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# Two decades of experience with laparoscopic varicocele repair in children: Standardizing the technique

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## Summary

### Background
Controversy still exists about the indications and the gold standard approach for varicocele treatment in pediatric population.

### Objective
The authors report their 23 years of experience in laparoscopic varicocele repair in the pediatric population.

### Study design
We retrospectively evaluated the data of 345 consecutive patients who underwent laparoscopic left varicocelectomy from January 1993 to December 2015. Average patient age was 12.5 years (range 8—17). Seven out of 345 patients (2%) had a recurrent varicocele, and five out of 345 patients (1.4%) had a varicocele on a single testis. In 335/345 patients (97.1%) we performed a Palomo procedure, and in 10/345 patients (2.9%) an artery-sparing Palomo procedure. After 2010, in 105/345 patients (30.4%) we performed a lymphatic sparing procedure using isosulfan blue injection preoperatively.

### Results
All procedures were completed in laparoscopy (Figure), without conversions or intraoperative complications. The average operative time was 17 min (range 14—45) for the Palomo procedure and 26 min (range 18—50) for artery-sparing Palomo. In 45/345 patients (13%) we performed additional procedures. We recorded 4/345 (1.3%) recurrences/persistences in patients undergoing Palomo, while we recorded 1/10 (10%) recurrence/persistence after artery-sparing Palomo. On 230 Palomo procedures performed in the pre-isosulfan blue era, we recorded 25 cases of hydrocele (10.8%), 13 of these were treated with transcrotal puncture and 12 required surgical operation. The last 105 patients undergoing isosulfan blue injection had no postoperative hydrocele. We also reported 10 other complications (I grade Clavien-Dindo) such as umbilical granuloma or instrumental problems.

### Discussion
Analyzing the international literature of the last 25 years, most papers focused on the minimally invasive treatment of pediatric varicocele. There are several reasons to perform laparoscopic repair of pediatric varicocele. First of all, it is technically easy to perform, the average operative time is very short, and it has excellent outcome in regard to varicocele persistence/recurrence. In addition it has a very low complication rate, and in particular adopting the intradartoic/intratesticular isosulfan blue injection before surgery we recorded no postoperative hydrocele.

### Conclusion
On the basis of our 23 years of experience with varicocele repair, we clearly believe that laparoscopic Palomo lymphatic sparing varicocelectomy should be considered the standard of care for the treatment of pediatric patients with varicocele. Laparoscopic varicocelectomy is technically easy and quick to perform, painless, and scarless, with a recurrence rate of about 1%. The use of a preoperative injection of isosulfan blue completely eliminates postoperative hydrocele formation.

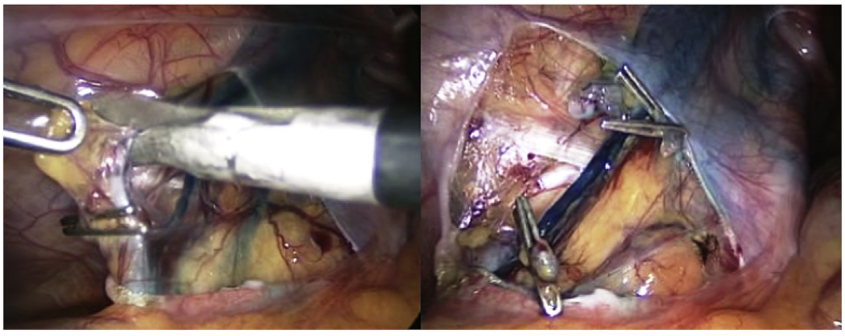

**Figure** Palomo procedure: bundle is clipped and sectioned and the blue-colored lymphatics are spared.

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## Introduction

Varicocele is considered to be one of the most common causes of male infertility [1]. With a prevalence varying between 15% and 25% in the adolescent population, varicocele presence can impair testicular function causing testicular hypotrophy with a long-term negative impact on spermatogenesis [2]. In semen analyses in patients with a high grade varicocele, there is a lower sperm density, lower sperm motility, and sperm morphological anomalies [3]. After varicocele repair, several studies have reported a catching-up in growth of the hypotrophic testis in about 40%–100% of patients and an improvement in semen density and motility [4,5]. For this reason, the importance of early treatment in childhood for preventing testicular damage is widely accepted [6].

One of the major challenges in management of adolescent varicocele is determining which patients would benefit most from varicocelectomy and at what age. The recommended indication criteria for varicocele repair in children and adolescents are well established and widely accepted. They are: varicocele associated with a persistent testicular size discrepancy of greater than 20%, varicocele patients presenting an additional condition that affects fertility, bilateral palpable varicocele, symptomatic varicocele, and varicocele associated with abnormal semen analysis (in older adolescents) [7].

However, the treatment of varicocele in children and adolescents is not without risks, including persistence or recurrence of varicocele (1–18%), formation of hydrocele (1–29%), and injury to the testicle affected [8–10].

Different treatment options employing surgical, radiologic, or combined methods have been described and no gold standard has yet been established [11]. Several techniques have been proposed being lymphatic sparing or artery sparing, and debate remains on whether to approach the varicocele in an open inguinal, laparoscopic, or percutaneous manner [12–14].

Analyzing the international literature of the last 25 years, most papers are focused on the minimally invasive treatment of pediatric varicocele using laparoscopy [15–17]. In this study, the authors report their experience in laparoscopic varicocele repair, analyzing their 23 years of experience with this procedure.

## Patients and methods

In our pediatric surgery unit we started to adopt laparoscopy for the treatment of pediatric pathologies at the beginning of the 90s. With the aim of standardizing the surgical repair of varicocele using MIS, we retrospectively reviewed the data of 345 consecutive patients who underwent laparoscopic left varicocelectomy from January 1993 to December 2015 at our unit. Patient age varied between 8 and 17 years (average age 12.5 years).

In 335/345 patients (97.1%) a Palomo procedure was performed, and in 10/345 patients (2.9%) an artery-sparing Palomo procedure was accomplished.

Three-hundred and thirty-eight (98%) out of 345 patients had a primary varicocele, and 7/345 (2%) had a recurrent varicocele, after prior ipsilateral inguinal surgery performed in other institutions. Five out of 345 patients (1.4%) had a varicocele on a single testis, as they had already received a right orchiectomy. No bilateral pathology was recorded in our series.

Indications for varicocelectomy included high degree varicocele (Grade II or Grade III according to the Dubin clinical classification), with a left testicular hypotrophy defined as 20% volume or greater differential between testicles or associated symptoms such as testicular pain/discomfort on the left side.

For the preoperative work-up, all the children received a testicular ultrasound (US) to assess the testicular volume and a testicular venous Doppler to assess the venous reflux.

Testicular volume was measured ultrasonographically using the formula: 0.71 × Length × Width × Height. The preoperative mean left testicular volume was significantly less than the right side in all patients ($p < 0.001$). All patients' characteristics are reported in Table 1.

In five patients with a single testis we performed a cryoconservation of the semen before surgery.

In regard to follow-up, we saw patients 1 week postoperatively for surgical wound check. Clinical controls were performed thereafter at 1, 6, and 12 months after surgery and then annually, assessing for varicocele persistence or recurrence or development of new onset hydrocele. Testicular US was repeated when possible. The study received the appropriate institutional review board (IRB) approval.

**Table 1** Patients' characteristics and outcome parameters.

| Characteristic/outcome parameter | Palomo ($n = 335$) | Artery-sparing palomo ($n = 10$) | $p$ value |
|---|---|---|---|
| Age, years | 11.8 ± 3.6 | 13.2 ± 2.3 | 0.28 |
| Varicocele grade | 269 Grade III, 66 Grade II | 10 Grade III | 0.65 |
| Preoperative left testis volume (mL) | 12.0 ± 5.2 | 12.4 ± 4.9 | 0.38 |
| Preoperative right testis volume (mL) | 16.1 ± 6.5 | 15.9 ± 6.3 | 0.28 |
| Postoperative left testis volume (mL) | 15.4 ± 4.8 | NA | NA |
| Postoperative right testis volume (mL) | 17.2 ± 4.0 | NA | NA |
| Operative time, minutes | 17 [14–45] | 26 [18–50] | <0.001 |
| Recurrence/persistence | 4 (1.1%) | 1 (10%) | <0.001 |
| Postoperative hydrocele | 23 (6.8%) in pre isosulfan blue era | 2 (20%) in pre isosulfan blue era | <0.001 |
| Other complications | 10 (2.9%) | 0 | <0.001 |

NA = not available.
The data are presented as mean ± SD. The numbers in square brackets are range values.

**Figure 1** Preoperative intradartoic/intratesticular injection of isosulfan blue permits identification of the lymphatic vessels in 100% of cases. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Statistical analysis included Student *t* test and chi-square test for continuous and categorical variables, respectively. A *p* value less than 0.05 was considered to be statistically significant.

## Surgical technique

All the procedures were performed under general anesthesia with oro-tracheal intubation. For the technical point of view, we always adopted three trocars. A 5 mm to 10 mm umbilical trocar for the 0° optic was always introduced in open laparoscopy and two other 5 mm working trocars were placed in triangulation. The posterior peritoneum covering the inner spermatic vessels (ISV) was opened using the monopolar hook for about 2 cm at least at 3—4 cm away from the internal inguinal ring. This distance is important because after sectioning the ISV you spare the collateral circulation between deferential vessels and the last 3—4 cm of spermatic vessels to permit the testis to survive well vascularized according to the Fowler-Stephens principle. A window was then created behind the ISV and the vessels were clipped and sectioned according to the technique planned preoperatively (sparing the testicular artery in artery-sparing Palomo procedure or clipping and sectioning all the bundle in Palomo procedure).

After 2010, in 105/345 patients (30.4%) we performed a lymphatic sparing procedure using isosulfan blue injection preoperatively. This technique, as we already described in a previous paper [18], consists of injecting preoperatively, before the insertion of the first trocar, a solution of 0.5 mL of isosulfan blue and of 2 mL of saline solution (Fig. 1). We already standardized the technique of injection to obtain visualization of the lymphatics in 100% of cases; in fact, we always inject 1.5 mL of isosulfan blue solution in the testicular dartos and 1 mL inside the testis. Using this technique the lymphatics appear blue colored in 100% of cases. After preoperative intradartoic/intratesticular injection of isosulfan blue, we can usually identify four to five lymphatic vessels along the bundle. There are usually at least two posterior lymphatics that are easy to spare. From our findings it is enough to spare at least two to three lymphatics to avoid hydrocele formation postoperatively (Fig. 2). It is important to inform the parents that the urine will be blue/green colored for 24—48 h after surgery.

The trocar orifices were always closed using resorbable stitches, steri-strips, or glue.

## Results

All procedures were completed in laparoscopy without conversions to open surgery or intraoperative complications. The procedures were performed by two senior surgeons and three trainees of our surgical team.

Operative time varied between 14 and 45 min (average time 17 min) for Palomo procedures whereas it varied

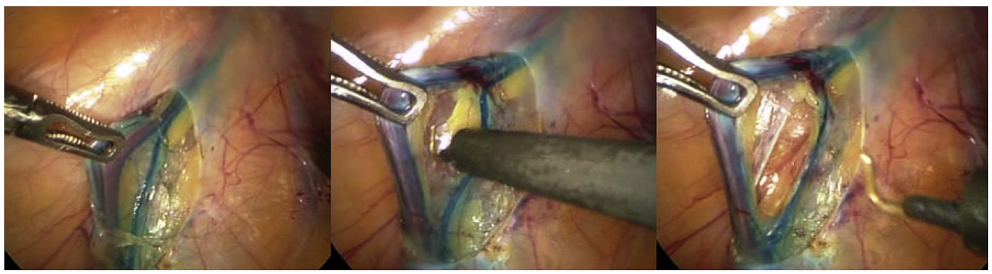

**Figure 2** Blue-colored lymphatics can be easily identified and spared. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

between 18 and 50 min (average time 26 min) for artery-sparing Palomo procedures.

All patients were discharged after 1 night of hospitalization. In 45/345 patients (13%) we performed additional procedures: closure of peritoneo-vaginal duct (pvd) incidentally found patent during the procedure in 19 cases, lysis of adhesions of colon that covered the ISV in 18 patients, and lysis of adhesions in the right iliac fossa in seven patients who had previously undergone appendectomy using an open method.

In patients who underwent the Palomo procedure we recorded 4/335 (1.1%) recurrences/persistences of varicocele requiring re-intervention, whereas we recorded 1/10 (10%) recurrence/persistence requiring redo-surgery in patients who underwent the artery-sparing Palomo procedure.

From 230 Palomo procedures performed in the pre-isosulfan blue injection era, there were 25 cases of hydrocele (10.8%), 13 of these were treated with transcrotal puncture and 12 required surgical interventions. In the last 105 patients who underwent preoperative intradartoic/intratesticular injection of isosulfan blue, there was no postoperative hydrocele. No patients in our series experienced any testicular pain either early or late following surgery secondary to the intratesticular injection. We also reported 10 other complications (2.9%), including umbilical granuloma or instrumental problems (I grade Clavien-Dindo).

With a follow-up varying between 1 and 23 years, we recorded no testicular atrophy. All symptomatic patients resolved symptoms postoperatively. Postoperative testicular US were available in 212 of the total 345 patients who underwent Palomo procedure (61.4%). Mean time after surgery was 28.8 $\pm$ 8.3 months. We recorded significant catch-up growth in testicular size postoperatively. Postoperative mean left testicular volume was 15.4 $\pm$ 4.8 mL compared with 12.0 $\pm$ 5.2 mL preoperative mean left testicular volume ($p < 0.001$). Also postoperative mean right testicular volume increased to 17.2 $\pm$ 4.0 mL from a preoperative value of 16.1 $\pm$ 6.5 mL ($p < 0.001$).

All patients' characteristics and outcome parameters are reported in Table 1.

## Discussion

Varicocele occurs in approximately 15—25% of the adolescent and adult male population, and as many as 20% will eventually be identified with an infertility problem [1,2]. Analyzing the international literature it seems that there exists a strong relationship between ipsilateral hypotrophy and abnormal semen parameters in both adults and teenage boys with a left varicocele [3]. In addition, both asymmetry and semen parameters can worsen with time, lending evidence to the progressive nature of the condition. The alternative of avoiding surgical repair of varicocele and waiting until an infertility problem presents itself does not seem to be the best option to adopt; for this reason the indication of an early treatment in childhood for preventing testicular damage is widely accepted [7,19—22].

The ideal surgical approach for adolescent varicocelectomy represents a current area of debate. Surgical techniques include open or laparoscopic abdominal (Palomo) approach, with high ligation of spermatic vascular structures. Alternatively, inguinal (Ivanissevich) and subinguinal approaches may be used, with or without the use of microsurgical techniques. While the subinguinal microscopic approach appears to have become the gold standard for varicocele ligation in adult males because of lower postoperative recurrence and complication rates compared with other techniques, this approach has not been widely adopted in the adolescent population. According to a recent paper, a microsurgical approach was reported in only 2% of children and adolescent patients using the Pediatric Health Information System (PHIS) database [15]. Several concerns have been raised regarding the application of this technique to pediatric patients. Inexperience or lack of familiarity with the microscopic technique is perhaps the most significant obstacle to more widespread adoption of this approach among pediatric urologists. Furthermore, it is technically more challenging because in children the testicular artery is small and systemic blood pressure is low, making identification of the artery difficult in a subinguinal or inguinal approach. Despite these concerns, several groups have performed subinguinal microsurgical varicocelectomy in children and adolescents with success rates comparable with those seen in adults [23].

Recently introduction of antegrade sclerotherapy in the adolescent population has resulted in a safe and cost-effective method for management of adolescent varicocele, but it has been associated with an initial steep learning curve to optimize the technique to achieve a high success rate with minimal complications. Antegrade sclerotherapy also rarely causes secondary hydroceles and a recent study showed a lower efficacy of embolization than for laparoscopy, with failure rates up to 16% [24].

In any case, over the past decade there has been a clear shift toward increasing use of the laparoscopic technique [25]. Laparoscopic varicocele repair is associated with shorter operative times and fewer negative outcomes compared with subinguinal microscopic approach and antegrade sclerotherapy, resulting in better cost-effectiveness [24,26,27].

In our opinion the key point for the success of the laparoscopic approach for varicocele repair has been standardization of the surgical technique that we have done in the last 23 years. For this reason we will expose some considerations on the basis of our two decades of experience. For the surgical technique itself, probably the use of the trocars is the best option; it is also possible to use one operative trocar or two trocars [28—30], but the use of three trocars is absolutely safer, technically faster, and has a lower complication rate. The classic trocars position, one 5—10 mm umbilical trocar for the 0° optic plus two 5 mm trocars in triangulation, seems to be the best to adopt. For the surgical procedure, it is important, before opening the posterior peritoneum, to free the inner spermatic vessels from the colon, if it is attached to the posterior peritoneum covering the vessels, to have a better view of the operative field. Another point of interest is to largely open the posterior peritoneum laterally to the ISV to minimize risk of damaging the vessels, and to have a good view of the vessels so as to easily perform a lymphatic sparing procedure. It is mandatory to section the vessels 3—4 cm far away from

the internal inguinal ring to save the collateral vascularization of the testis according to the Fowler-Stephens anatomic description and to avoid damaging the testicular vascular supply. Probably the best way to close the vessels before sectioning them is to use clips. Sealing devices are faster than clips but too expensive; ligatures are cheaper than clips but require longer operative time; clips represent the fastest and safest method at an acceptable cost.

It is advisable to spare the lymphatic vessels to avoid postoperative hydrocele formation [31,32].

Kocvara et al. reported that division of lymphatic supply at varicocelectomy is associated with testicular edema and reduced testicular function, leading to disruption of the hypothalamic–pituitary–testicular axis with higher LH and FSH stimulated values, and they stressed the importance of lymphatic drainage preservation not only to prevent hydrocele but also to ensure a better andrological outcome [33]. They proposed that laparoscopic magnification could be solely used to visualize lymphatic trunks, reporting a postoperative hydrocele rate of 1.9% in their series. However, laparoscopic magnification is not sufficient to ensure preservation, because of a high number of anastomoses between lymphatic and venous systems. The best results for hydrocele avoidance were found after dye administration. Several vital dyes have been employed, including methylene blue and isosulfan blue [34,35]. We prefer to use isosulfan blue, which is cheap, safe, and well established in the clinical routine.

There are three different modes of injection: subdartoic, intravaginal, and intraparenchymal. Subdartoic injection is performed in the space between the dartos and parietal tunica vaginalis. This is an easy, safe, and rapid method, but the lymphatic pathway preferred is the scrotal one that drains to inguinal nodes and partially to the testicular system. Much more vital dye and earlier performed injection may be necessary to avoid failure in lymphatic mapping. Intravaginal injection is performed in the narrow space between the two layers of tunica vaginalis. This is probably the most difficult and least performed approach. Intraparenchymal injection is achieved with a fine needle just within the body of the testis. This is a faster and most specific approach because of the related regional lymphatic drainage [34]. A common concern is the safety of the intratesticular injection of the vital dye, as pathological changes in the testicular tissues have been reported at histological examination [36]. Another study reported that seminiferous tubule histology appeared virtually unaffected by intratesticular injection, even at regions adjacent to the site of injection [37].

As previously published, we standardized the technique of injection, using a tandem scrotal intradartoic/intratesticular injection. This technique allowed a lower amount of isosulfan blue to be injected into the testicular parenchymal tissue, but visualization of the lymphatics was obtained in 100% of cases [18]. As already reported, the most important factor is preservation of big collecting trunks that are rapidly mapped after intraparenchymal injection [34]. From our findings it is enough to spare at least two to three lymphatics to avoid hydrocele formation postoperatively. There are usually at least two posterior lymphatics that are easy to spare. Very small vessels

**Table 2** Literature reports in the last 10 years of outcome of laparoscopic lymphatic sparing varicocelectomy in children.

| Reference | N° cases | Mean hospital stay, days | Conversion rate | Mean operative time, minutes | Recurrence/persistence rate | Postoperative hydrocele rate | Other complications rate | Re-operation rate |
|---|---|---|---|---|---|---|---|---|
| [14] Chiarenza et al., 2012 | 218 | NR | 0 | NR | 5/218 (2.2%) | 0 | 2/42 (4.7%) | 5/218 (2.2%) |
| [18] Esposito et al., 2014 | 50 | 1.5 | 0 | 15 | NR | 2/50 (4%) | NR | NR |
| [32] Tong et al., 2009 | 46 | 2.9 | 0 | 34.2 | 1/46 (2.1%) | 0 | NR | NR |
| [38] Healey et al., 2010 | 19 | NR | 0 | NR | 4/19 (22%) | 1/19 (5.2%) | 1/19 (5.2%) | 1/19 (5.2%) |
| [39] Rizkala et al., 2013 | 67 | NR | 0 | NR | 1/67 (1.3%) | 3/67 (4.5%) | NR | 0 |
| [40] Glassberg et al., 2008 | 174 | NR | 0 | NR | 5/174 (2.9%) | 6/174 (3.4%) | NR | 5/174 (2.9%) |
| [41] Capolicchio et al., 2013 | 25 | NR | 0 | 85 | 2/25 (8%) | 0 | 0 | 0 |
| [42] Golebiewski et al., 2007 | 26 | NR | 0 | NR | 0 | 0 | 0 | 0 |

(not visible with magnification and not mapped by the vital dye) can be divided without increasing complication rate. Our injection method gives the highest rate of successful mapping and also represents a safe approach, as neither toxicity nor adverse or allergic reactions have been recorded in our series.

Analyzing the international literature published in regard to the outcome of lymphatic sparing varicocele repair in pediatric age [14,18,32,38—42], our series is one of the largest published in the last 10 years (Table 2). According to literature reports and on the basis of our 23 years of experience, it seems that minimally invasive treatment using laparoscopy may be the best option to adopt in case of pediatric varicocele. First of all, it is technically easy to perform, it is the fastest technique to adopt, in expert hands the length of surgery is about 10—12 min, and it has excellent outcome in regard to persistence/recurrence of varicocele (less than 1.5% in our series). In addition, it has a very low complication rate, and in particular adopting the intradartoic/intratesticular injection of isosulfan blue before surgery we recorded no postoperative hydrocele. The laparoscopic technique affords the possibility of performing additional procedures, such as closure of patent pvd or lysis of adhesions. The postoperative period is painless and very short, with an overnight hospitalization. Probably the only disadvantage of laparoscopic varicocele repair is the need for general anesthesia with myorelaxation.

In case of recurrence after prior ipsilateral inguinal surgery, as happened in seven cases in the present series, the laparoscopic redo Palomo varicocelectomy can be accomplished successfully and has demonstrated a similar chance of achieving catch-up growth to that of an initial repair. A consistent intraoperative finding in all redo patients of our series was the presence of large veins within the cord, just proximal to the junction with the vas and in continuity with the dilated veins distal to the internal ring. We did not find any particular technical challenge and we reported no increase in postoperative complications rates or testicular atrophy in such cases. In the case of a single left testis, we advise performing cryoconservation of semen preoperatively.

On the basis of our 23 years of experience with varicocele repair, we clearly believe that laparoscopic Palomo lymphatic sparing varicocelectomy using preoperative intradartoic-intratesticular isosulfan blue injection should be considered the standard of care for treatment of pediatric patients with varicocele. Laparoscopic varicocelectomy is technically easy and fast to perform, painless, and scarless with no more than 1% recurrence rate. The use of a preoperative injection of isosulfan blue permits complete elimination of hydrocele formation postoperatively.

## Conflict of interest

None.

## Funding

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