



# Laparoscopic vs open varicocelectomy in children and adolescents: review of the recent literature and meta-analysis

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## Abstract

**Purpose:** Laparoscopic varicocelectomy has gained popularity in recent years. The aim of this study was to identify clinical evidence about the reliability of this technique in the recent literature.

**Methods:** We performed a Medline search for articles published during the last 10 years, using the key words “varicocele,” “treatment,” and “adolescent.” As limits, we used last 10 years, adolescent, clinical trials, randomized controlled trials, meta-analysis, and multicenter retrospective and prospective studies. The results were investigated in recurrence and hydrocele formation.

**Results:** We pooled 37 studies, but 26 of these were excluded because they were neither relevant nor concerned an adolescent population. Meta-analysis showed that there was no statistical difference between laparoscopic surgery and open surgery in recurrence rate and postoperative hydrocele rate. In the laparoscopic group, the incidence of recurrence was higher in the patients undergoing artery ligation compared to patients undergoing artery and venous ligation. Furthermore, a lower rate of postoperative hydrocele was recorded in patients undergoing dye injections before laparoscopic ligation.

**Conclusions:** Meta-analysis and literature analysis showed that the results after laparoscopic varicocelectomy are comparable to other surgical procedures. The laparoscopic approach has the advantage to treat simultaneously bilateral varicocele.

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Varicocele is generally considered the most common correctable cause of male infertility [1,2]. It is indicated as a factor in about one third of infertile males, being associated

with testicular atrophy and abnormal seminal factors [3]. Varicocele occurs in 10% to 15% of children and adolescents [4,5]. Several treatment options have been used, including spermatic vein sclerotherapy or embolization, open inguinal ligation of the spermatic vein, subinguinal microscopic varicocelectomy, and, most recently, laparoscopy, but the ideal method for varicocele treatment is still controversial

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[6-8]. The ideal procedure should perform a varicocelectomy with a low rate of recurrence, hydrocele formation, and testicular atrophy. The indication for varicocelectomy includes testicular volume discrepancy, chronic scrotal pain, and infertility. Meta-analysis is a useful statistical tool that can be used to compare and integrate different studies in both a qualitative and quantitative way, considering variations in characteristics that can influence the overall estimate of the outcome of interest. To our knowledge, there is no meta-analysis that compares the various techniques for varicocele treatment in children. The only one found in literature concerns adult patients [9]. Recently, a systematic review of surgical treatment of varicocele in children with open and laparoscopic Palomo's technique has been published, but results have not been analyzed with the meta-analysis method [10]. The aim of our study is to identify clinical evidence on the reliability of the laparoscopic technique compared to the open techniques, with the end points of recurrence rate and hydrocele formation. Because Palomo's laparoscopic technique is the most widely used method, this will be compared to the open inguinal techniques, unless otherwise specified in the meta-analysis.

## 1. Material and methods

A literature search was performed, using Medline and Pubmed database, on all articles published during the last 10 years (2000-2009), reporting on varicocele treatments. The following key words were used: "varicocele," "treatment," and "adolescent." Searches were also performed using the following as limits: last 10 years, adolescent, clinical trials, randomized controlled trials, meta-analysis, and multicenter retrospective and prospective studies. Articles with data regarding recurrence, complications (hydrocele, hypotrophy, atrophy), and, if available, semen parameters after treatment were analyzed. We recorded 37 studies, but 26 of these were excluded from our analysis using the following criteria:

- (1) studies that were not relevant, in which outcome of interest were not reported or were impossible to calculate from the results; and
- (2) studies not concerning an adolescent population.

Eleven studies published between 2000 and 2009 matched the inclusion criteria, comparing varicocele treatments in the adolescent population and reporting the incidence of complications. We separated these studies into multicentric studies, randomized trials, and clinical trials. The results of continuous variables were reported as mean  $\pm$  SD, and the statistical difference was calculated using the Student's *t* test. The statistical difference of percentages was calculated by Pearson's  $\chi^2$ . Statistical analysis for categorical variables was carried out using the odds ratio as the summary statistic. This ratio represents the odds of an adverse event occurring in a treatment compared with the reference group.

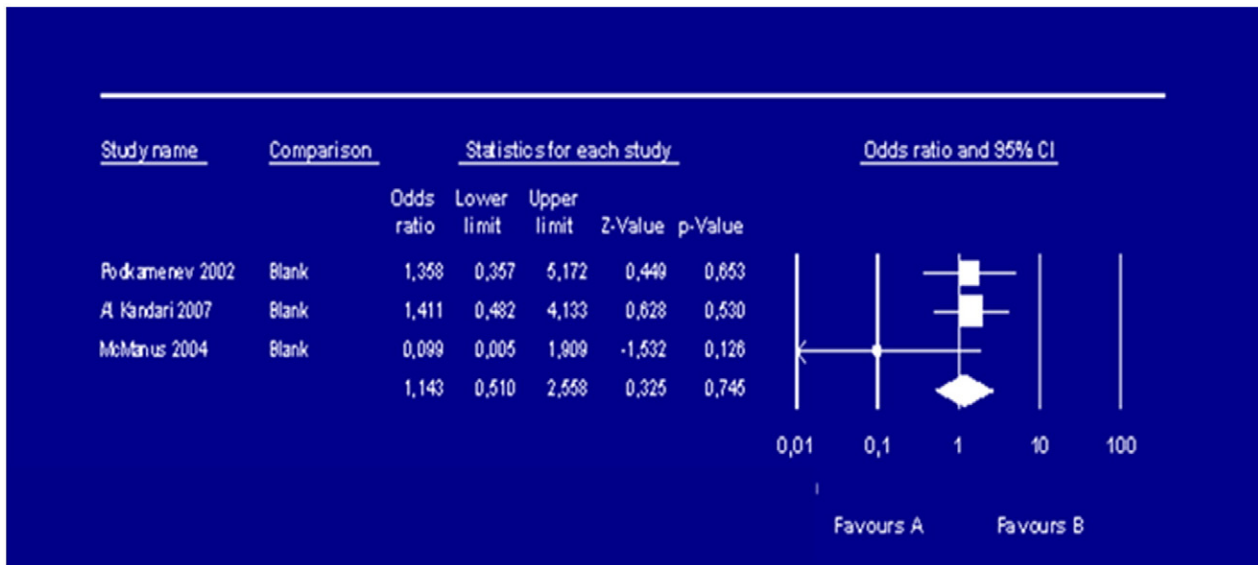
An odds ratio of less than 1 favors the treatment group, and the point estimate of the odds ratio was considered statistically significant at  $P < .05$  if the confidence interval does not include the value 1.

## 2. Results

Eleven studies published between 2000 and 2009 matched the inclusion criteria, comparing varicocele treatments in the pediatric population, and reporting the incidence of complications. Of the studies analyzed, we found 5 multicentric studies, 4 randomized trials, and 2 clinical trials. We first considered all studies that showed a population of 1443 children and adolescents (age, 6-17 years; mean age, 14.62 years) who underwent varicocelectomy by laparoscopic (LS) and open techniques (OS). The results, globally considered, demonstrated a recurrence rate of 4.7% and hydrocele formation in 9.5% of patients. Varicocele recurrence was evaluated in adolescents who underwent LS vs OS, and there was no statistical difference between the 2 groups ( $4.7\% \pm 6.5\%$  vs  $8.6\% \pm 6.4\%$ ;  $P =$  not significant). Similar results were obtained analyzing the recurrence of postoperative hydrocele. Hydrocele incidence was  $9.5\% \pm 7.1\%$  for LS and  $6.7\% \pm 6.7\%$  for OS ( $P =$  not significant). Because of nonhomogeneous studies, we could not apply the meta-analysis method to all studies simultaneously, but we analyzed different meta-analysis grouping studies with similar features. Recurrence rate in the first meta-analysis, including 3 studies, is not significantly different between adolescents treated with LS (ligation of both veins and artery) vs OS, showing an odds ratio of 1.143 and a  $P$  value that is not statistically significant (Fig. 1). Comparing the postoperative recurrence rate in adolescents undergoing laparoscopic ligation of the veins alone according to Ivanissevich's procedure vs ligation of the veins and the artery according to Palomo's technique, meta-analysis reveals a lower incidence of recurrence in patients undergoing ligation of the veins and artery obtaining an odds ratio of 4.086 and  $P = .003$  (Fig. 2). There is no significant difference between LS and OS regarding the postoperative hydrocele rate with an odds ratio of 1.091 and the  $P$  value is not significant (Fig. 3). Finally, the meta-analysis shows a lower rate of postoperative hydrocele in patients undergoing dye injection before laparoscopic ligation for lymphatic identification with an odds ratio of 0.083 and  $P = .020$  (Fig. 4).

## 3. Discussion

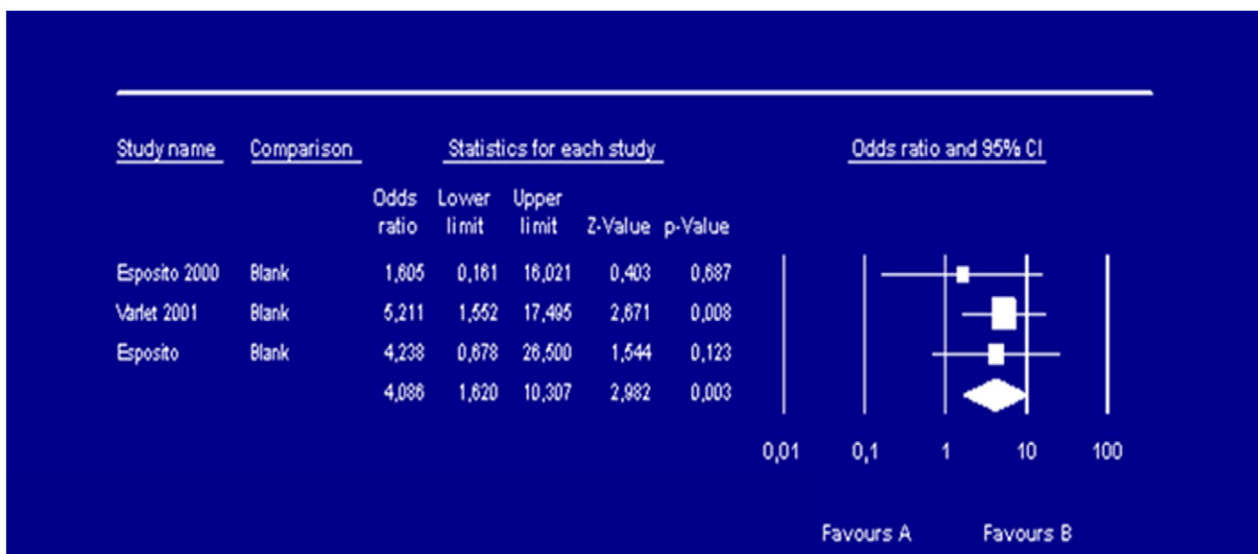
Varicocele has an adverse effect on the histologic, endocrine, and biochemical testis function [11]. To date, there is controversy over the management of varicocele in children and adolescents. The variety of treatment options



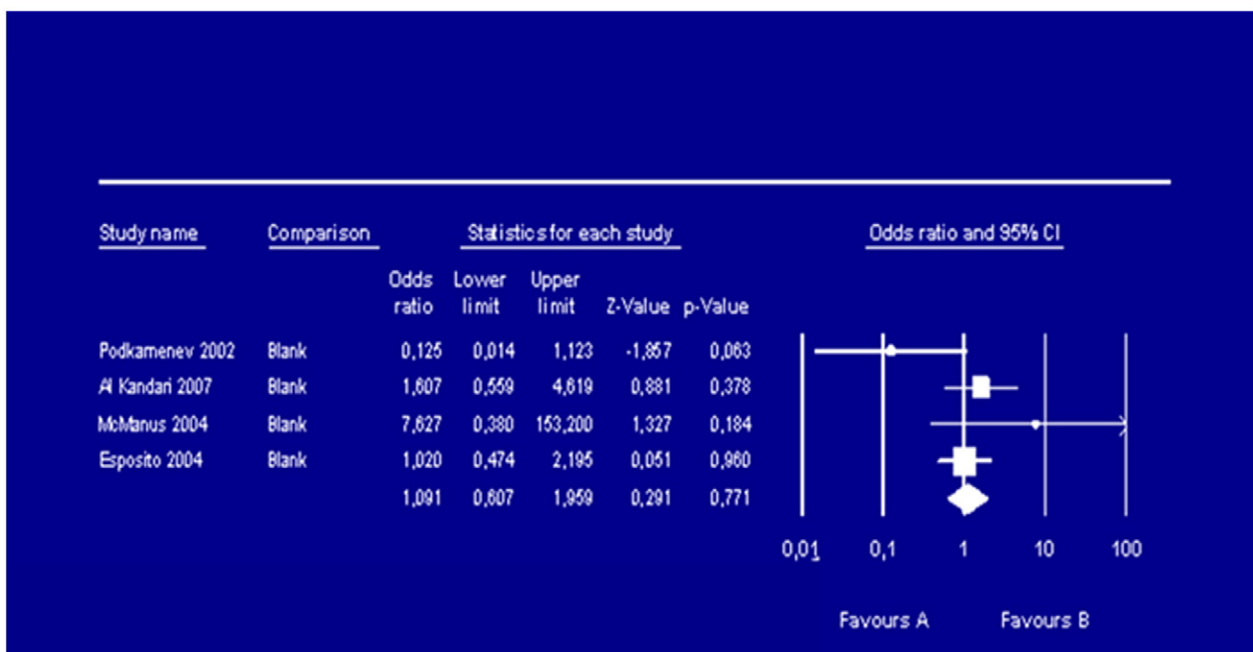
**Fig. 1** Meta-analysis comparing recurrence rate between adolescents treated with LS (A) vs OS (B). Recurrence rate is not significantly different between adolescents treated with LS (ligation of both veins and artery) vs OS.

indicates that the ideal technique to manage this pathologic condition has not yet been determined. The laparoscopic approach for varicocelectomy was introduced into clinical practice in early 1990s [12], and during the last decade, this procedure has gained popularity especially in children because it is a minimally invasive simple and safe technique. The surgical approach for adults is often an “open” procedure. The main reason is the possibility to perform the operation under local anesthesia, whereas each surgical approach in children requires general anesthesia. Another advantage of the laparoscopic approach is the possibility of simultaneously treating bilateral varicocele. The major complications after varicocelectomy are postoperative hydrocele and recurrence. In a recent randomized

clinical trial comparing open inguinal, laparoscopic, and subinguinal microscopic varicocelectomy, Al-Kandari et al [13] demonstrated that the subinguinal microsurgical technique offers the best outcome in hydrocele formation and varicocele recurrence, but the duration of the operation is usually longer. Podkamenev et al [14] in a randomized controlled trial compared laparoscopic varicocelectomy, performed in 434 patients, to open varicocelectomy, performed in 220 patients, both after injection of methylene blue under the tunica albuginea. He considered Palomo’s procedure with lymphatic sparing to be the most effective for varicocele treatment in children and adolescents. In a recent study comparing the laparoscopic approach to microscopic subinguinal approach, McManus et al [15]



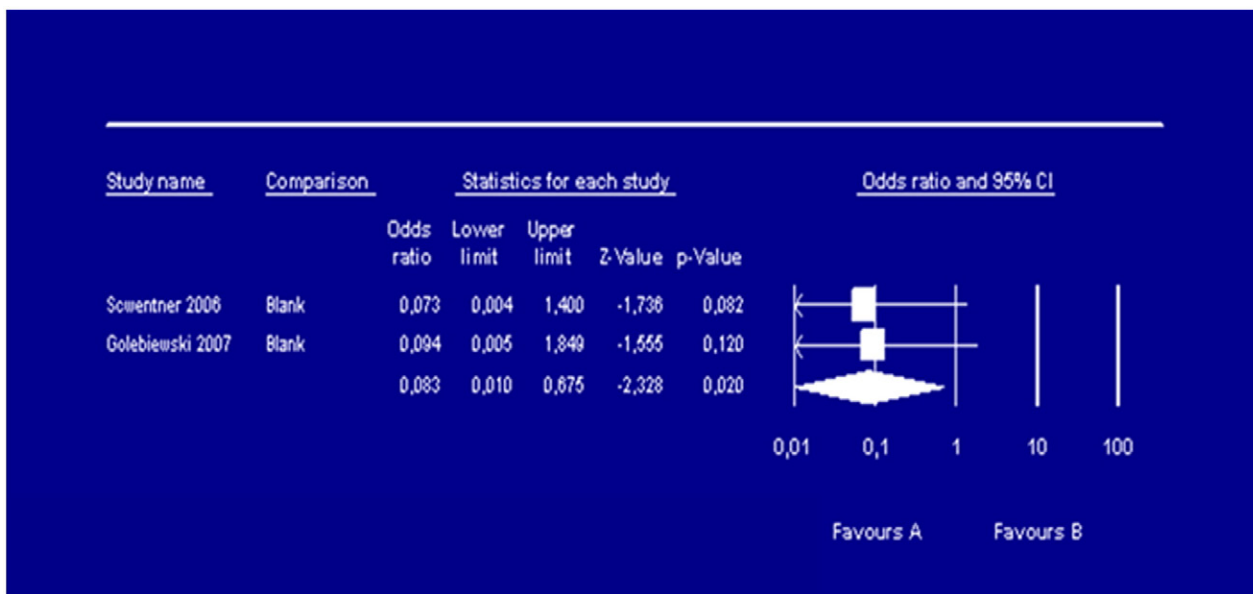
**Fig. 2** Meta-analysis comparing recurrence rate in ligation of the veins alone (A) vs ligation of the veins and the artery (B). Meta-analysis shows less incidence of recurrence rates in patients undergoing ligation of the veins and the artery.



**Fig. 3** Meta-analysis comparing postoperative hydrocele formation between adolescents who underwent LS (A) vs OS (B). Meta-analysis reveals no significant difference between LS and OS.

treated 72 patients divided into 2 groups (postpubertal adolescents and adults) and observed a comparable rate of complications in both techniques. Kocvara et al [16] demonstrated interstitial edema and local reduced spermatogenesis with desquamation of the germinal epithelium, atrophy, and Sertoli cell only pattern in up to 16% of the seminiferous tubules on testicular biopsy after varicocelectomy. He, therefore, concluded that dividing the lymphatic vessels can aggravate testicular function and interfere with the hypothalamic-pituitary-testicular axis. He

affirmed that lymphatic sparing is important not only to prevent postoperative hydrocele but also to optimize testicular function. Schwentner et al [17] and Golebiewski et al [18] confirmed the utility of applying a dye (isosulfan blue) before a laparoscopic Palomo’s procedure in identifying and sparing the lymphatic vessels that drain the testis and minimizing the risks of postoperative hydrocele and testicular dysfunction. They preferred the isosulfan blue dye in the study because it is cheap and its use is well established in clinical practice [19]. Tan et al



**Fig. 4** Meta-analysis regarding postoperative hydrocele using dye (A) in LS vs not using dye (B). There is a lower rate of postoperative hydrocele in patients who underwent dye injection before laparoscopic ligation.

[20] and Barot et al [21] described the technique of in vivo methylene blue mapping of testicular lymphatic vessels during laparoscopic varicocelectomy. However, methylene blue dye can cause local complications such as skin and fat necrosis because of its tissue-reactive properties. Esposito et al [22], in a multicentric study concerning the laparoscopic treatment of pediatric varicocele, investigated the outcomes in hydrocele formation and varicocele recurrence in 161 children comparing Ivanissevich procedure (venous ligation only) in 38 patients with the Palomo's technique (artery and venous ligation) in 133 patients. They affirm that, although the postoperative hydrocele rate after Palomo's procedure cannot be ignored, this technique is preferable to the ligation of the veins only because of the higher varicocele recurrence rate. In 2001, comparing the results and complications of laparoscopic surgery in the treatment of varicocele, Esposito et al [23] did not identify any cases of testicular hypotrophy or atrophy using Palomo's technique, explaining that the collateral blood supply to the testis comes from the gubernaculum, the anterior and posterior scrotal vessels, the intrascrotal anastomosis, and the deferential vessels and concluding that the laparoscopic approach is comparable to other procedures in recurrence and complication rates. The same author analyzed the outcome after surgical treatment of varicocele in 278 children by laparoscopic approach [18] and 91 by the open inguinal approach [24]. The hydrocele rate was higher after no-sparing artery vs artery sparing technique (17.6% vs 4.3%), whereas no differences were found between LS and OS. Finally, the Group d'Etudes en Coeliocirurgie Infantile in 2001 reported a multicenter prospective study with an excellent success rate without evidence of testicular atrophy after laparoscopic ligation of the entire vascular spermatic pedicle in 60 vs 28 patients in whom artery was not ligated [25]. As previously mentioned, meta-analysis has not been used in the past to compare the various techniques for varicocele treatment in children. In our first meta-analysis, including 3 studies (Podkamenev [14], Al-Kandari [13], McManus [15]), the recurrence rate is similar between adolescents treated with LS (ligation of both veins and artery) vs OS showing an odds ratio of 1.143 and a *P* value that was not significant. Comparing the postoperative recurrence rate in adolescents undergoing LS according to Ivanissevich's procedure vs Palomo's technique, the second meta-analysis regarding other 3 studies (Esposito [22], Varlet [25], Esposito [23]) revealed a lower recurrence rate in patients undergoing ligation of the veins and artery obtaining an odds ratio of 4.086 and *P* = .003. In the third meta-analysis, we analyzed 4 studies evaluating the incidence of postoperative hydrocele (Podkamenev [14], Al-Kandari [13], McManus [15], Esposito [24]). This included 1124 boys and compared LS (ligation of both veins and artery) vs OS. Meta-analysis showed no significant difference between LS and OS for the postoperative hydrocele rate with odds ratio of 1.091 and *P* value that was not significant. Finally, there

is a significantly lower rate of postoperative hydrocele in patients subjected to dye injection for lymphatic identification in LS vs patients without dye injection, with an odds ratio of 0.083 and *P* = .020.

From the analysis performed in our study, results after laparoscopic technique are similar to that after open inguinal approaches (grade A level of evidence 1C). The injection of blue dye before laparoscopic ligation significantly reduces the incidence of hydrocele formation (grade A level of evidence 1C). Ligation of both artery and veins during laparoscopic varicocelectomy significantly reduces the recurrence rate (grade A level of evidence 1C).

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