

Usefulness of indocyanine green in the laparoscopic Palomo technique: a comparative study

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ABSTRACT

Objective. To find out whether the use of indocyanine green for lymphatic sparing in the laparoscopic Palomo technique reduces the incidence of postoperative hydrocele.

Materials and methods. A comparative cohort study of varicocele patients treated with the laparoscopic Palomo technique from 2008 to 2023 was carried out. Patients were divided into two groups according to whether fluorescence lymphography (intratesticular indocyanine green) had been performed or not. Epidemiological, surgical, and clinical data, as well as complications, were recorded. A hypothesis test was conducted using the SPSS software.

Results. 30 patients undergoing varicocele surgery through the laparoscopic Palomo technique were included. They were divided into two groups –lymphatic sparing (n= 13) vs. spermatic vessel ligation without sparing (n= 17). Mean age at surgery was 14 years. 5 cases of postoperative hydrocele were identified in the no lymphatic sparing group. 1 of them required surgery for hydrocele treatment. No hydrocele cases were noted in the lymphography group. The difference was statistically significant (p= 0.032). There were no statistically significant differences in terms of operating times or mean hospital stay. No recurrences, postoperative testicular atrophies, or indocyanine-green-related complications were recorded. Mean follow-up was 11.4 months.

Conclusions. The use of indocyanine green for lymphatic sparing in the treatment of varicocele through the laparoscopic Palomo technique significantly reduces the incidence of postoperative hydrocele.

KEY WORDS: Varicocele; Laparoscopy; Indocyanine green; Lymphatic vessels.

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UTILIDAD DEL VERDE DE INDOCIANINA EN EL PROCEDIMIENTO DE PALOMO LAPAROSCÓPICO: ESTUDIO COMPARATIVO

RESUMEN

Objetivos. Comprobar si el uso del verde de indocianina para la preservación linfática en la técnica de Palomo laparoscópico reduce la incidencia de hidrocele postoperatorio.

Material y métodos. Se realizó un estudio comparativo de cohortes históricas incluyendo los pacientes tratados de varicocele mediante Palomo laparoscópico entre 2008 y 2023. Se dividieron en 2 grupos en función de la realización de linfografía con fluorescencia (verde de indocianina intratesticular). Se recogieron datos epidemiológicos, quirúrgicos, clínicos y complicaciones. Se realizó un análisis de contraste de hipótesis utilizando el programa SPSS.

Resultados. Se incluyeron 30 pacientes intervenidos de varicocele mediante la técnica de Palomo laparoscópico divididos en 2 grupos: en 13 se realizó preservación linfática y en 17 ligadura de vasos espermáticos sin preservación. La edad media en el momento de la cirugía fue de 14 años. Se identificaron 5 casos de hidrocele postoperatorio en el grupo sin preservación linfática. Uno requirió intervención quirúrgica para el tratamiento del hidrocele. No se identificó ningún caso de hidrocele en el grupo de la linfografía. La diferencia resultó estadísticamente significativa, p= 0,032. No hubo diferencias estadísticamente significativas en el tiempo quirúrgico ni en la estancia media. No se objetivaron recidivas, atrofias testiculares postquirúrgicas ni complicaciones asociadas al uso del verde de indocianina. El tiempo medio de seguimiento fue 11,4 meses.

Conclusiones. El uso del verde de indocianina para la preservación linfática en el tratamiento del varicocele mediante Palomo laparoscópico reduce significativamente la incidencia de hidrocele postoperatorio.

PALABRAS CLAVE: Varicocele; Laparoscopia; Verde de indocianina; Vasos linfáticos.

INTRODUCTION

Varicocele has an incidence of 15-20% in adolescence and can cause testicular hypotrophy with a subsequent impact on spermatogenesis⁽¹⁾. Varicocele treatment in adolescence has not been standardized yet, and the technique

of choice varies according to the institution and the experience of the surgical team⁽²⁾.

Accepted surgical criteria are based on a >20% difference in testicular volume vs. the contralateral testis, the presence of symptoms or other pathologies with an impact on fertility, and bilateral palpable varicocele cases⁽³⁾.

The laparoscopic Palomo technique is possibly one of the most widely used approaches in varicocele adolescents⁽⁴⁾. This technique is easily reproducible and has a > 95% success rate. However, it is also associated with a high rate of postoperative hydrocele –up to 20-30%^(2,5,6).

The use of indocyanine green to reduce the incidence of this complication has been recently described. By conducting an intratesticular injection, intraoperative lymphography can be carried out, and lymphatic vessels can be preserved, with good results in the descriptive series published^(1,2).

The objective of this article was to verify, by means of a comparative study, whether the use of indocyanine green for lymphatic sparing in patients undergoing varicocele surgery through the laparoscopic Palomo technique significantly reduces the incidence of hydrocele in the postoperative period.

MATERIALS AND METHODS

A comparative, retrospective cohort study of patients undergoing varicocele surgery through the laparoscopic Palomo technique in a tertiary pediatric hospital from January 2008 to December 2023 was carried out. Exclusion criteria were age > 17 years, postoperative follow-up < 6 months, and lack of data during follow-up.

Preoperative ultrasonography was conducted in all patients. Surgical criteria included presence of $\geq 20\%$ asymmetry in testicular volume vs. contralateral testis, presence of symptoms, and bilateral varicocele^(7,8). Sperm quality was not analyzed as patients were pediatric.

Patients were divided into two groups according to whether fluorescence lymphography through intraoperative intratesticular injection of indocyanine green had been performed or not. In all patients, a 3-port laparoscopic Palomo surgery was carried out, with one 10 mm umbilical port, two 5 mm ports in the left and the right flank, and a 5 mm, 30-degree scope. Peritoneal window and spermatic cord dissection were the first steps of the procedure. In those cases where indocyanine green was used, a 6.25 mg intratesticular injection (25 mg diluted in 8 ml of double-distilled water, with injection of 2 ml of the solution) was performed, and a laparoscopic device with a high-definition camera and infrared light vision for lymphography was used. Lymphatic vessels were viewed approximately 15-20 seconds following intratesticular injection for sparing purposes.

Clipping and division of the spermatic vessels were conducted in all cases.

The following variables were analyzed: surgical technique, laterality, varicocele grade (I-III)⁽⁷⁾, surgical indication, symptoms, age at surgery, weight, operating time, hospital stay, mean follow-up, preoperative testicular volume, difference between testicular volume and contralateral testis, postoperative testicular volume, and complications in the postoperative period according to Clavien-Dindo classification, whether early (first postoperative month) or late (including the occurrence of postoperative hydrocele, testicular atrophy, and varicocele recurrence).

Operating-time-related variables and results were compared according to whether lymphatic sparing had been carried out or not. Data was analyzed using the IBM SPSS Statistics software, version 26 (IBM Corporation[®]) for statistical analysis purposes. Descriptive data was expressed as frequencies and means with standard deviation (SD). The analysis of quantitative variables was conducted using Student's t-test, while displaying the standard error (SE) of the mean and the confidence interval (CI) of the difference. The analysis of qualitative variables was performed through the chi-squared test, with results being expressed as numbers. Statistical significance was established at $p < 0.05$.

All patients were informed of the surgery and signed a surgical consent form, while accepting the use of indocyanine green in the cases where it was employed for lymphography purposes.

Contraindications for the use of indocyanine green included allergy to iodinated contrasts and liver failure.

RESULTS

A total of 32 patients underwent the laparoscopic Palomo technique from January 2008 to December 2023. 2 patients who had not completed the 6-month postoperative follow-up were excluded. In 17 out of the 30 patients, the laparoscopic Palomo technique was carried out without lymphatic sparing, and in the remaining 13, the same procedure was conducted, but with lymphatic sparing.

Epidemiological data from each group is featured in Table 1.

All varicoceles were unilateral left. 2 varicoceles were grade I (6.6%), 14 were grade II (46.6%), and the remaining 14 were grade III (46.6%). 8 patients (26.6%) reported varicocele-related pain preoperatively, with pain being resolved following surgery.

The primary surgical indication was $\geq 20\%$ asymmetry in testicular volume, which was present in 25 patients (83.3%). In 5 cases, surgery was indicated as a result of pain, with a < 20% asymmetry in testicular volume (16.6%).

Mean operating time was 50 minutes in the lymphography and lymphatic sparing group, and 42 minutes in the

Table 1. Epidemiological data of patient groups.

	Age (years)	Weight (kg)	Preoperative testicular volume (cc)	Hospital stay (days)	Follow-up time (months)
Surgery with lymphatic sparing (n= 13)	14.38 (SD 1.55)	56.26 (SD 12.78)	7.90 (SD 3.60)	0.23 (SD 0.43)	9.54 (SD 2.96)
Surgery without lymphatic sparing (n= 17)	14 (SD 1.58)	55.53 (SD 15.22)	6.74 (SD 3.73)	0.29 (SD 0.47)	12.82 (SD 6.04)
p	0.51	0.88	0.39	0.70	0.06

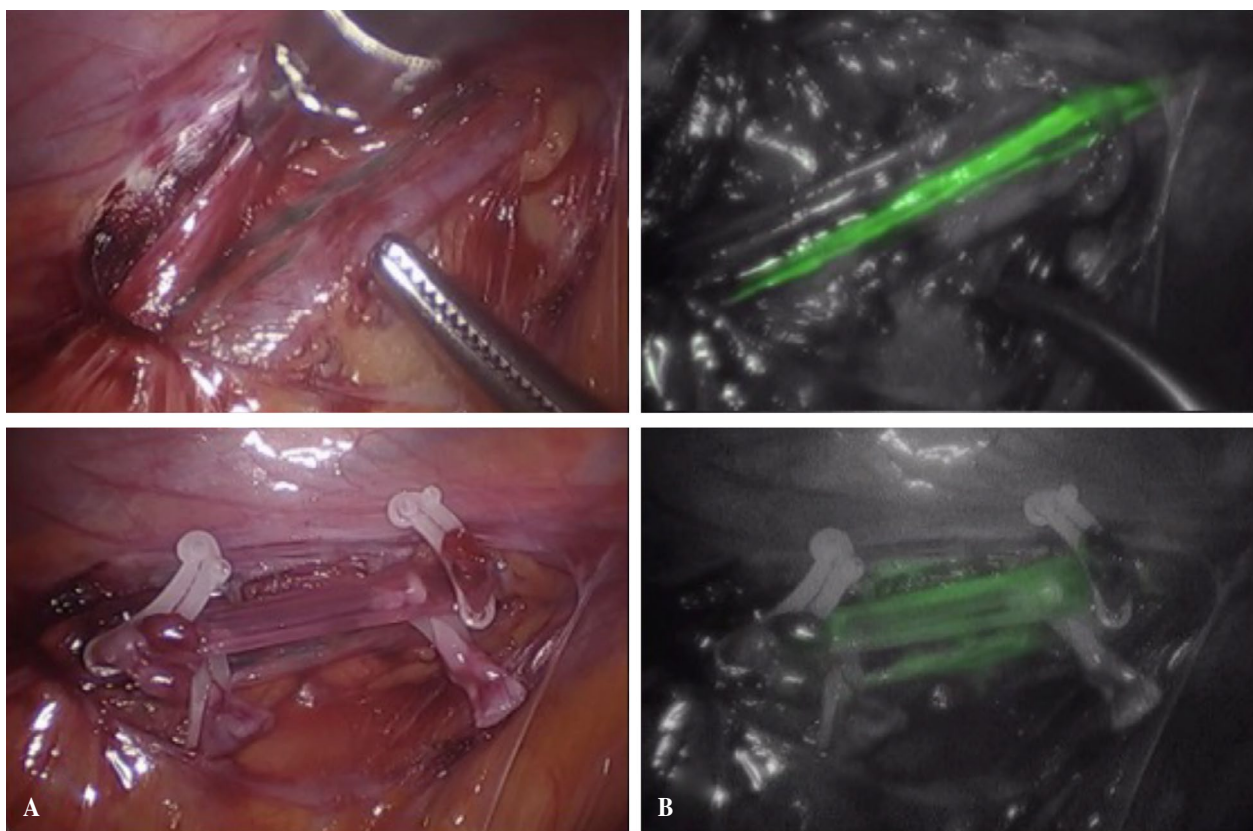


Figure 1. Dissection and spermatic vessel ligation with lymphography and lymphatic sparing using intratesticular indocyanine green. A) White light image: lymphatic vessels are seen in dark green. B) Infrared light image: lymphatic vessels are seen in fluorescent green.

vessel ligation and division, no lymphatic sparing group ($p=0.04$; SE: 3.9; CI: (0.42-16.41)).

Lymphography allowed lymphatic vessels to be identified and dissected in all cases (Fig. 1), with no adverse reactions related to the intratesticular injection of indocyanine green.

22 patients were discharged on the same day of the surgical procedure (73.3%), and 8 patients were discharged after spending one night in hospital (26.6%). No differences in terms of mean hospital stay were found between both groups ($p=0.07$).

Regarding early complications of the technique, there was 1 case of subcutaneous emphysema in a patient undergoing lymphatic sparing, and 1 case of hematoma in the wound caused by one of the ports in a patient not undergoing lymphatic sparing –both of them Clavien Dindo grade 1. Both cases were resolved with conservative management.

5 postoperative hydrocele cases were noted in the no lymphatic sparing group, which translates into a 29.4% rate of postoperative hydrocele. 1 of these patients required another surgery for hydrocele resolution, whereas a wait-

Table 2. Description and group-based distribution of the main complications.

<i>Complications</i>	<i>Lymphatic sparing group</i>	<i>No lymphatic sparing group</i>
Subcutaneous emphysema	1	0
Wound hematoma	0	1
Hydrocele	0	5
Testicular atrophy	0	0
Recurrence	0	0

Table 3. Mean testicular volume difference

	<i>Lymphatic sparing</i>	<i>N</i>	<i>Mean (SD)</i>	<i>p</i>
Preoperative testicular volume difference (mean in cc)	Yes	13	3.35 (SD 2.30)	0.20
	No	17	2.40 (SD 1.34)	
Postoperative testicular volume difference (mean in cc)	Yes	4	0.18 (SD 1.51)	0.78
	No	8	-0.15 (SD 2.69)	

Testicular volume = Σ (right testicular volume – left testicular volume) / no. of patients in the group

Volumes were ultrasound-calculated in the cases featured in this table. Postoperative ultrasonography was conducted a mean of 10.3 months (SD 6.53) following surgery.

and-see approach was adopted in the remaining ones. No postoperative hydrocele cases were recorded in the lymphatic sparing with indocyanine green group. The difference was statistically significant ($p=0.032$).

No varicocele recurrence cases or other late complications occurred. The group-based distribution of complications is featured in Table 2.

No cases of testicular atrophy were found, either at physical exploration or postoperative control ultrasonographies. A control ultrasonography was conducted in 4 patients from the lymphatic sparing group and in 8 patients from the no lymphatic sparing group, with an increase in testicular volume in all cases and a reduction in the difference of testicular volume vs. the contralateral testis down to 20% in 10 of the 12 cases. Data on postoperative testicular volume increase is featured in Table 3.

Postoperative pain was managed with intravenous metamizole and paracetamol while in hospital. Patients were discharged with oral analgesia (alternating paracetamol and ibuprofen). None of the patients reported pain or reoccurrence of varicocele symptoms in the postoperative period.

Mean overall follow-up was 11.4 months (SD: 5.15).

DISCUSSION

Various surgical techniques have been described for varicocele treatment in adolescence, including the

subinguinal, inguinal, retroperitoneal, and laparoscopic approaches, as well as embolization^(9,10).

The laparoscopic Palomo technique is a safe and widely used technique in the treatment of varicocele in adolescents, with a high success rate⁽⁹⁻¹²⁾. In our series, varicocele was resolved in all cases, with no evidence of persistence or recurrence during follow-up.

Regarding the surgical technique, lymphatic vessel sparing did not impact the laparoscopic Palomo technique's success rate, and no recurrence cases were recorded in either of the groups studied, consistent with other series^(1,5,6).

Even though clipping and division of the spermatic artery along with the vein may seem controversial, the postoperative testicular atrophy rate has not been demonstrated to be higher than with other techniques^(9,11). Indeed, spermatic artery sparing has been associated with less surgical success and with recurrence cases in numerous studies^(4,5,16).

In our study, intratesticular injection of indocyanine green proved to be a safe, simple, and reproducible method to identify the lymphatic vessels with a latency time of approximately 20 seconds since the injection was performed until the lymphatic vessels were visualized in the laparoscopic image –through fluorescence with infrared light, or green-stained in the regular white light modality. This was consistent with Esposito et al.'s findings regarding the lymphography technique used in the laparoscopic Palomo surgery^(1,4).

In addition, according to Kocvara et al., not preserving the lymphatic vessels could be associated not only with a higher incidence of postoperative hydrocele, but also with postoperative testicular hypertrophy and tubular edema that impairs testicular function and could cause a false impression of testicular growth misinterpreted as a good postoperative result^(13,17). Therefore, caution should be exerted when using postoperative testicular volume as a measure of short-term surgical success.

In spite of the postoperative hypertrophy that could be associated with the edema, multiple studies such as Mancini et al.'s report a postoperative testicular growth that equals the volume of the contralateral testis, along with an improvement in sperm quality following varicocele treatment^(2,18,19). In our study, postoperative increase in testicular volume was observed in all cases at physical exploration, with measurements being carried out in the 12 patients undergoing control ultrasonography. It should be pointed out, however, that growth was asymmetrical in 2 of them, which means a significant volume difference persisted. Control ultrasonography is not standardized in our institution and is carried out as per the leading surgeon's discretion.

Lymphography and lymphatic vessel dissection brought about a mean increase in operating times of 8 minutes in our institution. This should be considered when planning surgery, but it looks reasonable as this approach proves useful in reducing postoperative hydrocele rates.

In our study, mean operating time in both groups was longer than Esposito et al.'s, who reported a mean operating time of 18 minutes in procedures carried out by an expert surgeon⁽⁴⁾. However, it should be highlighted that our institution serves as an educational hospital for trainee surgeons, which means operating times may be impacted by the learning curve.

The laparoscopic approach is associated with rapid patient recovery. In our study, 73.3% of the patients were early discharged –on the same day that the surgery was performed^(6,10).

Surgery-related early complications were Clavien Dindo grade 1 –subcutaneous emphysema and hematoma at a port site. These complications were similar to those previously reported^(4,12) and did not increase as a result of lymphatic sparing. Regarding late complications, the group of patients not undergoing lymphatic sparing had a postoperative hydrocele rate within the 20-30% interval described by other series. In addition, postoperative hydrocele rate is greater in patients in whom lymphatic vessel clipping and division instead of clipping alone is carried out^(4,6). The incidence of this complication was reduced down to 0 in the lymphatic sparing group, with a minimum follow-up of 6 months.

Today, intratesticular injection of indocyanine green looks safe. Even though some groups prefer paratesticular puncture, intratesticular puncture is seemingly not asso-

ciated with a significant increase in complications, and it allows lymphatic vessels to be visualized for a longer time –in paratesticular injection, fluorescence is lost after 15-20 minutes⁽²⁰⁾. In our experience, the view of the lymphatic vessels when conducting paratesticular injections is less accurate.

We believe our results, which are consistent with those reported by other groups^(4-6,18), support the need for standardizing lymphography in the laparoscopic Palomo technique. The primary disadvantage of this surgery has traditionally been the high rate of postoperative hydrocele observed, but thanks to lymphatic sparing, it goes down dramatically.

In conclusion, the use of indocyanine green for lymphatic sparing in patients undergoing varicocele surgery through the laparoscopic Palomo technique is simple, reproducible, and safe, since it significantly reduces the incidence of hydrocele in the postoperative period without increasing complications.

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