Paediatric Urology

In a study from Italy, colour-Doppler ultrasonography was a reliable diagnostic tool in the preoperative assessment of patients with varicocele. The authors also found that it helped to distinguish those who could be treated laparoscopically from those who should be treated by microsurgical subinguinal ligature.

The role of Doppler ultrasonography in determining the proper surgical approach to the management of varicocele in children and adolescents

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OBJECTIVE

To investigate whether colour Doppler ultrasonography (CDUS) is a reliable diagnostic tool for selecting patients with varicocele to undergo either laparoscopy or open microsurgical subinguinal ligation.

PATIENTS AND METHODS

In a 3-year period, 42 boys affected by left varicocele were evaluated before surgery by inguinal and scrotal CDUS. Using this method it was possible to distinguish Coolsaet type-1 varicocele (due to isolated renal-internal spermatic vein reflux) and Coolsaet type-3 varicocele (due to associated renal-internal spermatic reflux and iliac-deferential reflux). Boys with Coolsaet type-1 varicocele were treated by a laparoscopic transperitoneal Palomo procedure, whereas those with Coolsaet type-3 varicoceles were treated by lymphatic-sparing microsurgical subinguinal ligation.

RESULTS

The varicocele was Coolsaet type-3 in six patients (14%), who had microsurgical open surgery, and the remaining 36 (86%) had Coolsaet type-1 and had laparoscopic surgery. At the follow-up there was no venous scrotal reflux. In two patients in the laparoscopic group a hydrocele developed after surgery, which resolved spontaneously.

CONCLUSIONS

This study showed that CDUS was a reliable diagnostic tool for assessing boys with varicocele. It clearly distinguished Coolsaet-type 1 varicoceles that can be treated laparoscopically, from Coolsaet type-3 varicoceles that should be treated with microsurgical subinguinal ligature.

KEYWORDS

varicocele, ultrasonography, colour Doppler, deferential reflux, adolescents, laparoscopy

INTRODUCTION

Varicocele is a well-established cause of male infertility [1], giving rise to a progressive and time-dependent impairment of spermatogenesis [2] and a significant volume loss of the ipsilateral gonad [3]. For this reason, the repair of varicocele at the time of presentation is widely advocated, as it can prevent testicular damage, as indicated by the increase in testicular volume after such surgery in patients with testicular hypotrophy

[4], and the improvement in semen variables [5]. The younger the patient when the varicocele is repaired the more likely the testis will recovery from varicocele-induced injury [6]. However, the ideal method for treating a varicocele remains controversial; the standard technique should provide for a low incidence of recurrences and complications after surgery, optimum testicular function, and should be cost-effective.

Several studies have examined different techniques to ascertain differences in efficacy and outcome. Although the short-term results are similar, the open microsurgical methods seem to cause fewer long-term complications, e.g. recurrences and hydrocele [7,8]. More recently, the transperitoneal laparoscopic and the retroperitoneoscopic approach to varicocele were described as feasible techniques, and their results were comparable to those of open surgery or radiological treatment [9].

However, little attention has so far been paid to the different aetiopathogenetic types of varicocele to outline the pros and cons of the different surgical techniques. Using the laparoscopic or retroperitoneoscopic approach, or sclero-embolization of the internal spermatic vein, the varicocele is treated according to the rationale of the Palomo technique; treatment is therefore successful only in Coolsaet type-1 varicoceles, which occur in two-thirds of cases in venographic studies [10]. The other patients may have persistent or recurrent varicocele, due to other components of the venous reflux, e.g. iliac-deferential reflux.

The aim of the present study was therefore to investigate whether colour-Doppler ultrasonography (CDUS) is a reliable diagnostic tool to assess the spermatic vessels and the related venous collateral network responsible for reflux, and thus select patients based on their type of venous reflux, consequently choosing the appropriate surgical approach. Hence, Coolsaet type-1 varicoceles can be treated laparoscopically, whereas Coolsaet type-2 and 3 varicoceles should be treated by microsurgical subinguinal ligature.

PATIENTS AND METHODS

During a 3-year period, 42 boys (mean age 10.25 years, range 6–16) were treated in our department for a left clinical varicocele. All patients were evaluated before surgery by scrotal examination while supine and upright, and by inguinal and scrotal CDUS, always performed by the same physician (M.P.). A linear multifrequency 7–13 MHz transducer, connected to a Prosound SSV500 system (Aloka, Japan) with a pulse-rate frequency at 1.5 kHz and colour gain at 60% in colour-Doppler mode, was used for the examination.

The testicular volume was calculated as $0.52 \times \text{length} \times \text{width} \times \text{thickness}$ of the testicular ellipsoid, with testicular hypotrophy defined, after serial measurements (three times at least), as a difference in volume between the testes of >2 mL [11,12], or >20% [13] in younger boys. The transverse diameter of dilated veins was measured (the maximum vein diameter considered normal was 3 mm while both supine and upright) [14], and the presence of intratesticular venous reflux was investigated.

The venous testicular network was then assessed using CDUS. A Valsalva manoeuvre was required to enhance the spermatic reflux into the scrotal veins. A venous reflux lasting for >2 s when both upright and supine was considered abnormal. Finally, both the inguinal canal and the left iliac fossa were examined to evaluate any possible retrograde refluxing blood flow in the internal spermatic vein and/or in the deferential vein.

The internal spermatic vein can be easily identified along the inguinal canal. After detecting the left iliac fossa, the deferential vein can also be easily identified as an arch over the external iliac vessels, running from the internal inguinal orifice down the pelvis and joining the internal iliac vein through the vesical vein (Fig. 1). First, the probe was positioned along the inguinal canal to identify the internal spermatic vein. The probe was then moved medially and positioned just above the pubic tubercle, ensuring that it was kept along the longitudinal axis of the iliac vessels. The probe was in the correct position when the iliac artery flow was shown as red (the flow moves towards the probe) and the iliac vein flow as blue (the flow moves away from the probe).

The left external iliac artery was used as a landmark (Fig. 2). In healthy boys, the deferential vein is not visible on CDUS either at rest or after a Valsalva manoeuvre. When reflux was evident in the internal spermatic vein, detected in the inguinal canal but not in the deferential vein, we concluded that there was a renal-internal spermatic vein reflux (Coolsaet type-1 varicocele.)

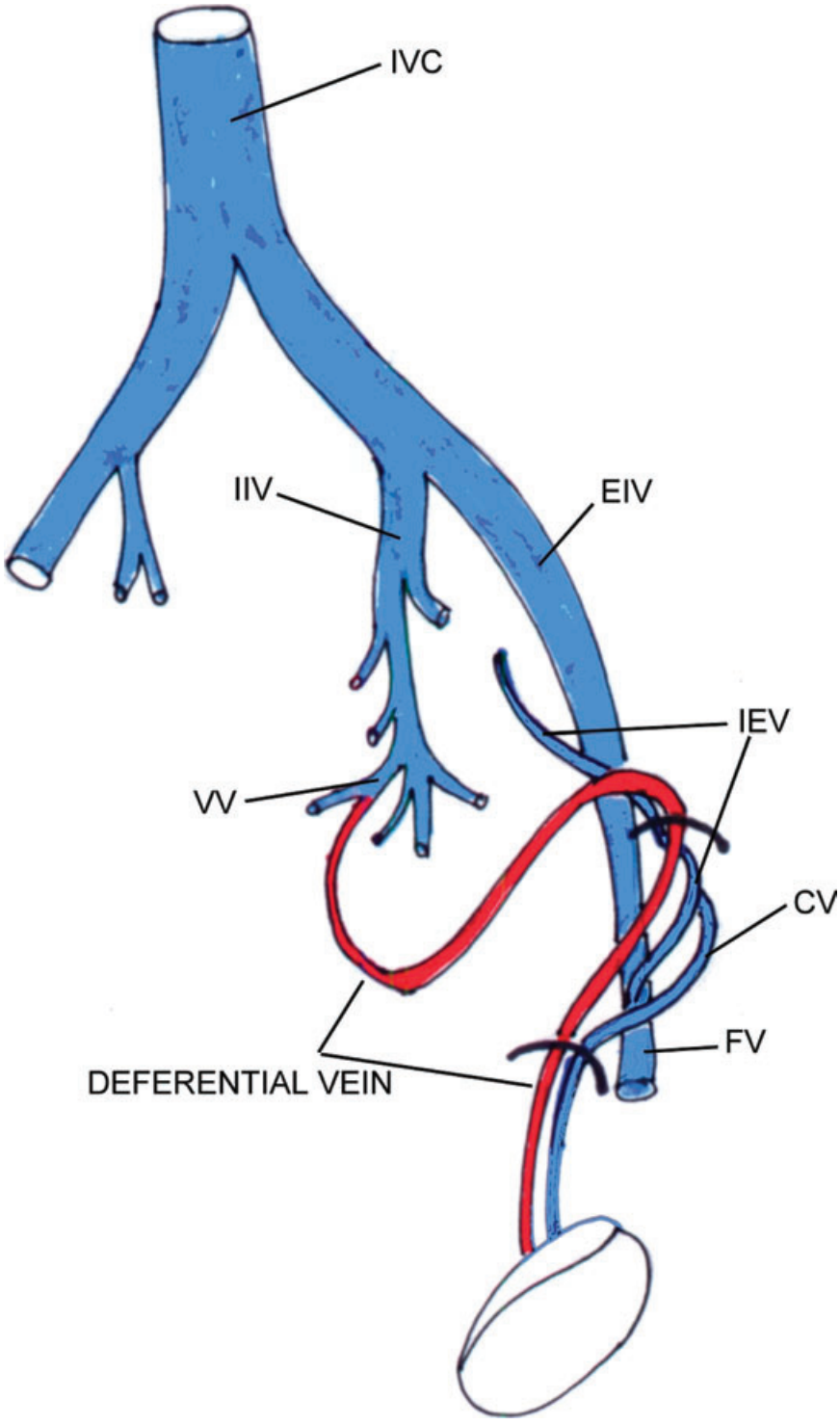
Only if dilated, and consequently refluxing, did the deferential vein become visible, the CDUS image changing from blue (normal venous flow) to red (refluxing flow). In Fig. 3, at rest, the deferential vein can be identified as blue and, beside it, the trace of its normal flow, visible under the baseline (the flow is negative because it moves away from the probe). Figure 4 shows the sequence of deferential reflux under Valsalva manoeuvre; on the left, the deferential vein is in the refluxing phase, and thus shows as red, and the trace of its flow is inverted, visible above the baseline (the flow is positive because it moves towards the probe). On the right, at rest, the deferential vein is again not refluxing, is shown as blue, and its flow returned to below the baseline, as noted above.

When the internal spermatic vein and deferential vein were both visible and refluxing, we concluded that there was an associated reflux, both renal-internal spermatic and iliac-deferential reflux (Coolsaet type-3 varicocele). During open surgery the deferential veins were easily identified, running as satellites of the vas deferens (Fig. 5).

In the present series, patients were treated surgically following the Dubin-Amelar criteria [15], i.e. grade III varicocele (dilated veins visible at physical examination) and grade II (dilated veins palpable but not visible), the latter presenting with pain and/or scrotal discomfort and/or testicular asymmetry with hypotrophy of the left side.

Boys affected by Coolsaet type-1 varicocele (isolated renal-internal spermatic vein reflux) had laparoscopic treatment according to the transperitoneal Palomo procedure; those with Coolsaet type-2 (isolated iliac-deferential reflux) and type-3 varicocele (renal-internal spermatic vein reflux associated with an iliac-deferential vein reflux) were treated with a subinguinal lymphatic-sparing microsurgical ligature of the dilated veins. The clinical examination and CDUS were repeated at 1, 3 and 12 months after surgery, and then every year.

FIG. 1. Vascular anatomy of the testicular venous posterior group, showing in red the deferential vein joining the internal iliac vein through the vesical vein. IVC, inferior vena cava; EIV, external iliac vein; IIV, internal iliac vein; VV, vesical vein; IEV, inferior epigastric vein; CV, cremasteric vein; FV, femoral vein.



RESULTS

Thirty-one boys (74%) had a grade III and 11 a grade II varicocele; of the boys with a grade II varicocele, seven reported left scrotal discomfort or pain. Of the 42 patients, 17 had testicular asymmetry, 13 with grade III varicoceles and four of 11 with grade II.

CDUS showed that the varicocele was Coolsaet type-3 in six boys, and Coolsaet type-1 in the remaining 36. There was no isolated iliac-deferential reflux (Coolsaet type-2). There was no clinical correlation between grade, type of varicocele and physical appearance or symptoms; in Table 1 the different features are correlated, showing no significant statistical relationship by chi-square and Student's *t*-tests.

Laparoscopy was therefore used in 36 boys and lymphatic-sparing microsurgical open surgery in six. At the follow-up (0.5–3 years), the same CDUS procedure as used before surgery was repeated; none of the patients had venous scrotal reflux after a Valsalva manoeuvre, when either upright or supine. The deferential vein, previously identified as refluxing, was not apparent during the follow-up. There was persistence of dilated but nonrefluxing veins in 13 boys; of these, two still showed dilated veins at the 1-year follow-up CDUS. In two patients who had laparoscopy a hydrocele developed, which resolved spontaneously in both.

DISCUSSION

It is widely accepted that children and adolescents with testicular growth retardation ipsilateral to the varicocele may represent an 'at-risk' group for late infertility [16,17]. Moreover, it was stated that patients with grade III varicocele had a significantly smaller left testis than controls at each Tanner stage ($P \leq 0.05$), and these patients are at risk of bilateral volume loss. Early surgical intervention is recommended in this group [18].

Thomas and Elder [19] reported, in a series of 124 boys aged 7–18 years, testicular growth arrest in 13 of 33 (39%) of those with grade II and 47 of 84 (56%) with grade III varicoceles ($P < 0.01$). Cozzolino and Lipshultz [17] stated that many adolescents with varicocele will need to be treated because there is convincing evidence that a varicocele might have a progressive toxic effect on the testes that may ultimately result in irreversible infertility if left untreated.

Varicoceles are often corrected in boys before puberty; Riccabona *et al.* [6] treated 121 boys and young adolescents (mean age 12 years), Koyle *et al.* [20] treated 122 patients age 9–19 years, Esposito *et al.* [21] reported

278 children aged 7–17 years treated in a multicentric study, and Thomas and Elder [19] reported a series of 124 boys aged 7–18 years.

From these data we decided to always correct a left varicocele in every patient with a Dubin-Amelar grade III varicocele. Furthermore, in the present series, grade II varicoceles were only treated if associated with an ipsilateral testicular volume loss of >2 mL (or >20% in younger boys) and/or testicular symptoms. A 6-year-old boy had a grade III primary varicocele and imaging studies showed no secondary cause of the varicocele. Based on the report by Cozzolino and Lipshultz [17], that a varicocele is a progressive lesion, we considered that the boy was better served with an early correction.

Various therapeutic strategies show that no single approach can be adopted as the best [1,9]. Some authors prefer percutaneous embolization or sclerosis, others prefer retroperitoneal, inguinal or subinguinal open surgery; only a few surgeons approach the varicocele using a microsurgical venous bypass. The laparoscopic or retroperitoneoscopic treatment of varicocele has recently been advocated as a simple, safe and effective technique, and its results in terms of recurrence and complication rates are comparable with those from the other procedures.

However, a review of published reports shows that little attention has so far been paid to the different types of venous reflux (renal-internal spermatic and/or iliac-deferential reflux) in selecting the best surgical procedure. We think that the right approach to treating a varicocele should be based only on a correct understanding of the Coolsaet type. Otherwise, every surgical technique should imply the mandatory interruption of all venous networks potentially causing reflux. Hence, the only effective technique should be subinguinal ligation, which clearly exposes the vessels, thus allowing the sectioning of all networks (internal spermatic vein, cremasteric vein, deferential vein(s)). However, the Palomo and Ivanissevich techniques, either by open surgery or laparoscopically or retroperitoneoscopically, can only be used to treat Coolsaet type-1 varicoceles. Therefore, many varicoceles due to venous reflux involving not only the internal spermatic vein remain untreated, thus causing variable varicocele recurrence rates.

FIG. 2. On the left, the external iliac artery, in red. On the right, the peculiar Doppler trace of arterial flow. This artery is the landmark for identifying the deferential vein.

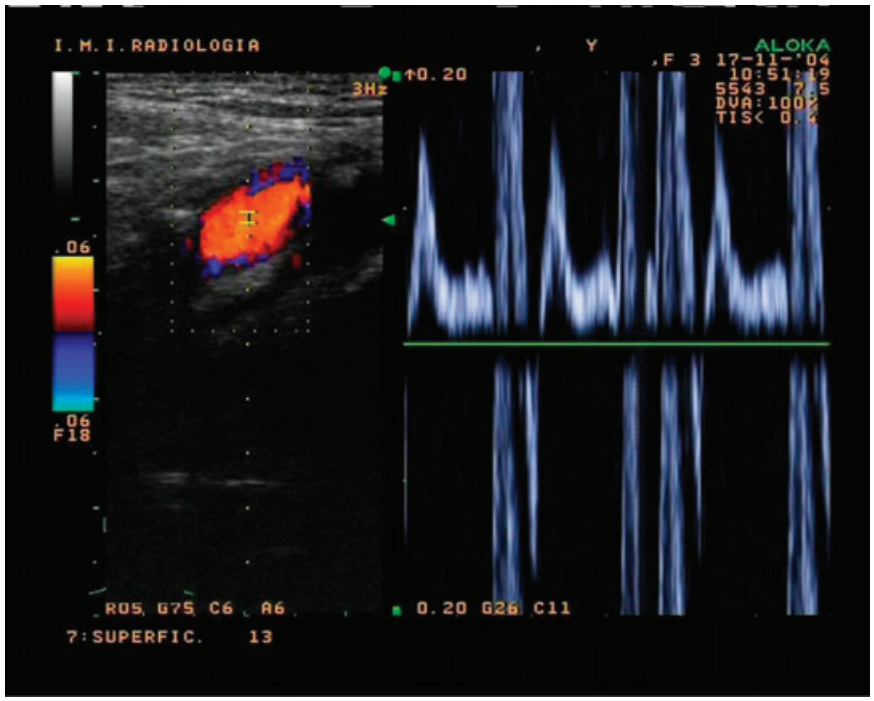
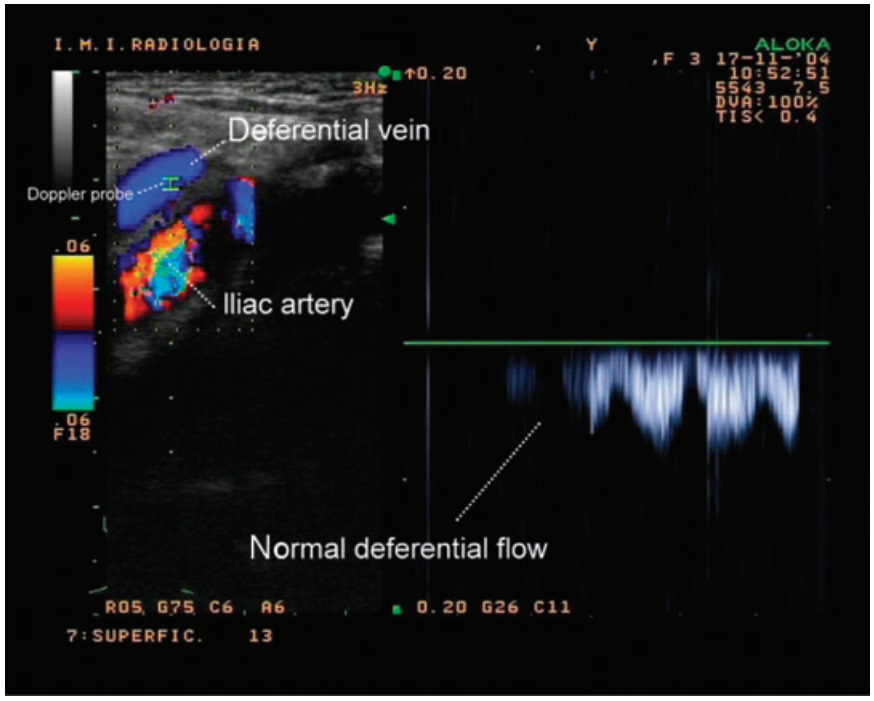


FIG. 3. The deferential vein is clearly visible (blue), running over the iliac artery. Adjacent, the related Doppler trace, showing normal venous flow under the baseline.



Hence, we think that the right approach to a varicocele should not be 'how to treat' but 'how to diagnose and then to treat' the different types of varicocele. In this framework, a venographic study before surgery is not acceptable in childhood and early adolescence, as in most cases it can only be carried out under general anaesthesia.

FIG. 4. The sequence of deferential reflux under Valsalva manoeuvre. On the left, the deferential vein is in the refluxing phase, changing colour from blue to red. Beside, the Doppler trace clearly shows the inversion of flow (venous flow above the baseline). On the right, at rest, the deferential vein is now not refluxing and the flow has returned under the baseline.

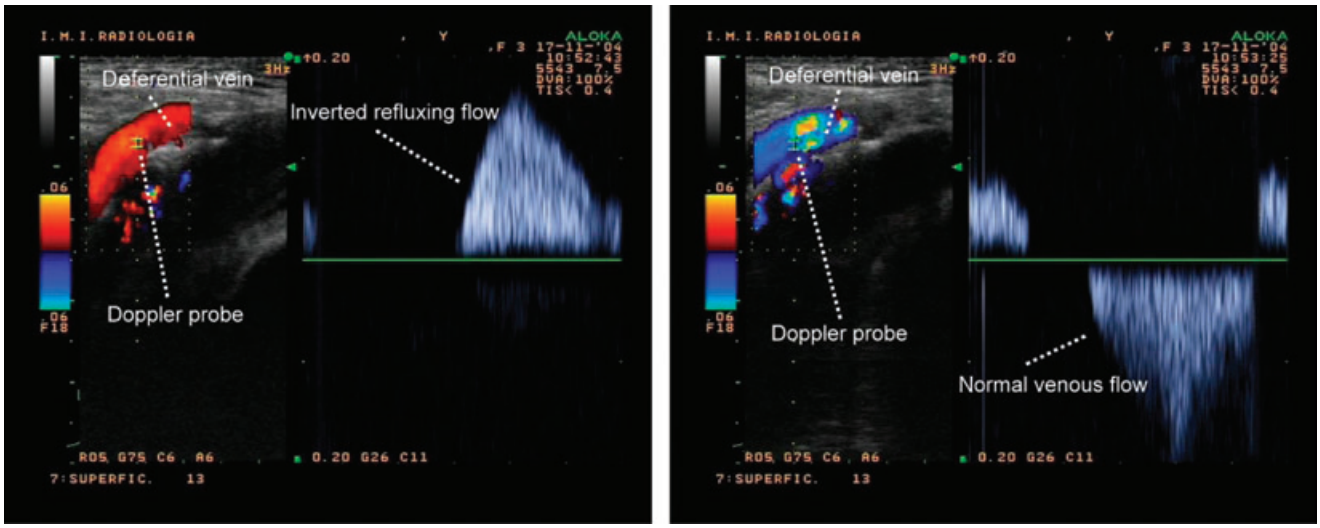
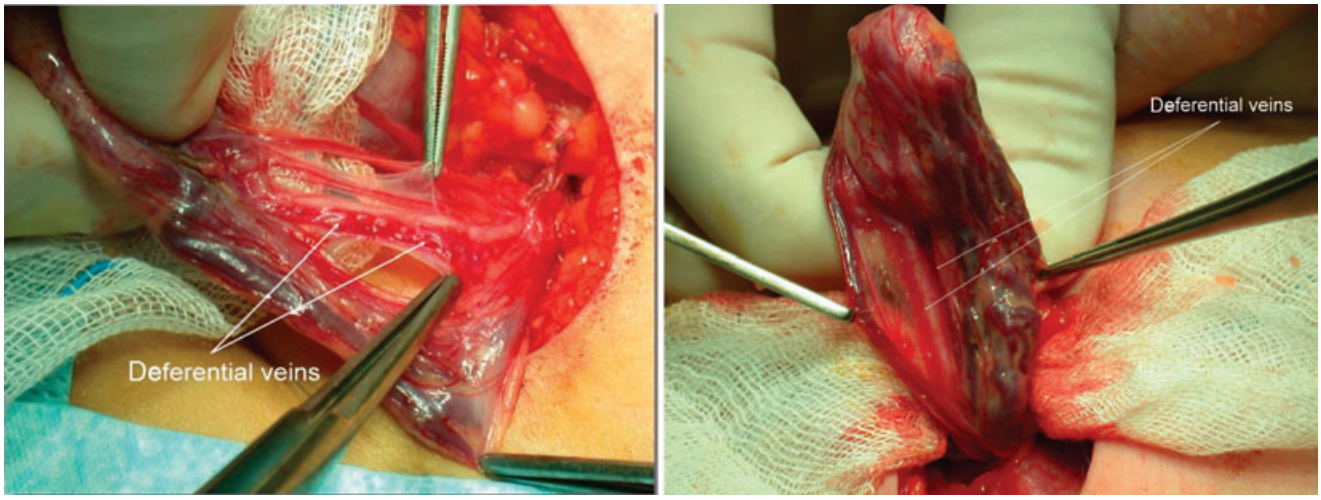


FIG. 5. The appearance at open surgery of dilated deferential veins.



Variable	Grade [15], n (%) II	III	Total
Number of patients	11	31	42
Coolsaet type [10]:			
Type 1	9	27 (87)	36 (86)
Type 3	2	4 (13)	6 (14)
Testicular asymmetry [11–13]	4	13 (42)	17 (40)
Symptoms*	7	6 (19)	13 (31)

**Testicular pain or discomfort.*

TABLE 1
The correlation between grades, types, testicular asymmetry and symptoms. None of the differences were statistically significant

Instead, to distinguish Coolsaet type-1 varicocele from type-2 and -3, CDUS can be useful before surgery; indeed, the deferential vein, which is a satellite of the vas deferens, is invisible on CDUS in healthy boys, either at rest or under a Valsalva manoeuvre. It only becomes visible if dilated and refluxing, when the CDUS image changes from blue (normal venous flow) to red (refluxing flow), and the flow is inverted. To detect such a change easily, the left external iliac artery can serve as a landmark, as the deferential vein runs over it

and arches downwards. The latter can be easily identified as an arch over the external iliac vessels running from the internal inguinal orifice down the pelvis and joining the vesical vein.

This diagnostic evaluation provides the opportunity to clearly identify Coolsaet type-1 varicoceles as the only ones that can be treated laparoscopically by a transperitoneal non-artery-sparing ligature of the internal spermatic vessels. Furthermore, by CDUS we clearly diagnosed Coolsaet type-3 varicoceles involving deferential vein(s) reflux, that were approached by a microsurgical lymphatic-sparing subinguinal ligation. There were no Coolsaet type-2 varicoceles resulting from an isolated iliac-deferential reflux. Moreover, according to the venographic studies of Franco *et al.* [22], who challenged the existence of cremasteric vein reflux, we did not investigate the presence of this component of the varicocele.

Evaluating the spermatic venous networks by CDUS is easy, noninvasive and creates no risk for the patient, whereas venography, which can also be used for obtaining the same information, does not have the same favourable characteristics, safety and comfort of CDUS. While venography gives a comprehensive picture of the spermatic vessels, anatomical variations (e.g. if there is more than one spermatic vein, or a rare venous by-pass) do not imply, straightforwardly, the presence of anomalous reflux and consequently the failure of surgical correction for the varicocele. Unfortunately, it is rather difficult to validate CDUS against venography, as understandable ethical reasons prevent the use of venography under general anaesthesia in children if the only purpose is to obtain a control value. We consider that the present study was ethical, based on the results, and to date there has been no recurrence of varicocele.

The use of CDUS has improved the results of managing varicocele from a recurrence rate of 2.5% [8] with microsurgical subinguinal venous ligation, to none in the present study using laparoscopy or open surgery in selected cases. These results are comparable with those in other reports both after a laparoscopic approach (recurrence rate 0–2.2% [23–26]) or microsurgical inguinal ligation (0–3.5% [27–30]). A hydrocele occurring after surgery, but spontaneously resolving was reported in 4.7% of patients undergoing laparoscopic procedures. However, not all the dilated scrotal veins after surgery are necessarily refluxing. Only CDUS or pulsed-Doppler can detect the inversion of flow after a Valsalva manoeuvre. In our experience, reflux is present only if the inversion of blood flow persists for >2 s. In the present series, 31% of patients had residual dilated veins after surgery, but none of these were refluxing.

In conclusion, our experience of managing varicoceles has changed markedly in the last 3 years; we have sought a diagnostic tool, different from venography, for clearly distinguishing Coolsaet type-1 varicoceles that can be treated laparoscopically, from Coolsaet type-3 that can be treated with a microsurgical subinguinal ligature. CDUS has provided a better understanding of varicocele pathophysiology, as it allows a clear differentiation between type-1 and type-3 varicoceles.

CONFLICT OF INTEREST

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Abbreviations: **CDUS**, colour Doppler ultrasonography.