Antegrade Sclerotherapy to Treat All Types of Varicoceles in the Pediatric Population: Experience of a Single Center

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OBJECTIVE To analyze our experience with antegrade sclerotherapy for the treatment of Coolsaet types I, II, and III varicoceles in a pediatric and adolescent population.

MATERIALS AND METHODS Between 2005 and 2015, 73 patients who underwent antegrade sclerotherapy were retrospectively evaluated. Patient age, side, clinical and Doppler ultrasound grade, and anatomical variations were collected. Varicoceles were grouped following Coolsaet's classification: all types were sclerosed. Follow-up consisted in clinical examination 3 and 6 months following surgery and testicular Doppler ultrasound 6 and 12 months following surgery. Patients were then telephonically interviewed. Success was defined as varicocele resolution or reduction to a grade not requiring surgery.

RESULTS Mean patient age was 14.7 years and mean operating time was 50.8 minutes. Based on phlebographic imaging and following Coolsaet's classification, we identified 57 (78.1%) type I, 3 (4.1%) type II, and 13 (17.8%) type III varicoceles. No intraoperative complications were observed. Three patients (4.1%) presented a short-term complication in the form of pampiniform plexus thrombosis; 1 patient also developed wound dehiscence: all complications occurred in Coolsaet type I varicoceles and during surgeon learning curve. No hydrocele occurred. Out of 59 patients with a satisfactory follow-up (range: 14 months-10 years), 2 recurrences occurred, the success rate thus being 96.6%.

CONCLUSION Tauber's antegrade sclerotherapy is a simple and feasible technique, effective in treating all kinds of varicocele with low complication, recurrence, and persistence rates. Phlebography reveals frequent venous anatomical variations, allows grouping of varicoceles into Coolsaet types, and enables performing of sclerosis safely in all 3 kinds. UROLOGY 98: 149–153, 2016. © 2016 Elsevier Inc.

Varicocele is the most common cause of male infertility: approximately 20% of varicocele patients are subfertile, and 20%-40% of subfertile men have varicocele.[1] Moreover, varicoceles are almost exclusive of pubertal boys. Their incidence rises from 2.5% at 10 years of age up to 15% in 15 years-old boys.[2,3]

Indications for varicocele correction in the pediatric and adolescent population have been unanimously established,[4] but still no standard treatment exists, and advantages and disadvantages of each available technique are still discussed. Moreover, most procedures only treat varicoceles secondary to internal spermatic vein reflux (type I by Coolsaet's classification[5]).

The present study reviewed our 10-year experience with Tauber's technique in the treatment of pediatric and adolescent varicoceles by analyzing surgical outcome in terms of recurrence, persistence and complication rates.

MATERIALS AND METHODS

Between May 2005 and January 2015, 73 boys were treated for varicocele with antegrade sclerotherapy in the Paediatric Surgery Division of "A. Gemelli" Hospital in Rome. Patients' medical records were reviewed retrospectively. Patients' details and indications to treatment are summarized in Table 1.

Before surgery, every patient underwent clinical evaluation and was graded according to Dubin and Amelar's classification; testicular volume was assessed by means of testicular ultrasound or clinical evaluation (Prader's orchidometer). Semen analysis was performed only in patients over 21 years of age.

Based on intraoperative phlebographies, varicoceles were grouped in types I, II, and III following Coolsaet's classification[5] that distinguishes:

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Table 1. Patient characteristics, varicocele side, and indications to surgery

Personal Data	Mean (Range)
Age	14.7 (8-29)
Weight	57.9 (25-80)
Varicocele side	No. of patients (%)
Left unilateral	63 (86.3)
Bilateral	10 (13.7)
Indications to surgery	
III grade varicocele	59 (80.8)
Symptomatic varicocele	13 (17.8)
Testicular hypotrophy	5 (6.8)
Associated testicular disease	1 (1.4) monorchid
Abnormal semen analysis	2 (2.7)

- Type I varicocele: early and clear visualization of the internal spermatic vein; no dilated veins in the posterior plexus.
- Type II varicocele: the posterior plexus is dilated, and after contrast medium injection the iliac venous district can be observed.
- Type III varicocele: both portions of the pampiniform plexus are dilated. Two phlebographies are required to show both iliac and internal spermatic venous districts.

Anatomical variations in Coolsaet type I varicoceles were identified and organized, where possible, using Bähren's classification[6] in which the following features are identified:

- Type 0: no evidence of venous reflux on venography.
- Type I: reflux into a single gonadal vein without duplication.
- Type II: reflux into a single gonadal vein that communicates with accessory gonadal, lumbar and/or iliac veins, or the vena cava.
- Type III: reflux into a gonadal vein duplicated caudally, coalescing into a single trunk at the renal vein junction
- Type IV: reflux into a renal hilar or capsular collateral vessel that communicates with the gonadal vein.
- Type V: reflux into a gonadal vein that drains into a circumaortic renal vein.

Patients returned for a physical examination 3 and 6 months after surgery, and underwent testicular Doppler ultrasound 6 and 12 months after surgery. All patients were then interviewed telephonically and asked to submit a questionnaire meant to evaluate long-term outcomes of surgery by investigating presence of symptoms and, if present, additional and more recent ultrasound examinations.

Success was defined as varicocele resolution or reduction to a stage that did not require further surgery; recurrence as the presence of varicocele after at least 1 negative ultrasound and persistence as the presence of an unmodified varicocele at the first postoperative ultrasound.

SURGICAL TECHNIQUE

Under general or local anesthesia, the patient is placed supine in slight anti-Trendelenburg position to allow abdomen exposure to X-ray tube. After disinfection and sterile draping of the operative field, a 1-2 cm long transverse incision is made 2 cm below the external inguinal ring. The subcutaneous tissue is incised and the spermatic chord mobilized and encompassed by a vessel loop. The spermatic fasciae are incised and the pampiniform plexus is exposed. The most dilated vein in the plexus is isolated and a Vicryl loop is positioned both proximally and distally to the vein portion intended for phlebotomy. After proximal suture ligation, phlebotomy is performed and a 3.5 Fr umbilical catheter is introduced in the vein to perform phlebography. The radiation beam is never applied directly on the scrotum. If failure of catheter positioning occurs, the vessel is ligated and the process repeated on a second vein.

If phlebography shows the cannulated vein to drain in the iliac district (Coolsaet type II varicocele), a first sclerosis is performed and the procedure is continued: a second vein is then chosen among those belonging to the anterior plexus and, once phlebography has confirmed its drainage into the internal spermatic vein, sclerosis is performed in this district as well (Figs. 1, 2).

Sclerosis is performed on all types of varicocele using 3% polidocanol in the form of foam. Polidocanol is the most commonly used sclerosing agent in Europe and it has been extensively used in the US as a "home made" foam formulation produced by a variety of manual practices.[7] In 2010, the Food and Drug Administration approved the use of polidocanol in the form of endovenous microfoam to treat small varicose veins. The volume of administered sclerosing agent varies in relation to vasal caliber, varicocele type, and therefore number of carried out scleroses.

Before sclerosing agent is injected, the cannulated vein is filled with contrast material to accurately control the progression of the sclerosing agent. The sclerosing agent pulls the contrast medium forward and its injection is continued until complete disappearance of contrast medium is documented by fluoroscopy. During the whole injection, pressure is applied on the patient's left hypochondrium or, if the patient is conscious, he is instructed to perform Val-

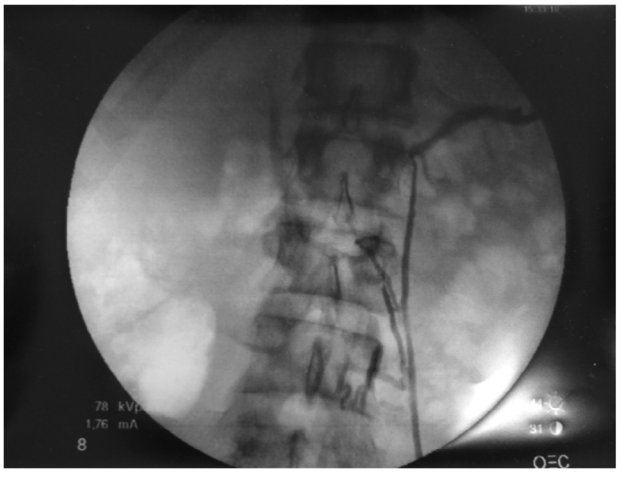

Figure 1. Type I varicocele. The cannulated vein drains in the internal spermatic vein. Note the presence of anastomoses with ureteral veins and the contralateral internal spermatic vein.

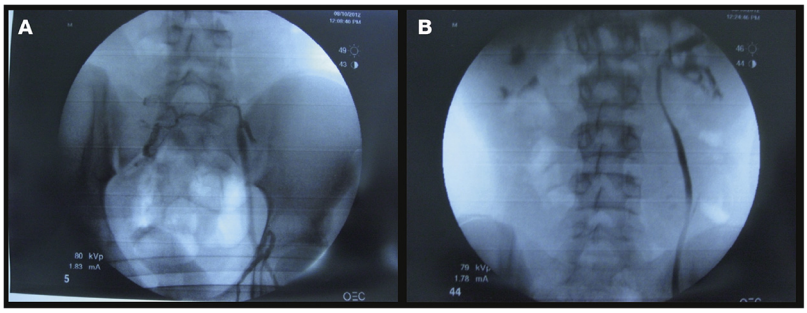

Figure 2. Type III varicocele. **(A)** The cannulated vein showed a drain in the iliac district with testicular contralateral anastomoses. A first sclerosis is performed and then a second vein is chosen among those belonging to the anterior plexus. **(B)** Phlebography confirmed its drainage into a dilated internal spermatic vein and sclerosis is performed in this district as well. (Color version available online.)

salva's maneuver. This precaution cannot be employed during sclerosis of a vein draining in the iliac district, as pressure applied in the lower abdomen (fossa) would mask the phlebographic finding. The cannulated vein is then ligated on both sides of phlebotomy, and cutaneous and subcutaneous planes are sutured.

RESULTS

Mean operating time was 50.8 minutes (range 25-130) and mean effective dose for phlebography was approximately 1.2 mSv. A mean volume of 2.46 mL of polidocanol was used (range: 1-5 mL).

In 4 patients, the first phlebotomy failed, but in all cases surgery was carried out successfully by dissecting and cannulating a second vein.

Based on intraoperative phlebography, using Coolsaet's classification we identified the following: 57 patients (78.1%) presenting type I varicocele, 3 patients (4.1%) presenting type II varicocele, and 13 patients (17.8%) presenting type III varicocele.

Anatomical variations of type I varicoceles, grouped using Bähren's classification, were numerous, as shown in Table 2.

Early complications, all minor, were observed in 3 patients out of 73 (4.1%): 3 patients presented with pampiniform plexus phlebothrombosis, and in 1 patient wound dehiscence also occurred. No hydrocele occurred following surgery. No complications secondary to sclerosing agent migration in other districts were noted.

A satisfactory follow-up was conducted on 59 out of 73 patients who underwent surgical correction (80.8%). Out of these 59 patients, 1 case of varicocele recurrence and 1 case of varicocele persistence were noted, the success rate therefore being 96.6%. The recurrence occurred in a patient presenting type III varicocele, whereas the persistence occurred in a patient presenting a varicocele initially misinterpreted as type II, but correctly identified as type III during the second, successful operation. Four patients showed varicocele persistence with significant grade reduction (to grades I or II): as there was no further indication to surgery, these patients were considered in the success group.

COMMENT

The recommended indication criteria for varicocelectomy in children and adolescents are well established and widely accepted.[4] They are: varicocele associated with a small testis, varicocele patients presenting an additional condition that affects fertility, bilateral palpable varicocele, symptomatic varicocele, and varicocele associated with pathological sperm quality (in older adolescents).

However, numerous treatment options employing surgical, radiologic, or combined methods have been described, and no gold standard has yet been established. In addition, most techniques only treat type I varicoceles.

Historically, varicocele's surgical treatment was based on Palomo or Ivanissevich techniques, but both procedures have been related to many limitations and complications. As reported by Diegidio et al, the Palomo technique is quick, easily performed, and cost-effective, but testicular artery ligation can lead to subsequent hypotro-

Table 2. Anatomical variations of type I varicoceles, grouped using Bähren's classification

Anatomical Variation	Bähren Type	No. of Patients (%)
No variation	I	40 (54.8)
Collateral veins branching from internal spermatic vein	II	11 (15.1)
Testicular-lumbar anastomoses	II	4 (5.5)
Multiple internal spermatic veins	III	14 (19.2)
Internal spermatic vein bifurcation at its termination in renal vein	IV	2 (2.7)
Anastomoses between deferential vein and contralateral testis	—	2 (2.7)

phy, and ligation of adherent lymphatic vessels causes iatrogenic hydrocele in as much as 9% of patients.[8] Moreover, this technique does not treat type II or III varicoceles. The Ivanissevich technique demands a higher operating time; types II and III varicoceles remain untreated and hydrocele rates are only slightly reduced, owing probably to the sole sparing of periarterial lymphatic vessels.[9] Furthermore, no study has yet demonstrated that artery ligation leads to actual testicular damage.[10-12] In recent years, the Palomo and Ivanissevich techniques have been increasingly performed using laparoscopy, therefore adding to the inherent limitations of these techniques those of a laparoscopic approach: the resulting surgery is costly, invasive (the surgeon cuts twice through the peritoneum), and offers a dubious aesthetic advantage as it provides multiple scarring. Furthermore, hydrocele and varicocele recurrence rates remain overall unaltered.[8] Ligation of single veins in the pampiniform plexus can also be performed at an inguinal or subinguinal level, resulting in treatment of all types of varicocele. However, this technique exposes to a certain risk of damaging other funicular structures such as the vas deferens, and, as shown in a review by Diegidio et al,[8] no benefits occur in regard to both hydrocele and recurrence rates. On the contrary, the technique becomes highly efficient when accompanied by the use of an operating microscope, as described by Goldstein et al in 1992, and performed at a subinguinal level, as developed by Mirilas and Mentessidou in 2012.[13,14] Mean secondary hydrocele rates dropped to 0.72% and recurrence rates to 2.07%, with other studies reporting better results still.[8,14] Disadvantages may be related to operating time, cost, and necessity to obtain a higher magnification in pediatric and adolescent populations.[15,16] An alternative to surgery is retrograde sclerotherapy, which uses a percutaneous radiological approach to treat any kind of varicocele with an endovascular injection of sclerosing agent. This minimally invasive, artery and lymphatic-sparing method is scarcely recommended in younger patients because of high recurrence and failure rates.[17,18]

Tauber et al first introduced antegrade sclerosis in 1989[19]: this technique is feasible in almost all patients, has a low complication rate, and, as opposed to retrograde sclerosis, is particularly efficient in a pediatric population. Tauber and Pfeiffer and Galfano et al report a 9% failure rate in adults and lower failure rates in children and adolescents (6.5% in Galfano et al's population, 3% in Tauber and Pfeiffer's population).[20,21] Endovascular sclerosis employed by this technique allows lymphatic vessels sparing, reducing iatrogenic hydroceles to the minimum. In Tauber and Pfeiffer's original approach, however, only type I varicoceles are treated, even though sclerosis can safely be applied to all 3 conditions, as shown by our experience. We performed sclerosis in all types of varicoceles, using additional safety measures like polidocanol foam and contrast medium blockage. The foam ensures friction between the sclerosing agent and the vessels' walls, allowing greater control on its progression and, therefore, reducing the possibility that it will reach the renal or internal iliac vein. The contrast medium blockage is obtained by injecting the sclerosing agent immediately after the contrast medium: the latter will therefore act as a barrier to the sclerosing agent's passage, and its progression will accurately be noted by observing the gradual disappearance of the contrast medium signal.

According to Tauber and Pfeiffer's approach, we performed sclerosis after cannulation of the most dilated vein in the pampiniform plexus. This led to the finding of a considerable amount of patients presenting venous dilation in the hypogastric district (21.9%). In 1 of these patients, treated with sclerosis in the sole hypogastric district, we observed varicocele persistence, which required further surgery. During the second operation, we cannulated a vein of the anterior plexus and treated the patient successfully. Following this experience, we decided to treat type II varicoceles with sclerosis of both the posterior and anterior plexus, even in the absence of an obvious dilation of a vein belonging to the anterior plexus.

In our study, both recurrence rates (3.4%) and complication rates (4.1%) are consistent with previous studies. No hydroceles occurred.

In our experience, this procedure is proven feasible and efficient, as no complications arose in patients treated for type II or III varicocele. All pampiniform plexus thromboses were noted in patients treated for type I varicocele and all occurred during the first year since the described technique had been adopted. They were therefore probably due to operator learning curve and local sclerosant spillage.

As reported by many studies, variations in venous anatomy of the testicular district are very frequent.[22-25] Phlebography performed in an antegrade fashion allows contrast medium to flow according to the physiological blood drainage and therefore enables a faithful visualization of venous anatomy. In our population, 54.8% of varicoceles were Bähren type 1, 20.5% were Bähren type 2, 19.2% were Bähren type 3, and 2.7% were Bähren type 4. No type 5 was noted. These results are not consistent with those noted by Nagappan et al, as these authors reported 74.1% Bähren type III varicoceles.[25] Moreover, Bähren's classification only accounts for internal spermatic vein varicoceles, whereas 2 patients out of 16 who underwent deferential vein phlebography (12.5%) showed deferential course variations in the form of anastomoses with contralateral testis.

CONCLUSION

In our experience, Tauber and Pfeiffer's antegrade sclerotherapy has been proven a feasible and simple technique, effective in treating all kinds of varicocele with low complication, recurrence, and persistence rates. We confirm that antegrade phlebography is effective in clarifying the complexity of testicular venous drainage. Accurate identification of all 3 Coolsaet types of varicoceles allows performing of sclerosis also in both internal spermatic and deferential vein districts, thus bringing advantages in terms of total recurrences.

Finally, we believe that to further reduce the recurrence or persistence rates in the treatment of varicocele, more at-

tention should be given to diagnosing and treating types II and III varicoceles: for this reason, phlebography should always be performed. In our experience, antegrade sclerosis is proven effective in the pediatric population; nevertheless, further prospective studies should be carried out.

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