Best practice in the diagnosis and treatment of varicocele in children and adolescents

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Abstract: A varicocele is an abnormal dilation of the pampiniform plexus of veins in the scrotum which begins at puberty in approximately 15% of males. Although common in the general population and often asymptomatic, varicoceles are associated with gonadal dysfunction including testicular atrophy, infertility, and hypogonadism in a subset of men diagnosed later in life. Because of the high prevalence and uncertain pathogenesis, definitive management guidelines for varicoceles diagnosed in the pediatric and adolescent population remain poorly defined. The varicocele is the most common etiology of male factor infertility, and treatment in the pediatric and adolescent population may improve semen quality and improve fecundity in adulthood. Evaluation of the pediatric and adolescent varicocele should include history, physical exam, and measurement of testicular volume with orchidometer or ultrasound. Testicular volume differentials and peak retrograde flow on Doppler ultrasonography are important factors in risk stratification of the pediatric varicocele population. Semen analysis and reproductive endocrine assessment should also be considered as part of the workup for adolescent patients. A variety of treatment approaches exist for varicocele, and while the microsurgical subinguinal approach is the gold standard for the adult population, it has yet to be confirmed as superior for the adolescent population. Referral to an andrologist for the adolescent patient with varicocele should be considered in equivocal cases. While active treatment of varicocele in the pediatric and adolescent population is controversial, it is clear that some untreated patients will suffer symptoms later in life, while overtreatment remains a concern for this large, vulnerable population. Therefore, surveillance strategies and improved accuracy in diagnosis of clinically important pediatric varicoceles prompting treatment are needed in the future.

Keywords: adolescent varicocele, fertility, pediatric varicocele

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Overview

A varicocele is defined as an abnormal dilation and tortuosity of the pampiniform plexus venous system that drains the testis. The prevalence of varicocele in the adolescent population has been shown to mirror that of adults. A recent European study that included over 7000 patients found a 15.7% varicocele rate in young males with a median age of 19.[1] The prevalence of varicocele in prepubescent boys younger than 10 years of age was much lower at <1%. In 2000, Akbay and colleagues reported a 0.8% prevalence in boys aged 2–6 years, 1.0% at 7–10 years, 7.8% at 11–14 years, and 14.1% at 15–19 years.[2] These data suggest that varicoceles are progressive and increase in prevalence as boys approach puberty. Multiple studies have shown a positive association between varicoceles and significantly taller patients with lower body mass indices (BMIs). Alternatively, increasing BMI has a protective effect against varicocele formation.[3–5] This association is also seen within the adult population. The majority of varicoceles are left-sided since venous drainage from the testicle enters the left renal vein at a sharp 90° angle as opposed to drainage directly into the inferior vena cava on the right.

Many studies in the adult population have suggested that varicoceles are a progressive process resulting in testicular atrophy over time, which may

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Table 1. Grades of varicocele.

Varicocele grade	Description
Subclinical	Not visible or palpable on physical exam; noted on ultrasound alone
I	Not visible; palpable on physical exam only with Valsalva
II	Visible with Valsalva, palpable on physical exam without Valsalva
III	Visible without Valsalva

also apply to the pediatric population. Poorer semen quality is associated with a higher grade of varicocele. Sperm concentrations in patients with grade III varicoceles have been reported as less than half of that in men with no varicocele.[1] The impact of a varicocele on fertility is unclear within the adolescent group. In adults, up to 40% of patients with primary male infertility and 70–80% of patients with secondary infertility will have a varicocele, making it the most common identifiable cause of male factor infertility. Fortunately, depending on the population being studied, up to 80–85% of patients with a varicocele diagnosis will not have fertility problems. However, 20–35% of individuals with varicoceles will eventually have infertility issues requiring treatment.[6–9] Based on these findings, treatment of varicoceles in the adolescent should theoretically maximize gonadal function, improve semen parameters, and may increase paternity when compared with deferring varicocelectomy to adulthood, when intervention occurs after the diagnosis of infertility has been established.

In this review, we aim to highlight the best practice in the diagnosis and treatment of varicocele in children and adolescents. We will discuss the evaluation and workup of varicocele, the established guidelines by the American Society for Reproductive Medicine (ASRM), the American Urological Association (AUA), and the European Association of Urology (EAU), and the full array of management options. Although the indications for treatment of varicocele in the pediatric and adolescent population remain controversial, clinicians must recognize the current best practices in order to accurately diagnose clinically meaningful varicoceles and determine the most appropriate management, which may include reassurance, surveillance, or active treatment.

Evaluation and workup

Children and adolescents suspected of having varicoceles should undergo a thorough history and physical exam, including examination of the scrotum in the standing and supine position in a warm environment. The grading scale for varicoceles range from subclinical to grade III, depending on the severity, as depicted in Table 1. Subclinical varicoceles are noted only with ultrasound imaging. Dubin and Amelar developed a scale for varicocele grades I through III in the early 1970s.[10] Grade I varicoceles are palpable only with Valsalva. Grade II varicoceles are visible with Valsalva pressure and palpable without Valsalva pressure, while grade III varicoceles are visible without Valsalva pressure and are historically correlated with the pathognomonic 'bag of worms' appearance. Depending on the scrotal skin thickness and room temperature, the 'bag of worms' is not always readily apparent even with a grade III varicocele. In general, grade II and III varicoceles are readily identifiable on physical exam and are commonly referred to urologists.

There are conflicting data in the adolescent literature concerning the impact of varicocele presence on testicular volume differentials and the correlation between varicocele grade and testicular volume. Testicular growth is typically considered to be negatively affected by varicocele grade in an inverse relationship.[11] However, other studies have not observed a relationship.[12] Therefore, some authors argue that varicocele grade alone is not an indication for surgery in the majority of patients.[13]

Testicular volumes are commonly measured with physical exam, orchidometer, or ultrasound. Ultrasonography including Doppler flow studies is very sensitive and specific in the diagnosis of varicoceles, particularly for pediatric patients.[14] Testicular volumes can be more accurately followed with ultrasound in pediatric patients rather than physical examination alone, and serial ultrasound imaging can be utilized in active surveillance of varicocele impact on testicular growth.[15]

While ultrasound is a better study for accurately measuring testicular volumes, the orchidometer is a reasonable alternative.[16,17]

Total testicular volume is predictive of total motile sperm count in adolescents. However, one study suggested that neither age nor testicular volume differential can predict semen volume, sperm density, sperm motility, or total motile count.[18] Total testicular volumes have been shown to improve after surgical repair of varicocele. In 1997, Paduch and Niedzielski reported that varicocele repair in patients aged 15–19 with grade II or III varicoceles reversed testicular growth arrest and resulted in catch-up growth within 12 months of surgery.[19] Improved testicular growth, in theory, may then result in improved semen parameters, but this has not been thoroughly established in the pediatric and adolescent populations.

Semen analysis is not widely utilized by pediatric urologists in the United States in pediatric and adolescent patients with a varicocele. A 2016 survey found that only 13% of pediatric urologists included semen analyses routinely in their practice, and half had some degree of discomfort discussing semen collection with patients. Patients and parents were also surveyed and reported discomfort with the idea of obtaining a semen specimen, most notably citing a lack of knowledge.[20] This is a concerning finding as studies have found that varicocele presence can have an impact on semen parameters in this population. Haans and colleagues found a decrease in total sperm count in patients 17–20 years of age with a left varicocele and ipsilateral hypotrophy, although sperm concentration, motility, and morphology were not altered.[21] Similarly, a 1996 study by Paduch and Niedzielski reported that varicoceles can affect spermatogenesis in patients aged 17–19, with decreased motility, vitality, and morphology in patients with varicocele when compared to controls. Additionally, this study found that sperm motility decreases as maximal blood flow velocity, basal blood flow velocity, and pampiniform vein diameter increases.[22] In contrast to findings noted above from Christman and colleagues' publication,[18] a 2007 study of 57 Tanner V adolescent males aged 14–20 reported that patients with testicular volume differentials >10% had significantly lower sperm concentration and total motile sperm counts when compared to patients with differentials <10%. This effect was even more dramatic for testicular volume differentials >20%. In fact, almost 60% of Tanner V boys with >20% testicular volume asymmetry were shown to have a total motile count of <10 million.[12] Lastly, Christman and colleagues found that adolescent males with an untreated unilateral varicocele had semen analysis profiles more similar to those of patients with surgically treated bilateral, not unilateral, cryptorchidism with lower sperm density and total motile count.[23]

Hormone profile studies may be beneficial in the workup of a varicocele in the pediatric and adolescent male patient, just as with the adult population. Varicocele presence has been associated with higher serum levels of follicle-stimulating hormone (FSH) and luteinizing hormone (LH) with lower inhibin B levels in one study.[1] Alternatively, Romeo and colleagues found that inhibin B was decreased but all other hormones (LH, FSH, testosterone) were normal and there was no correlation with semen parameters.[24] There is currently no consensus on the utilization of hormone profile laboratory values in the workup of this population.

Established guidelines

Currently, the ASRM, the AUA, and the EAU endorse varicocele management in the realm of male infertility, albeit with somewhat inconsistent recommendations (Table 2). Guidelines addressing adolescent varicocele management are even more vague.

Based on the most recent update from the ASRM practice committee, adolescents with detectable unilateral or bilateral varicoceles may be considered for varicocele repair.[25] This stance was extrapolated from the AUA/ASRM Report on Varicocele and Infertility initially composed in 2001. This report states that if objective evidence of reduced testicular size is present or semen analysis is abnormal, varicocele repair is indicated.[25] Implicit to the guidelines, however, is the necessity of objective measurement of testicular size. Accurate measurements are necessary at each patient encounter to document testicular size and to determine volume differentials. If varicoceles are detected but testicular size is equal, annual follow up should be advised in an effort to identify the first sign of testicular impact related to varicocele presence. With early detection and treatment of varicoceles, evidence suggests testicular size may recover after varicocele repair.[19]

Table 2. Summary of AUA/ASRM and EAU guideline recommendations on adolescent varicocele.

	ASRM/SMRU/AUA	EAU
Title	Report on varicocele and infertility: A committee opinion	Guidelines on male infertility: the 2012 update
Most recent update	2014	2012
Varicocele detection method	Dubin and Amelar grading classification: grades I–III	Dubin and Amelar grading classification: grades I–III
Role of scrotal ultrasound	If exam is inconclusive	Used to confirm physical exam
Indication for treatment of the adolescent varicocele	Unilateral or bilateral varicoceles with reduced testicular size or semen abnormalities	Not indicated; states adolescent varicoceles are often overtreated
Contraindications to treatment	Subclinical varicoceles	Not stated
Review of treatment approach	Surgical repair *versus* percutaneous embolization. Superiority not determined. Recurrence rates are lowest with microsurgical subinguinal approach.	Open, laparoscopic, inguinal, and microscopic subinguinal mentioned. No clear benefit of single approach. States subinguinal microscopic has lower recurrence rate and complications.
Follow up advised	Annual follow up with objective measurement	Not stated

ASRM, American Society for Reproductive Medicine; AUA, American Urological Association; EAU, European Association of Urology; SMRU, Society for Male Reproduction and Urology.

Likewise, abnormal semen values may also return to normal.

The EAU guidelines on male infertility briefly discuss adolescent varicocele and the relationship with future fertility implications. The 2012 update suggests that varicoceles developing during adolescence are likely to cause slow, progressive testicular damage resulting in infertility in some men.[26] However, in terms of management, the statement indicates that adolescent varicoceles are often overtreated. Furthermore, according to the EAU, untreated adolescent varicoceles are unlikely to cause future fertility concerns in most affected men. How this can be extrapolated to pediatric and adolescent males is unclear.

Studies in the pediatric and adolescent population are limited and the level of evidence as it relates to treatment and progressive testis damage in this population is poor. A recent meta-analysis on the treatment of adolescent and childhood varicoceles indicated that the current literature is rife with heterogeneity and lacks the presence of randomized controlled trials.[27] Given the paucity of literature and lack of quality evidence, established guidelines would theoretically optimize care while simultaneously setting a foundation for future studies. A proposed starting point would create clinical standards for diagnosis and index parameters of treatment.

Management

The management of varicocele within the pediatric and adolescent population remains controversial. A study performed by Lee and colleagues in 2016 queried 70 pediatric urologists about indications for testicular repair. With a response rate of 53%, the authors reported the most important indication for varicocelectomy was a decrease in ipsilateral testicular size (78%), followed by testicular/scrotal pain (11%) and varicocele grade (11%). The most common surgical approach was subinguinal microsurgical (51%), followed by inguinal (24%) and laparoscopic (14%).[28] A US survey performed by Pastuszak and colleagues in 2014 found that varicocelectomy is most commonly performed for decreased ipsilateral testicular size (96%), testicular pain (79%), and altered

semen analysis parameters (39%). The most common surgical approaches to varicocelectomy in this study were laparoscopic (38%), subinguinal microsurgical (28%), inguinal (14%), and retroperitoneal (13%).[29] These studies suggest a lack of consensus regarding diagnosis, management, and operative approaches for pediatric and adolescent varicoceles among pediatric urologists. Moreover, this degree of heterogeneity limits the development of standardized guidelines in this population.

There are proponents for conservative management with the observation and surveillance of varicoceles in the pediatric and adolescent population. Nearly 80% of testicular volume discrepancies have been shown to resolve in time without surgery.[30] However, a potential confounder underlying this finding is that bilateral testicular volume may equilibrate when each testis volume is compared to one another, but that does not necessarily suggest that normal testicular volume has been achieved. Indeed, there is potential for unilateral varicocele to have deleterious effects on bilateral testicular maturation.

Serial ultrasounds and annual physical exams, with or without the inclusion of semen analyses, have been proposed as important clinical values in active surveillance of the varicocele in the adolescent population. This would seemingly allow the detection of accelerated testicular injury until a patient were to reach Tanner V stage, at which point care could be transitioned to an adult urologist who could subsequently follow the patient until paternity or further evaluation of fertility is established. Chu and colleagues reported that conservative management of adolescents with Tanner V development, asymptomatic left varicocele, and normal testicular volumes was reasonable. In this study, 45% of patients had initial semen analysis with total motile count defined as 'poor' (<20 million). Semen analyses were then repeated in this subset of individuals with 55%, 67%, and 69% of patients showing normal total motile count after an initial, second, and third semen analysis, respectively. The correction of total motile count was not dependent on varicocele grade or age. These authors reported that approximately 50% of patients with an initial poor total motile count would normalize without surgery and that semen analyses should be followed and repeated in asymptomatic Tanner V adolescent males with varicoceles. This is especially important in a subset of patients with persistently poor total motile counts since surgical intervention could be implemented.[31] Of note, this same group published in another study that Tanner V males with clinically detected left varicoceles and no testicular asymmetry treated with varicocelectomy showed improvement in total motile count from a median of 2.8 million preoperatively to 18.2 million postoperatively.[32]

The question then arises, when does a varicocele in the pediatric population require intervention? Classically, significant testicular volume discrepancy, presence of pain or other symptoms, varicocele grade, and semen analysis parameter abnormalities have been indications for surgical intervention. Table 3 depicts signs and symptoms within the pediatric and adolescent population with varicocele that warrant consideration of surgical intervention.

Testicular volume differential is a useful tool in the diagnosis and management of varicoceles, and testicular volume differentials of 15–20%, or >2 cc in size, have historically been treated with surgery. However, some patients will have catch-up growth without surgery, which may limit use of testicular volume differential as an indicator for surgical intervention. Kolon and colleagues found that 85% of adolescents with >15% asymmetry will have catch-up growth without surgery to <15% over a median follow up of 39 months.[30] Based on these findings, this group recommend that at least 2–3 testicular volume measurements be performed over time to allow for catch-up growth and potentially spare an unnecessary surgery.

Kozakowski and colleagues found that peak retrograde flow on Doppler ultrasound was a significant predictor for persistent or worsening testicular asymmetry, and therefore may be a useful tool in predicting persistent, progressive, and new-onset asymmetry. In this study, patients with peak retrograde flow <30 cm/s were less likely to require surgery.[33] A sentinel study combining testicular volume differential and peak retrograde flow on Doppler ultrasound coined the term 'the 20/38 harbinger'. This study found that persistent or worsening future asymmetry was strongly associated with a combination of ⩾20% asymmetry and a peak retrograde flow of 38 cm/s using Doppler ultrasound. Of the patients diagnosed with the '20/38 harbinger', 94% did not demonstrate catch-up growth after a mean follow up of 15.5 months. Interestingly, these findings could be extended to

Table 3. Signs and symptoms that warrant consideration of surgical intervention.

Factors that should prompt surgical consideration in the adolescent
Persistently abnormal semen quality
Altered sperm function tests
Pain
Significantly altered persistent total testicular volume differentials (>15–20%)
Peak retrograde flow >38 cm/s
Infertility
Failure of testicular development
20/38 harbinger (can be extended to 15% asymmetry as well)

patients with 15% testicular asymmetry as well. This suggests that surgical intervention of the varicocele may be better than observation in this subset of patients.[34] Additional studies have confirmed these findings.[35] Recent recommendations by Glassberg and colleagues state that boys who have the 15/38 cutoff, and certainly those that have the 20/38 cutoff, should undergo surgery rather than waiting for catch-up growth. Patients with borderline asymmetry or peak retrograde flow can be evaluated with semen analyses, which if abnormal, may warrant surgical intervention.[36]

The 'at-risk' patient in the pediatric and adolescent population seems to be the one who falls within the 15–20% testicular volume differential, has peak retrograde flow >38 cm/s, and possesses abnormal semen parameters. However, there are no current formal definitions or guidelines for the 'at-risk' patient with a varicocele in this age group. While treating every adolescent varicocele is certainly not necessary, the risk of irreversible and detrimental spermatogenesis defects can occur in a small, unknown percentage of adolescent patients who are not treated until infertility presents as an adult. This is problematic as up to one-third of adults undergoing varicocele repair for infertility have no improvement in semen parameters.[37] Therefore, correctly identifying the 'at-risk' pediatric and adolescent patient is vitally important and is currently an unmet need in the literature and guidelines.

There have been conflicting data regarding pubertal screening of varicoceles and paternity as an adult. Cayan and colleagues found that adolescent males (12–19 years of age) who underwent microsurgical varicocelectomy had an odds ratio of 3.63 for paternity success compared to unrepaired controls. Interestingly, 77.3% of patients in the microsurgical varicocele repair group produced desired offspring compared to 48.4% in the control group. Furthermore, there was a significantly shorter mean time to conception in the microsurgical varicocele repair group.[38] While this study supports intervention, the majority of these patients had bilateral varicoceles, which may represent a separate cohort. Conversely, in 2013 Bogaert and colleagues reported no beneficial effect of pubertal screening in a large cohort of pubertal boys from Belgium with asymptomatic varicocele treated with observation versus antegrade sclerotherapy. This study coincides with reports that 80–85% of adults with varicocele do not have paternity issues.[39]

Randomized controlled trial and meta-analysis data

Few randomized control trials have been conducted on varicocele treatment in the adolescent population. Laven and colleagues showed that left testicular volume increased and sperm concentration improved by >40% in patients who were treated with embolization.[40] Paduch and colleagues showed improvement in testicular volume differential after treatment of a unilateral varicocele,[19] and Yamamoto and colleagues showed improvement in sperm concentration in boys undergoing varicocele repair (although the preoperative concentration was comparable to healthy controls).[41]

A 2017 meta-analysis was performed by Locke and colleagues on nine randomized controlled

trials assessing treatment of varicocele in the pediatric population aged <21 years. This analysis found that there is only intermediate and low levels of evidence to support radiological or surgical intervention for varicoceles in children and adolescents to improve testicular volume and sperm concentration, respectively.[27] While they reported a 3.2 cc improvement in testicular volume and increase of 25.5 million total sperm count overall, there was no evidence that surgical intervention improved other semen analysis parameters. Therefore, the authors concluded that the long-term effects of varicocelectomy on fertility remained unknown. The ultimate conclusion from this meta-analysis was that a multicenter randomized control trial with long-term follow up would be required.

Treatment options

Multiple surgical approaches have been utilized in the history of varicocele treatment, including open inguinal (Ivanissevich), high retroperitoneal (Palomo), subinguinal, high inguinal, microsurgical (inguinal and subinguinal), and laparoscopic approaches. Diamond and colleagues found higher success rates with the laparoscopic (100%) and Palomo techniques (93%) compared with the subinguinal technique (88%). A higher hydrocele rate was seen in the laparoscopic approach, with 32% of patients affected postoperatively. Incorporating microsurgical technique had no effect on success rates, but had 0% hydrocele formation. In this report, one case of testicular atrophy occurred in the microsurgical group out of 16 total cases.[42] The microsurgical subinguinal and high inguinal approaches have been shown to have similar success rates in terms of testicular growth (70% and 78%, respectively). The high inguinal approach is typically associated with a significantly shorter length of surgery as it requires fewer divisions of veins and is associated with a larger diameter of the internal spermatic arteries, making them easier to identify and preserve.[43]

Overall, a wide range of varicocele recurrence rates (0–18%) and postoperative hydrocele formation (0–29%) have been reported in the pediatric population. Lurvey and colleagues performed a large multicenter analysis in 2015 on recurrence rates and complications for pediatric patients. In this study, 15% of patients with the diagnosis of varicocele ultimately underwent surgical intervention. Of those, 39% had open repair, 51% underwent laparoscopic intervention, and 9.7% underwent percutaneous embolization.[44] The 1–5-year retreatment rates after open, laparoscopic, and percutaneous embolization were 1.5%, 3.4%, and 9.9%, and the incidence of hydrocele was 4.9%, 8.1%, and 5%, respectively. A significantly higher rate of hydrocele formation was seen in younger patients. While the differences between retreatment rates and hydrocele formation did not differ significantly between the open and laparoscopic treatment groups, there was a trend toward increased rates in the laparoscopic cohort. The main postoperative complication of the Palomo technique, often utilized in the adolescent patient, is hydrocele formation, which can be seen in up to 29% of patients, 20% of which require hydrocelectomy.[45]

The most recent data in the adult population suggest that the best surgical results are typically seen with the inguinal or subinguinal microscopic approaches, although this has not been confirmed in the pediatric and adolescent population. These approaches have low recurrence rates (2%) and hydrocele formation (0.75%). The overall pregnancy rate in adult patients is 38%, with the highest rate in the microsurgical inguinal technique (42%). The Palomo (34%), embolization (32%), inguinal (31%), and laparoscopic techniques (28%) had lower pregnancy rates.[46] Unfortunately, pediatric urologists are less likely than andrologists to use the microscopic approach due to limited experience and concern over post-varicocelectomy ipsilateral testicular atrophy, a rare but devastating occurrence. Harel and colleagues examined the practice patterns of choice for surgical approach in adolescent varicocelectomy from 2003 to 2012 and found that a microsurgical approach was reported in only 2% of open varicocelectomies.[47]

Percutaneous embolization *via* antegrade and retrograde approaches is utilized in the treatment of varicocele in the pediatric population. The antegrade method has been utilized since the 1970s and was well described by Tauber and Johnsen in a 1993 study.[48] Proponents of percutaneous embolization argue that it allows preservation of the spermatic artery, has high success rates, and presents little risk of testicular atrophy or hydrocele. This method is widely used in Europe. Keene and Cervellione recently reported that several modifications to the technique of antegrade sclerotherapy have been used to achieve high success rates (up to 96%) with minimal complication rates (1–2% rates of wound infection, hematoma,

hydrocele).[49] Another study showed a technical success rate of 93%, recurrence rate of 13% with the theoretical benefit of avoiding the testicular artery and spermatic cord damage. The authors of this study argued that embolization is a superior method when compared to surgery, although similar success rates and recurrence rates were noted in the embolization and surgery groups. While this approach is promising, the undesirable exposure to radiation is significant in the percutaneous embolization procedure, and the long-term risk of radiation exposure in the pediatric and adolescent population is concerning.[50]

Retrograde embolization under local sedation has also been described in a 184-subject study by Zampieri and colleagues in boys aged 10–14 years with left grade II or III varicocele with 93% success rate and 6.5% recurrence rate at 6 months.[51] Similar findings were noted in a smaller study by Hawkins and colleagues in 2012.[52] Lastly, Wang and colleagues recently established a technique of subcutaneous endoscopically assisted ligation of spermatic vessels, termed SEAL-SV, using a modified epidural-and-spinal needle technique in a small study of five adolescent males with varicoceles, with promising results.[53]

Conclusion

Varicoceles are common in the pediatric and adolescent population, with rates in the adolescent years mirroring those of the adult population. While 80–85% of patients with varicocele will have no long-term impact on fertility, ASRM guidelines suggest that varicocele repair is indicated in adolescents with reduced testicular size or abnormal semen analysis parameters. However, there are no implicit guidelines with clear indications for surgical repair for the adolescent varicocele.

The evaluation of varicocele includes history and physical, testicular volume measurement, and scrotal ultrasound with Doppler flow studies. Semen analysis is strongly encouraged but not commonly used in this population due to physician and patient factors. Hormone profiles can be utilized but there are no current guidelines regarding use of these laboratory data in the workup of the adolescent varicocele.

It is difficult to extrapolate from the current literature which pediatric and adolescent varicocele should be managed conservatively and which varicocele should undergo repair. Adolescent varicocelectomy is likely overperformed and it is important to accurately identify patients at risk for future complications due to the unknown long-term impact of the varicocele on fertility and risks of recurrence, hydrocele formation, and testicular injury with varicocelectomy. Utilization of semen parameters such as persistently poor total motile counts on sequential semen analyses, sperm functional tests, testicular volume differentials, and peak retrograde flow may be important in identifying the at-risk adolescent. Recent data suggest that it may be unnecessary to follow a pediatric or adolescent patient with observation who is at or above the 20% total testicular volume (possibly 15%) differential and >38 cm/s peak retrograde flow cutoff.

Variations in surgical technique and radiologic approaches for varicocele repair allow for a variety of options for treatment. However, rates of recurrence and hydrocele formation should be noted as these may require additional surgical intervention. While the success rates and complications in the adult population are most favorable with the microsurgical approach, this has not been confirmed in the adolescent population. Pediatric urologists remain hesitant to proceed with the microsurgical approach, which prevents studies of this technique in pediatric and adolescent patients. The management of pediatric and adolescent varicocele remains poorly defined and can be variable within the pediatric urology community. Based on these findings, referral to an andrologist who is proficient in the microsurgical technique may be beneficial for the adolescent patient with a varicocele.

While active treatment of varicocele in the pediatric and adolescent population is controversial, it is clear that some untreated patients will suffer symptoms later in life related to infertility and possibly hypogonadism. In contrast, overtreatment remains a concern for this large and vulnerable population. Therefore, surveillance strategies and improved accuracy in diagnosis of clinically important pediatric varicoceles prompting treatment are needed in the future.

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Conflict of interest statement

The authors declare that there is no conflict of interest.

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