J, Zhang H, Yang C, Pu J, et al. Lymphatic sparing versus lymphatic non-sparing laparoscopic varicocelectomy in children and adolescents: a systematic review and meta-analysis. Eur J Pediatr Surg 2011; 21: 147–53.

55. Beck EM, Schlegel PN, Goldstein M. Intraoperative varicocelectomy anatomy: a macroscopic and microscopic study. J Urol 1992; 148: 1190–4.

56. Murray RR Jr, Mitchell SE, Kadir S, Kaufman SL, Chang R, et al. Comparison of recurrent varicocele anatomy following surgery and percutaneous balloon occlusion. J Urol 1986; 135: 286–9.

57. Shalskyn-Goldberg RD, Vanarsdal LN, Rutter CM, Soulen MC, Haskal ZJ, et al. Percutaneous varicocele embolization versus surgical ligation for the treatment of infertility: changes in seminal parameters and pregnancy outcomes. J Vasc Interv Radiol 1997; 8: 759–67.

58. Vermeulen A, Vandeweghe M, Deslypere JP. Prognosis of subfertility in men with corrected or uncorrected varicocele. J Androl 1986; 7: 147–55.

59. Rageth JC, Unger C, DaRugna D, Steffen R, Stucki D, et al. Long-term results of varicocelectomy. Urol Int 1992; 48: 327–31.