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An Analysis of Major Causes of Surgical Failure Using Bähren System in Intraoperative Venography During Varicocelectomy

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Purpose: In young patients with varicocele, preservation of the internal spermatic artery may be advantageous for catch-up growth, but it may also increase the likelihood of treatment failure. Intraoperative venography reduces the likelihood that unsealed veins will remain after varicocelectomy. We analyzed the characteristics of remnant veins visualized through intraoperative venography to investigate the cause of surgical failure in artery-sparing varicocelectomy (ASV).

Materials and Methods: We retrospectively analyzed clinical characteristics and outcomes of patients aged 18 years or younger who underwent varicocelectomy with intraoperative venography from January 2005 to December 2017. During varicocelectomy, intraoperative venography was performed to distinguish veins from other structures. Any unsealed veins that were discovered were ligated and classified using the Bähren system.

Results: One hundred and sixty-two patients underwent intraoperative venography: 153 cases (94.4%) were for primary varicocelectomy, and 9 cases (5.6%) were for repeat varicocelectomy. Open varicocelectomy was performed in 105 cases (64.8%), and laparoscopic varicocelectomy was performed in 57 cases (35.2%). Venography revealed remnant veins after the first ligation in 51 cases (31.2%), 46 (90.2%) and 5 (9.8%) of which were Bähren types 3 and 4, respectively. Five patients (3.1%) experienced varicocele recurrence, classified as persistence in 1 patient (0.6%) and relapse in 4 patients (2.5%).

Conclusion: Remnant collateral veins of the internal spermatic vein (ISV) (Bähren type 3) are the most common cause of failure in ASV. In a few patients, an external spermatic vein merges with the ISV at a higher level (Bähren type 4) and is unidentifiable without venography.

Key Words: Varicocele, phlebography, laparoscopes

INTRODUCTION

In varicocele treatment, surgical intervention including ligation or occlusion of the internal spermatic vein (ISV) is the primary treatment option. Since varicocele is basically a problem of the veins, ligation of spermatic arteries might not be the appropriate approach, in theory. Nevertheless, it has been suggested that artery-sparing varicocelectomy (ASV) can increase the failure rate of corrective surgery by preventing complete removal of the ISV.[1]

To overcome this drawback of ASV, we use intraoperative venography in our institution. In 1987, Levitt, et al.[2] administered post-ligation intraoperative venography to 26 children to detect occult communications, and doing so led to a low varicocele recurrence rate of 3.6%. Keene and Cervellione[3] administered post-ligation intraoperative venography with intravenous

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methylene blue injection to 24 patients undergoing ASV, and found that it helped to increase the success rate of ASV and lower the incidence of complications. In our institution, intraoperative venography is performed to confirm the absence of unsealed veins after ASV. When venography reveals remnant veins, those veins are ligated, and venography is performed again until no more remnants are found. In this study, we analyzed the vessel types of the remnant veins discovered by postligation venography, and by analyzing the anatomy of these remnant veins, we aimed to determine the types of veins that can be easily missed.

MATERIALS AND METHODS

Study population

With the approval of our Institutional Review Broad (IRB No. 4-2019-0042), we collected data of patients who underwent Palomo or laparoscopic varicocelectomy before 18 years of age at our institution from January 2005 to December 2017 and were followed for more than 1 year postoperatively: this study was conducted on patients who underwent varicocelectomy by full-time pediatric urologists working at Severance Children's Hospital, and that is why there was an age limitation. In our institution, standard indications for varicocele repair are testis atrophy and pain. Testis atrophy was defined as a size reduction of more than 20% on ultrasonography. Testicular volume was calculated using the formula length (L)×width (W)×height (H)×0.71, which is known as the best method for measuring the actual size of the testicles.[4] The degree of asymmetry was measured as [(right testis volume)-(left testis volume)/right testis volume]×100, and testicular asymmetry was defined as 15% or greater. All cases were followed by testis ultrasonography after surgery. Catch-up growth of the testis was determined as less than 15% of testicular asymmetry. Intraoperative venography was attempted in 176 patients during that period. Exclusion criteria were cases in which venography was not performed for any reason or cases in which available images could not be interpreted due to poor quality. Catheterization was unavailable in five patients, and extravasation occurred in another nine patients. These patients were excluded from our study. The remaining 162 patients were included in the final study group. Data on the characteristics of the patients, including age at operation, surgical indication, and postoperative outcomes, were collected. We followed up with the patients by asking whether they had any symptoms on the scrotum and by performing a physical examination and ultrasonography. We defined recurrence as grade 2 or grade 3 varicoceles that could be confirmed by palpation.[5]

Operation technique

The operational technique for each patient was determined according to surgeon preference. Open Palomo varicocelectomy was performed by four surgeons, and laparoscopic varicocelectomy was performed by a single surgeon (LYS).

In open Palomo varicocelectomy, the largest ISV was isolated and ligated, and a pediatric double-lumen 4-Fr×13-cm central venous catheter (AR-CS-14402, Teleflex, PA, USA) was inserted into the ISV. In laparoscopic varicocelectomy, two 5-mm trocars and one 3-mm trocar were inserted and introduced into the peritoneal space. After exposure of the left psoas muscle, the largest ISV was selected and ligated. In open varicocelectomy, the ligation level was L5-S1, and in laparoscopic varicocelectomy, it was L3-L4. Then, a Chiba Biopsy Needle (G03020, EA-COOK, Bloomington, IN, USA) was introduced into the abdominal cavity percutaneously while securing the field of view with a laparoscope camera. A 3-Fr×70-cm open-end ureteral catheter (020013, EA-COOK) was inserted into the Chiba Biopsy Needle. An incision was made to the side of the stump of the ligated ISV, and the 3-Fr catheter was put into it (Fig. 3A). Then, the selected ISV was sealed using Laploop® (Polyglycolic acid, Sejong Medical, Paju, South Korea). After catheterization, all visually distinct veins were ligated. Vessels that were questionable as to whether or not they were a vein were left unligated, and venography was performed to confirm that they were a vein. In case of indistinguishable vessel-like structures, indigo carmine was injected through the catheter to determine if the structures were veins. In particular, spiral veins around the spermatic artery and other visible veins were ligated while the artery was preserved. After all of the identified veins in the operation field were ligated, 30 cc of omnihexol 350 inj (Iohexol, A12958421, Korea United Pharm. Inc, Seoul, South Korea) was forcefully injected by hand for venography to determine if there were any remaining veins that were missed. A few minutes after the indigo carmine injection, lymphatics could also become stained. Therefore, indigo carmine injection can only be used once or twice during the operation. If there were still any ambiguous structures after two indigo carmine injections, further ligation was not performed until the structures were clearly identified by venography. When venography revealed remaining unsealed veins, ligation and venography were repeated until there were no more unsealed veins. In total, kidney, ureter, and bladder (KUB) radiography was performed once for the scout film, once in venography, and once again to determine if there were any remaining veins, usually two to three times.

Bähren classification

We used the Bähren classification, which was first introduced by Bähren, et al.[6] in 1992, to classify the types of veins in varicocele. The Murray classification, another classification system of varicocele anatomy,[7] was not used in this analysis since only remnant veins appeared in the intraoperative venography, so the classification could not be applied (Fig. 1B). For the same reason, Bähren types 0, 1, and 5 were not seen in intraoperative venography, and only Bähren types 2, 3, and 4 could be observed (Fig. 1A).

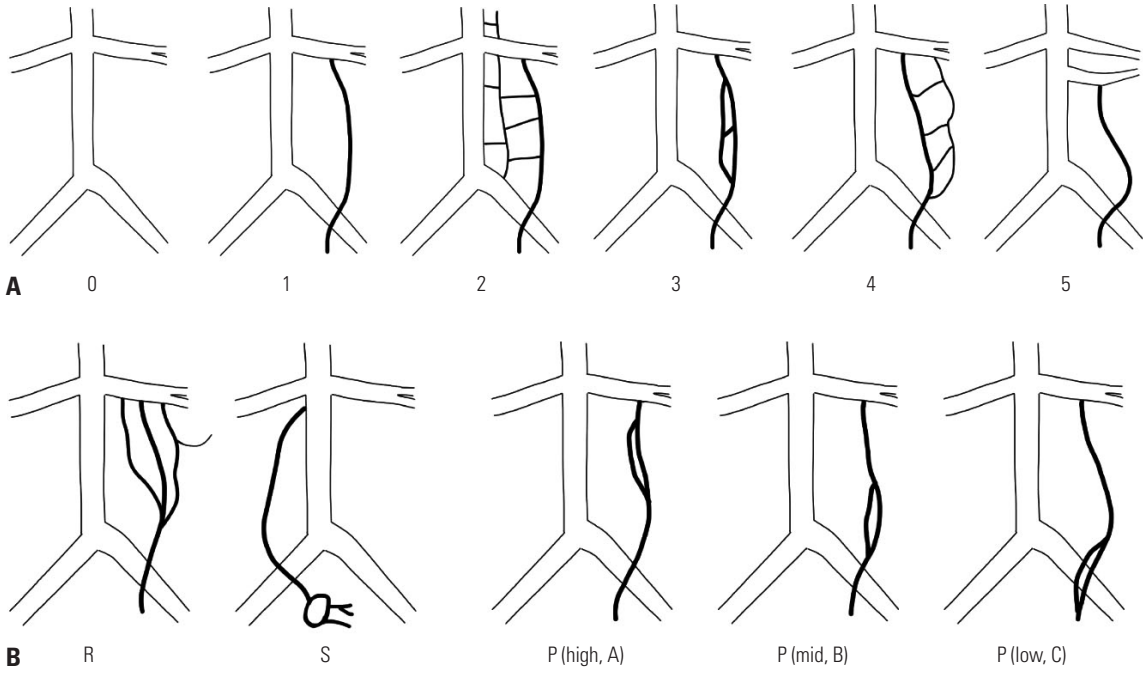

Fig. 1. Bähren (A) and Murray (B) classification.[6,7] In Bähren classification, type 0 does not exhibit venous reflux on venography. Type 1 shows reflux with a single ISV. Type 2 refers to reflux into a single ISV in communication with an accessory gonadal vein, lumbar vein, iliac veins, and vena cava. Type 3 exhibits reflux into ISV duplicated caudally, merging with a single vessel. Type 4 shows reflux into renal hilar or capsular collateral vessels that communicate with an ISV. Type 5 demonstrates reflux into an ISV that drains into the circumaortic renal vein. In Murray classification, type R (renal) includes types 2 and 4 from Bähren classification. Type S exhibits the presence of cross-scrotal collateral vessels. Type P (parallel duplication of ISV) is divided into subtypes A (high), B (mid), and C (low) according to the location of collateral vessels. ISV, internal spermatic vein.

Human and animal rights
This clinical research involved human participants but not animals.

Ethical approval
All procedures performed in the studies involving human participants were in accordance with the ethical standards of the institutional or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent
The Institutional Review Board of Yonsei University College of Medicine waived the requirement of obtaining informed consent, since this study retrospectively reviewed anonymous patient data and did not involve a patient intervention or the use of human tissue samples.

Table 1. Baseline Characteristics of Patients Who Underwent Varicocelectomy with Intraoperative Venography

Variable	Value
Age (yr)	13.6±2.4
Surgical indication	
Testicular atrophy	134 (82.7)
Pain	38 (23.5)
Side of varicocele	
Left	152 (93.8)
Bilateral	10 (6.2)
Side of operation	
Left	161 (99.4)
Bilateral	1 (0.6)
Operation method	
Open	105 (64.8)
Laparoscopy	57 (35.2)

Data are presented as a n (%) or mean±SD.

RESULTS

Patient characteristics are listed in Table 1. Of the 162 patients included in the study (mean age, 13.6±2.4 years), 9 (5.6%) had a history of previous varicocelectomy. One hundred 5 (64.8%) of the patients underwent open varicocelectomy, and 57 (35.2%) underwent laparoscopic varicocelectomy.

Varicocele was present on the left side in 152 patients, and was bilateral in 10 patients. There was no patient with right side-only varicocele. Since right varicocele is affected and caused by the left side, we only operated on the left side, except for one case, even when both sides were present. In one case, varicocelectomy was performed on both sides since the right varicocele was severe enough to cause discomfort and pain. There was no case of conversion from laparoscopic varicocelectomy to open surgery.

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The first session of post-ligation intraoperative venography revealed remnant veins in 51 (31.5%) patients. After those remnant veins were ligated, a second session of intraoperative venography revealed remnant veins in 4 (7.8%) patients. No remnant veins were found in any patients after the second session of venography. Of the 51 patients who had remnant veins identified by the first venography, 46 (90.2%) had Bähren type 3 anomalies, and 5 (9.8%) had Bähren type 4 anomalies.

We also performed a separate analysis of the 56 cases of laparoscopic varicocelectomy, which were performed by a single surgeon. In the first 28 cases, five patients had remnant veins (four Bähren type 3 anomalies and one Bähren type 4 anomaly) identified by the first venography. However, in the next 28 cases, only one patient had remnant veins (Bähren type 3 anomaly) identified after the initial ligation.

Regarding the operation time, it took an average 129.3±4.4 minutes for laparoscopic varicocelectomy and an average of 125.1±4.5 minutes for open varicocelectomy. There was no significant difference between them. However, in the first 30 cases of laparoscopic varicocelectomy, it took an average of 142.9±6.4 minutes, while in the remaining 27 cases, it took an average of 111.8±4.4 minutes to complete the procedure, a difference that was significant (p<0.05).

During follow-up (median, 21 months), 5 patients (3.2%) experienced recurrence. One recurrence was due to persistence after surgery, and the other four were due to relapse. There were 6 cases (10.5%) of hydrocele in the laparoscopy group and 10 (9.5%) in the open group. None of the cases required any further treatment, such as surgery or any invasive treatment, and all cases spontaneously regressed. As for catch-up growth, 19 cases (18.1%) in the open group and 8 (14%) in laparoscopy group did not achieve catch-up growth (Table 2). Interestingly, in one of the early laparoscopic cases, orchialgia persisted for about 1 year and then regressed.

Table 2. Data on Intraoperative Venography and Operation Time

Variable	Value
Number of venography sessions	
1	111 (68.5)
2	47 (29.0)
3	2 (1.2)
4	2 (1.2)
Bähren type	
III	46 (90.2)
IV	5 (9.8)
Recurrence	
Persistence	4 (2.6)
Relapse	1 (0.6)
Hydrocele	
Open	10 (9.5)
Laparoscopy	6 (10.5)
Catch-up growth	
Open	86 (81.9)
Laparoscopy	49 (86)
Average operation time (min)	
Open	125.1±4.5
Laparoscopy	129.3±4.4
Operation time of laparoscopic varicocelectomy (min)	
Initial 30 cases	142.9±6.4
Last 27 cases	111.8±4.4

Data are presented as a n (%) or mean±SD.

DISCUSSION

There are several surgical methods for treating varicocele, including microsurgical subinguinal varicocelectomy, inguinal varicocelectomy, laparoscopic varicocelectomy, and percutaneous varicocele embolization.[8] The recommended treatments of choice are subinguinal or inguinal microsurgical (microscopic) repairs and suprainguinal open or laparoscopic lymphatic-sparing repairs.[9,10] The former has the advantage of being a less invasive procedure, whereas the latter has the advantage of requiring fewer veins to be ligated and providing a safety benefit of incidental division of the artery at the suprainguinal level. In our institution, open microsurgical, open Palomo, and laparoscopic varicocelectomy are performed according to the surgeon's preference. Since only cases with intraoperative venography were included in the study, microsurgical cases were excluded.

There is a debate over whether or not to save the artery in adolescent patients with varicocele. For open Palomo varicocelectomy, Fast, et al.[11] reported that artery-sparing surgery resulted in higher recurrence and persistence rates compared to surgery in which arteries were ligated (12.2% vs. 5.4%), and the overall success rate of ASV was low. Feber and Kass[1] reported that patients that underwent artery-ligation varicocelectomy had a lower recurrence rate than patients that underwent ASV, since small collateral vessels around arteries could be ligated perfectly in artery-ligation surgery, but not in ASV. Also, Huk, et al.[12] performed laparoscopic varicocelectomies and found that artery-ligating surgeries had better results in terms of semen characteristics and fertility compared to artery-preserving surgeries, and they suggested that collateral veins that were missed and remained unligated in the artery-preserving surgeries were the causes of such results. According to Yu, et al.,[13] in laparoscopic varicocelectomy, there is no significant difference in outcomes between artery-sparing procedures and artery-ligating procedures, although the 12-month catch-up growth rate appears to be higher after artery-sparing procedures. Therefore, they recommended an artery-sparing technique as a first-choice treatment for varicocele.

There have been several attempts to develop techniques to increase the success rate of varicocelectomy while also saving arteries. One such technique is intraoperative venography. In

1992, Hart, et al.[14] reported an overall varicocele persistence rate of 9% among 64 patients who underwent intraoperative venography and a 17% increase in left testicular volume on average among 24 of 30 patients who were followed up for a sufficient period of time, which led to them performing intraoperative internal spermatic venography as a routine procedure. In 2001, Niedzielski and Paduch[15] reported that intraoperative venography using a high retroperitoneal approach with artery sparing reduced recurrence rates.

In our institution, intraoperative venography is performed routinely. To our knowledge, this is the first report of intraoperative venography in laparoscopic varicocelectomy. The most common type of remaining veins discovered in the first venography were Bähren type 3 anomalies (Fig. 2A), which involve collateral veins running parallel to the ISV. Theoretically, if all collateral veins are ligated, there should be no remnant veins on the first venography. The greater the proficiency of the surgeon, the more likely it is that all small collateral veins will be identified and ligated, which may lower the failure rate. For example, in our institution where all laparoscopic varicocelectomies are performed by a single surgeon, primary venography revealed remnant veins in five of the first 28 patients (8.9%) who underwent the procedure, but in only one of the next 28 patients (1.8%) who underwent the same procedure performed by the same surgeon. Since repeated experience with post-ligation venography trained the surgeon as to where the remnant collateral vessels tended to be located, it appeared to become more likely that the surgeon would ligate all collateral veins in the first attempt. In our institution, the operation is performed with an emphasis on the ligation of spiral veins, which are very thin collateral vessels that run just around the artery. As a result, there are few remaining veins on the venography when spiral veins are removed well.

Bähren type 3 corresponds to the P type when assigned to Murray classification (Fig. 1). The P type is divided into high, mid, and low. In case of P (mid, B) and P (low, C), if the varicocelectomy of Palomo incision is performed, accessory veins will be located below the position of ligation, whereas P (high, A) will not. Therefore, in this surgical method, P (high, A) will most likely be missed. In the case of P (high, A), it is particularly easy for a beginner to miss accessory veins, although any missing veins can be addressed through intraoperative venography.

Bähren type 4 anomalies, in which an external spermatic vein (ESV) merges with the ISV at a higher level, were present in about 3.2% of the patients in our study (Fig. 2B). It is known that leaving ESV contributes to varicocele persistence and can be a factor in varicocelectomy failure.[16] In addition, ESV can be difficult to identify in any surgical procedure without venography. Therefore, although it is an anatomy existing only in a minority of patients, if ESV is detected, ligation of those vessels can reduce the likelihood that treatment will fail.

In laparoscopic varicocelectomy, ISVs are ligated at a higher level (L3-4) than that in open varicocelectomy (L5-S1), laparoscopic varicocelectomy has a clinically useful aspect espe-

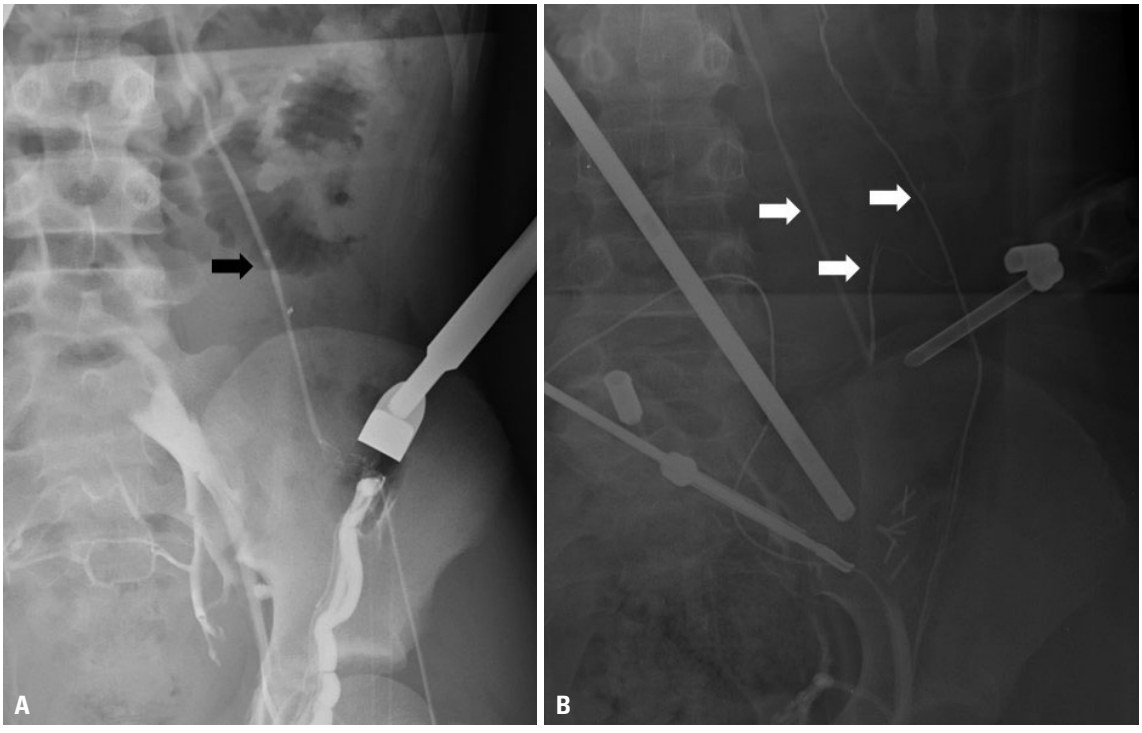

Fig. 2. Bähren types 3 and 4 on intraoperative venography. (A) Bähren type 3, reflux into the testicular vein is duplicated caudally, coalescing into a single trunk at the junction of the renal vein (black arrow). There are collateral veins of ISVs. (B) Bähren type 4, an external spermatic vein merges with the ISVs at a higher level (white arrows). Type 4 shows a competent valve at the renal vein and testicular vein junction, but reflux into renal hilar or capsular collateral vessels that communicate with the testicular vein. ISV, internal spermatic veins.

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cially for young adolescents of small stature and with thin blood vessels. A recent study has shown that a high level ligation of the ISVs may lead to reasonable low hydrocele and recurrence rates, regardless of the varicocelectomy technique used.[17] Also, laparoscopic varicocelectomy may have an advantage in that it can detect Bähren type 4 vessels that can be easily missed in open varicocelectomy without venography.

When patients require reoperation, a Palomo incision and laparoscopic approach are both used at our institution regardless of the method used previously. There was no recurrence after reoperation among the patients in our study. This suggests that remnant veins can be ligated again even with a Palomo incision, since the cause of failure of the first operation is due to a failure to remove all collateral vessels, in most cases. Nevertheless, there is still controversy regarding which approach should be used for repeat varicocelectomy. Çayan and Akbay[18] performed microsurgical subinguinal repeat varicocelectomy in cases of recurrence and reported that the patients that received the repeat procedure had increased sperm parameters, total serum testosterone levels, and fertility, compared to an observation group. Glassberg, et al.[5] recommended that repeat varicocelectomy should be performed in a different way than the previous varicocelectomy so that the veins can be exposed in a different way and to prevent devascularization of the affected testis. However, in our experience, we were able to obtain good results using either a Palomo approach or laparoscopic approach even when the same method was used previously. In such cases, we used the same ap-

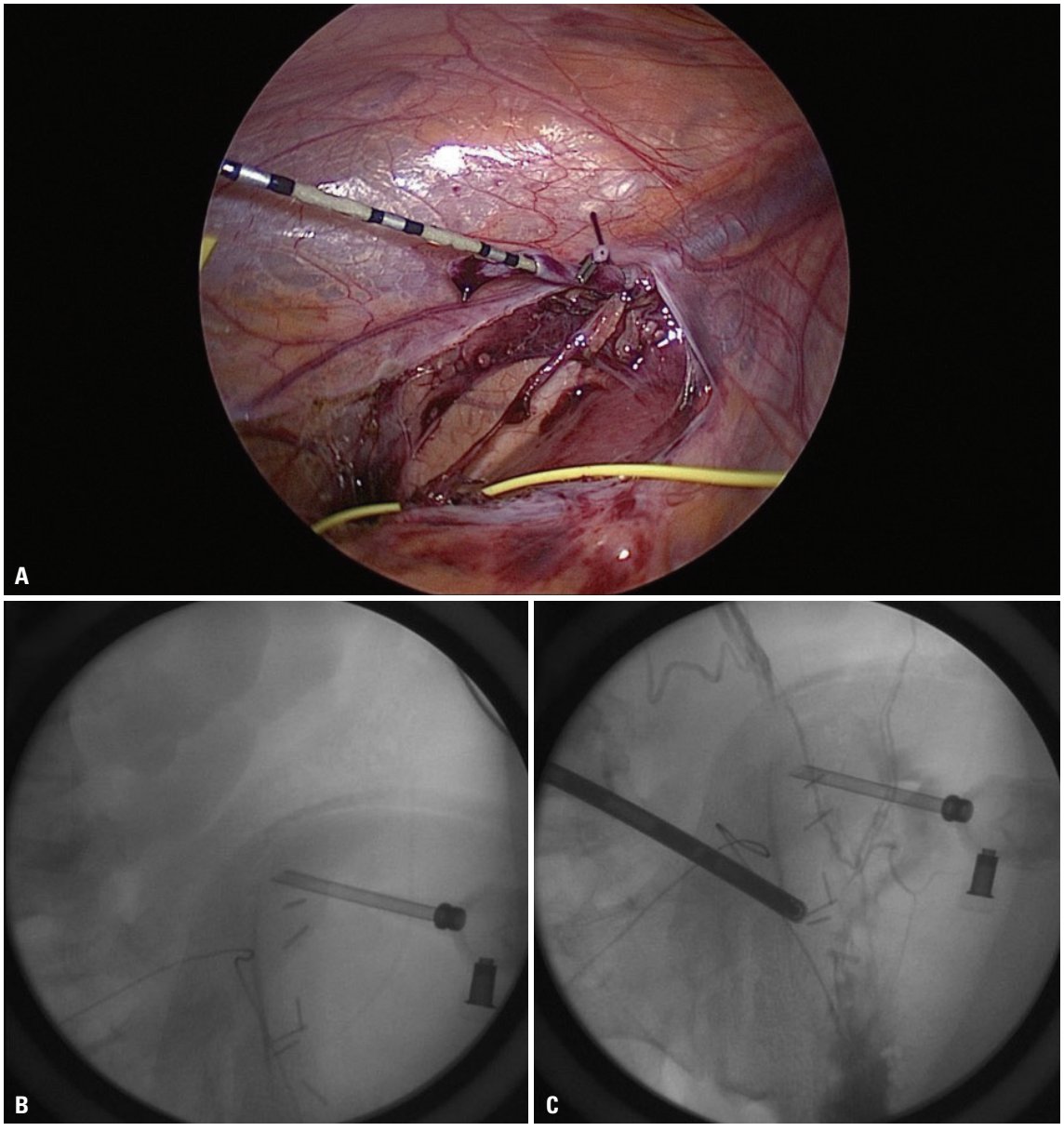

Fig. 3. Procedure of laparoscopic intraoperative venography. (A) Laparoscopic intraoperative venography. (B and C) Comparison of injections of 20 cc (B) of dye and 30 cc (C) of dye during intraoperative venography.

proach, but performed the ligation about 2 cm above the site of the original ligation. Recurrence is typically due either to a failure to remove all of the ISVs in the first varicocelectomy or due to proliferation of the vessels after the varicocelectomy is performed. Therefore, approaching at a similar level and ligating the remnant vessels or newly proliferating vessels may reduce the failure rate of repeat varicocelectomy. In the patients in our study, recurrence was caused by remnant collateral veins (Bähren type 3), and there was no further recurrence after the remnant vessels were ligated.

In intraoperative venography, 30 cc of undiluted Omnipaque was injected in the retrograde direction into the vessel. We did not encounter any safety problems using Omnipaque. Up to 150 cc, or twice the amount per kg body weight that we used, is commonly used in adults. Omnipaque has different limitations depending on whether it is being used for gonadal vein embolization or for intraoperative venography. In gonadal vein embolization, 30 cc of dye cannot be injected into the vein. According to Tay, et al.,[19] after a 7-F multipurpose angiographic catheter (MP A1;Cordis) is placed into the lower pole branch of the renal vein, 20 cc of nonionic contrast medium can be injected by forceful manual injection while the patient performs the Valsalva maneuver. Since the injection of dye into the vein requires strong pressure, there is a risk of applying too much pressure in embolization. On the other hand, in intraoperative venography, more dye can be injected using stronger pressure, because even if the dye leaks out of the vessel, the vessel can be ligated directly on the spot. In our study, among a total of 178 cases, venography failed in nine cases due to extravasation resulting from forceful shooting. In our institution, the dye is injected in two amounts, first 20 cc and then 30 cc, and the veins are photographed after each injection. There were cases in which a small vein that did not appear after the injection of 20 cc of Omnipaque (Fig. 3B) was found after the injection of 30 cc (Fig. 3C). In summary, intraoperative venography can be superior to interventional treatment in terms of the ability to use a greater amount of dye and to detect finer veins.

In terms of radiation dose, intraoperative venography has an additional advantage over radiological intervention. In radiological intervention, the patient is exposed to radiation dose throughout the procedure, with venography being taken continuously. On the other hand, since KUB is performed only two or three times, the patient is exposed only that amount of radiation.

In regards to operation time, overall, there was no significant difference between open varicocelectomy and laparoscopic varicocelectomy. However, operation times for the initial 30 cases of laparoscopy were significantly longer than those of the remaining 27 cases (p<0.05). This was presumably due to the learning curve of the operator. As the number of cases increased, the operation times for laparoscopic varicocelectomy became similar to those for open varicocelectomy.

This study had some limitations. First, since our study was conducted retrospectively, there is the potential for selection bias. Second, since all of the veins, including ESVs, observed during surgery were ligated, we could not assess the clinical significance of ESV. Regarding recurrence, the nine cases of recurrence in our study sample were not enough for meaningful analysis. Prospective multicenter studies should be conducted to fully understand the causes of recurrence. Third, since this study was conducted only on cases where intraoperative venography was performed, there is a limitation in that the results cannot be compared with or without venography. Notwithstanding, to our best knowledge, this is the largest study, to date, of patients who have undergone ASV with intraoperative venography. Also, the current study is the first to examine intraoperative venography using a laparoscopic approach.

In conclusion, the most common reason why varicocelectomies fail is that collateral veins to the ISV are not ligated. This source of treatment failure can be overcome by performing the surgery at a higher level and by increasing the proficiency of the surgeon. In about 3.2% of patients, an ESV merges with the ISV at a higher level than normal and is considered to be an unidentifiable structure if venography is not performed.

DATA AVAILABILITY

The datasets generated during and/or analyzed in the current study are available from the corresponding author upon reasonable request.

AUTHOR CONTRIBUTIONS

Conceptualization: Kyung Tak Oh and Yong Seung Lee. Data curation: Sung Ku Kang, Sung Hoon Kim, and Cho Nyeong Lee. Formal analysis: Kyung Tak Oh and Sung Ku Kang. Methodology: Yong Seung Lee. Supervision: Sang Won Han and Yong Seung Lee. Writing—original draft: Kyung Tak Oh. Writing—review & editing: Sang Woon Kim and Yong Seung Lee. Approval of final manuscript: all authors.

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REFERENCES

1. Feber KM, Kass EJ. Varicocelectomy in adolescent boys: long-term experience with the Palomo procedure. J Urol 2008;180:1657-9.
2. Levitt S, Gill B, Katlowitz N, Kogan SJ, Reda E. Routine intraoperative post-ligation venography in the treatment of the pediatric varicocele. J Urol 1987;137:716-8.
3. Keene DJ, Cervellione RM. Intravenous methylene blue venography during laparoscopic paediatric varicocelectomy. J Pediatr Surg

https://doi.org/10.3349/ymj.2021.62.10.928

2014;49:308-11.
4. Sakamoto H, Saito K, Oohta M, Inoue K, Ogawa Y, Yoshida H. Testicular volume measurement: comparison of ultrasonography, orchidometry, and water displacement. Urology 2007;69:152-7.
5. Glassberg KI, Badalato GM, Poon SA, Mercado MA, Raimondi PM, Gasalberti A. Evaluation and management of the persistent/recurrent varicocele. Urology 2011;77:1194-8.
6. Bähren W, Biehl C, Danz B. Failed sclerotherapy trials with the V. spermatica interna. A retrospective analysis in 1141 patients with idiopathic varicocele. Rofo 1992;157:355-60.
7. Murray RR Jr, Mitchell SE, Kadir S, Kaufman SL, Chang R, Kinnison ML, et al. Comparison of recurrent varicocele anatomy following surgery and percutaneous balloon occlusion. J Urol 1986;135:286-9.
8. Johnson D, Sandlow J. Treatment of varicoceles: techniques and outcomes. Fertil Steril 2017;108:378-84.
9. Goldstein M, Gilbert BR, Dicker AP, Dwosh J, Gnecco C. Microsurgical inguinal varicocelectomy with delivery of the testis: an artery and lymphatic sparing technique. J Urol 1992;148:1808-11.
10. Minevich E, Wacksman J, Lewis AG, Sheldon CA. Inguinal microsurgical varicocelectomy in the adolescent: technique and preliminary results. J Urol 1998;159:1022-4.
11. Fast AM, Deibert CM, Van Batavia JP, Nees SN, Glassberg KI. Adolescent varicocelectomy: does artery sparing influence recurrence rate and/or catch-up growth? Andrology 2014;2:159-64.
12. Huk J, Fryczkowski M, Bihun M, Połać R. Laparoscopic varicocele ligation. The comparative assessment of artery-ligating and artery-preserving varicocelectomy. Wiad Lek 2001;54:621-31.
13. Yu W, Rao T, Ruan Y, Yuan R, Cheng F. Laparoscopic varicocelectomy in adolescents: artery ligation and artery preservation. Urology 2016;89:150-4.
14. Hart RR, Rushton HG, Belman AB. Intraoperative spermatic venography during varicocele surgery in adolescents. J Urol 1992;148:1514-6.
15. Niedzielski J, Paduch DA. Recurrence of varicocele after high retroperitoneal repair: implications of intraoperative venography. J Urol 2001;165:937-40.
16. Chehval MJ, Purcell MH. Varicocelectomy: incidence of external spermatic vein involvement in the clinical varicocele. Urology 1992;39:573-5.
17. Ulusoy O, Karakus OZ, Ateş O, Hakgüder FG, Olguner M, Akgür FM. Successful outcomes in adolescent varicocele treatment with high-level laparoscopic varicocelectomy. J Pediatr Surg 2020;55:1610-2.
18. Çayan S, Akbay E. Fate of recurrent or persistent varicocele in the era of assisted reproduction technology: microsurgical subinguinal redo varicocelectomy versus observation. Urology 2018;117:64-9.
19. Tay KH, Martin ML, Mayer AL, Machan LS. Selective spermatic venography and varicocele embolization in men with circumaortic left renal veins. J Vasc Interv Radiol 2002;13:739-42.