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THE EFFECT OF VARICOCELE REPAIR ON TESTICULAR VOLUME IN CHILDREN AND ADOLESCENTS WITH VARICOCELE

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ABSTRACT

Purpose: We investigated the effect of varicocele repair on testicular volume according to age in children and adolescents and review the long-term results of varicocele surgery.

Materials and Methods: The study included 39 boys 11 to 19 years old with clinical palpable varicocele who underwent varicocele surgery with at least 1 year of postoperative followup. Preoperative and postoperative testicular volumes were monitored and measured with an ellipsoid Prader orchidometer. Physical examination findings (testicular volumes and testicular consistency) in all boys, and serum hormone values and semen parameters in 16 adolescents were recorded and compared before and after surgery.

Results: Left unilateral varicocelectomy was done in 29 boys (74%) and bilateral varicocelectomy in 10 (26%). While no postoperative hematoma, infection or testicular atrophy was observed, 1 boy (2.5%) had varicocele recurrence and 2 boys (5.1%) had minimal hydroceles that required no intervention. Significant increases were observed in postoperative sperm concentration ($p = 0.01$), total motile sperm count ($p = 0.009$), testis volume ($p = 0.000$) and serum testosterone level ($p = 0.014$). All 15 boys with preoperative soft testis had normal testicular consistency postoperatively. Of the 19 boys with preoperative testicular atrophy 10 (53%) did regain normal testicular growth, while 9 (47%) retained testicular volume loss after surgery. When comparing preoperative to postoperative increase in testicular volume according to age in all boys, the mean was statistically significantly higher in boys younger than 14 years (left testis $p = 0.037$, right testis $p = 0.000$).

Conclusions: Testicular consistency achieved normal firmness after varicocelectomy in all boys with preoperative soft testis. While there was catch-up growth in comparison to the contralateral testis, testicular consistency improved but testicular volumes may not increase significantly after varicocele repair at ages older than 14 years. However, in these adolescents postoperative semen parameters and serum hormone values may significantly improve regardless of testicular volume. Therefore, boys with varicocele and their families should be fully informed in light of these findings.

KEY WORDS: varicocele, adolescence, testis

Although varicocele is rarely seen in children, the prevalence of varicocele in adolescents is 7.8% in 11 to 14-year-olds and 14.1% in 15 to 19-year-olds.[1] We previously showed that varicocele related testicular atrophy occurs in 7.3% of children with varicocele 11 to 14 years old and 9.3% of those 15 to 19 years old but it was not present in children younger than 11 years.[1] These findings support the theory that varicocele is a progressive disease and that the incidence of varicocele and varicocele related testicular atrophy increases with puberty.

Many investigators recommend that varicocele be treated at an early age, possibly because the testis is still developing.[2–6] Although varicocele repair does not result in a significant increase in testicular volume of infertile men,[7] it has been reported to result in catch-up growth of the testis in adolescents.[3,4,6] However, to our knowledge, the influence of pediatric and adolescent varicocelectomy on testicular volume according to age has not been studied in detail. Varicocele repair has also been reported to improve testicular consistency and semen parameters,[2,6] although, following boys after varicocele repair based on testicular consistency is subjective and reflects interobserver variation. Therefore, specific testicular volume measurement is an important objective parameter to use after varicocelectomy. We investigate the effect of varicocele repair on testicular volume according to age in children and adolescents and review the long-term results of varicocele surgery.

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MATERIALS AND METHODS

A total of 39 children and adolescents 11 to 19 years old with varicocele were included in the study. The varicocele had been detected on physical examination and scrotal color Doppler ultrasonography, and the patients had been followed at least 1 year after varicocele surgery. Preoperative and postoperative physical examination findings (varicocele grading, testicular volume and testicular consistency) were available for all patients. The boys were examined in a warm room in the supine and upright positions with and without Valsalva's maneuver. Varicoceles were classified according to Dubin and Amelar as grade 1—palpable only during Valsalva's maneuver, grade 2—palpable without Valsalva's maneuver or grade 3—visible without need for palpation.[8] Preoperative and postoperative testis volume was measured with an ellipsoid Prader orchidometer (ASSI, Westbury, New

York).[9] If the testicular size discrepancy was greater than 2 ml. or more than 10% on the affected side, it was considered testicular atrophy. Serum follicle-stimulating hormone (FSH), testosterone and semen analyses were also obtained in 16 adolescents 15 to 19 years old. Semen was collected by masturbation after 2 to 4 days of abstinence and processed within 1 hour of ejaculation. All semen analyses were performed in the same andrology laboratory according to World Health Organization criteria.[10] Preoperative and postoperative total motile sperm counts (ejaculate volume × concentration × motile fraction) were calculated on all semen analyses.

Varicocelectomy was performed by a single surgeon (S. Ç.) using a microscope in 27 boys and a loop magnification (3.5×) in 12 by either a subinguinal or inguinal approach performed as an artery and lymphatic sparing technique.[11,12] Preoperative and postoperative physical examination findings in all patients, and serum hormone values and semen parameters including sperm concentration, sperm motility and total motile count in 16 patients were recorded and compared. Boys with other scrotal pathology were excluded from study after performing a detailed history, physical examination and further diagnostic modalities.

Statistical analysis was performed using the paired t test to compare preoperative and postoperative testicular volumes, semen parameters and serum hormone values and the independent t test to compare testicular volume according to age. The increases in postoperative testicular volume according to the site and grade of varicoceles were compared using the Mann-Whitney U and Kruskal-Wallis tests, and $p < 0.05$ was considered statistically significant. The values are presented as mean plus or minus standard deviation.

RESULTS

Mean patient age was 14.5 ± 1.75 years (range 11 to 19). Unilateral varicocele was grade 1 in 2 (6.9%) cases, grade 2 in 12 (41.4%) and grade 3 in 15 (51.7%). Bilateral varicoceles were grade 2 in 3 (30%) cases and grade 3 in 7 (70%) on the left side, and grade 1 in 7 (70%), grade 2 in 1 (10%) and grade 3 in 2 (20%) on the right side. Of the boys 15 presented with soft testis and 19 had testicular atrophy on the affected side.

Left unilateral varicocelectomy was performed in 29 (74%) boys and bilateral varicocelectomy was done in 10 (26%). Mean postoperative followup was 22.5 ± 2 months (range 17 to 25). While no postoperative hematoma, infection or testicular atrophy was observed, 1 boy (2.5%) had varicocele recurrence and 2 (5.1%) had minimal hydroceles that required no intervention. Table 1 shows preoperative and postoperative semen parameters and serum hormone values in 16 adolescent patients with varicocele. Using the paired t test, significant postoperative increases were observed in sperm concentration ($p = 0.01$), total motile sperm count ($p = 0.009$) and serum testosterone ($p = 0.014$).

Postoperative testicular volumes increased from 13 ± 5.6 to 16.1 ± 4.6 ml. on the left side, and from 14.1 ± 5.8 to 16.7 ± 4.6 ml. on the right side, revealing high statistical significance ($p = 0.000$ for left and right testis volumes). Postoperative increases in testicular volume were 3.75 ± 2.8 ml. in patients with left varicocele, 2.55 ± 1.6 ml. in those with bilateral varicocele on the left side, and 3.03 ± 2.6 and 1.66 ± 1.8 ml. in those with right varicocele and bilateral varicocele, on the right side, respectively. No significant differences were detected in the increases of testicular volume between boys with left unilateral and those with bilateral varicoceles (left testis $p = 0.255$, right testis $p = 0.2$) before and after surgery. There were also no statistically significant differences in postoperative testicular volume according to varicocele grade in patients with left varicocele (left testis $p = 0.546$, right testis $p = 0.606$) and bilateral varicoceles (left testis $p = 0.667$, right testis $p = 0.667$ for left varicocele grade and left testis $p = 0.274$, right testis $p = 0.450$ for right varicocele grade).

All boys with a soft testis preoperatively had normal testicular consistency postoperatively. Of the boys with preoperative testicular atrophy 10 (53%) regained normal testicular growth, while 9 (47%) retained testicular volume loss in comparison to the contralateral testis. Postoperative left testicular hypertrophy (10% larger than unaffected testicular volume) occurred in 1 boy (5.2%). Figures 1 and 2 show postoperative increases in testicular volume after varicocele repair in the boys with left unilateral and bilateral varicoceles. When comparing the increase in testicular volume according to age, patients younger than 14 years achieved normal values postoperatively but postoperative testicular volume did not increase statistically significantly at age 14 or older. Table 2 shows the increase in testicular volume before and after surgery between the boys younger than 14 years and 14 years old or older. The increase in postoperative testis volume was significantly higher in boys younger than 14 years than in the older boys (left testis $p = 0.037$, right testis $p = 0.000$, both testes $p = 0.002$).

DISCUSSION

Varicocele that develops in early childhood is a progressive but surgically correctable disease that deteriorates testicular function and semen parameters.[1,6] Testicular volume increase after varicocelectomy has been reported in adolescents with preoperative testicular volume difference or atrophy.[3,6] Therefore, in addition to semen analysis of and serum reproductive hormones, testicular volume measurement is important in followup of boys treated with varicocelectomy.

In a prospective controlled study Paduch and Niedzielski reported that the volume of the involved left testis increased to almost normal in treated boys, and varicocele repair in adolescents resulted in catch-up growth within 12 months of

TABLE 1. *Preoperative and postoperative semen parameters and serum hormone values in 16 adolescent patients with varicocele*

Semen and Hormone Parameters	Mean ± SD		p Value
	Preop.	Postop.	
Sperm concentration (million/ml.)	17.9 ± 5	59.9 ± 12.4	0.01
Motility (%)	42.5 ± 5	46.2 ± 4	0.6
Total motile sperm count (million)	58.3 ± 1	61.4 ± 1	0.009
Serum FSH (mIU./ml.)	10.1 ± 5.8	5.4 ± 1.45	0.461
Serum testosterone (ng./ml.)	1.91 ± 0.75	4.94 ± 0.45	0.014

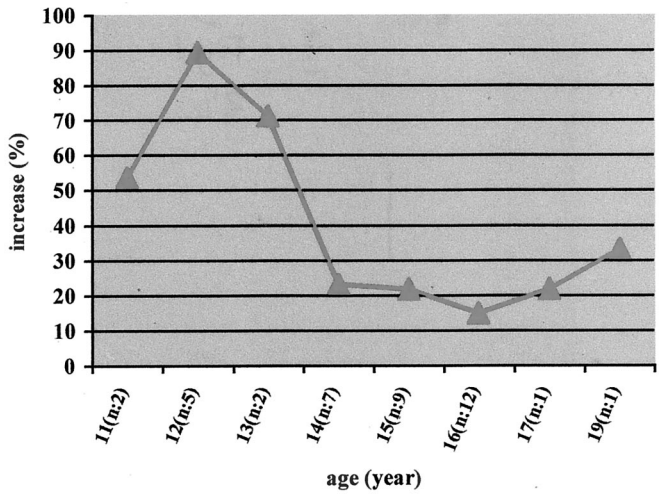

FIG. 1. Postoperative increase in left testicular volume after varicocele repair in all 39 boys.

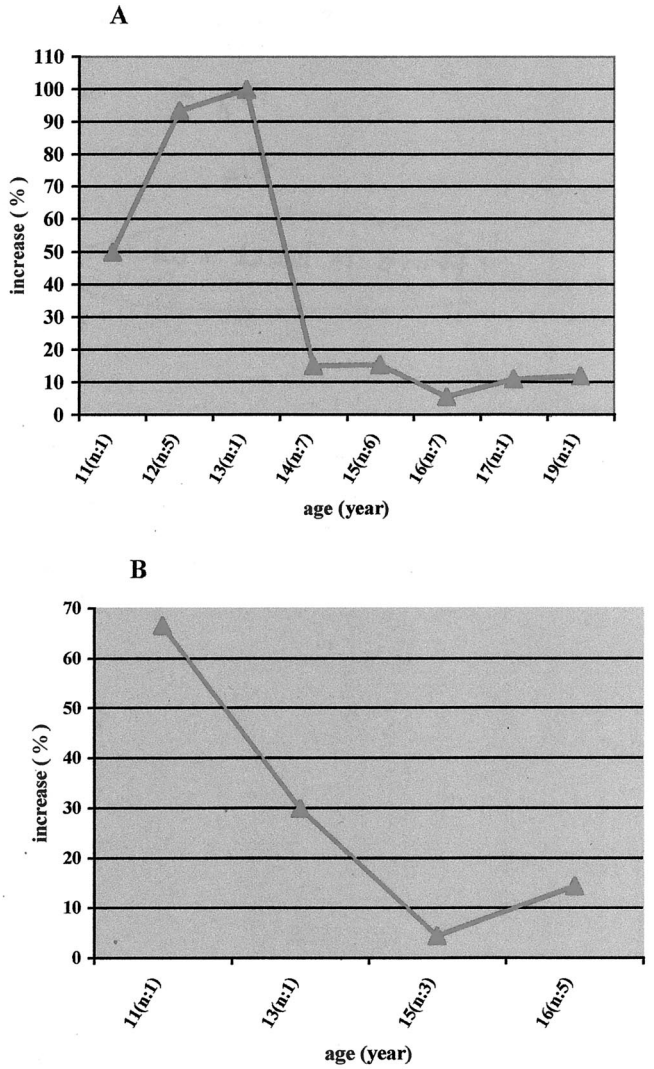

FIG. 2. Postoperative increase in right testicular volume after varicocele repair in 29 boys with left varicocele (*A*) and 10 boys with bilateral varicocele (*B*).

surgery.[13] In other studies varicocele correction resulted in a significant increase in testicular volume.[3–6] However, such studies lack information on the age at which testicular volume significantly increases. To our knowledge, no study has detailed the influence of pediatric and adolescent varicocelectomy on testicular volume according to age. In our study 53% of boys with preoperative testicular atrophy did regain normal testicular growth, while 47% retained testicular volume loss. The testicular volume did not increase significantly at ages 14 years or older with a mean postoperative followup of almost 2 years. This finding may be explained by the fact that testicular growth is mostly completed by that age and only interstitium of the testes may partially develop to produce testosterone.

In addition to testicular catch-up growth, testicular hypertrophy has been reported in some adolescents postoperatively. Gershbein et al reported left testicular hypertrophy (left at least 10% greater than right testicular volume), regardless of age at surgery, in 38% of boys who underwent varicocele repair.[14] In contrast, we detected left testicular hypertrophy after varicocelectomy in only 1 (5.2%) of 19 boys with preoperative left testicular atrophy.

Papanikolaou et al reported that adult varicocele repair does not result in a clinically significant increase in testicular volume despite an increase in total motile sperm count at an average of 7 months after repair.[7] In our study total motile sperm count significantly increased postoperatively, regardless of the increase in testicular volume. In postpubertal adolescents varicocele repair is indicated for abnormal semen analysis, low serum testosterone and/or increase in serum FSH.[15] In our study statistically significant increases were observed postoperatively in sperm concentration, total motile sperm count and serum testosterone. These results and those from our previous study suggest that defective testosterone synthesis is associated with varicocele, and varicocelectomy probably has positive effects on Leydig cell function.[16]

The main goal of treatment of pediatric and adolescent varicocele is preservation of fertility. Therefore, the ideal technique for varicocele repair should include preservation of optimal testicular function, elimination of the varicocele and lower complication rates. Recurrences after varicocele repair have been reported in 0% to 16.6% of cases, depending on varicocelectomy techniques.[6, 17, 18] Postoperative hydrocele in adolescents is a potential problem with the incidence ranging from 1% to 24%.[6, 19] In our study no postoperative hematoma, infection or testicular atrophy was observed, while 1 boy (2.5%) had varicocele recurrence, and 2 (5.1%) had minimal hydroceles that required no intervention. Our postoperative recurrence and hydrocele rates are similar to other microscopic varicocelectomy.[6, 20]

Varicocele is seen more commonly on the left than on the right side. While the prevalence of bilateral varicocele is 10.8% in patients 11 to 19 years old,[1] there were 10 (26%) boys in our study with bilateral palpable varicoceles, which was much higher than the bilateral varicocele rates reported in the literature.[1] However, this finding in this unselected group may reflect the incidence of bilateral varicocele in adolescents who require surgery. Steckel et al investigated the relationship between varicocele size and response to varicocelectomy in men.[21] They suggested that repair of a large varicocele results in greater improvement in semen quality than repair of a small varicocele. In our study postoperative increase in testicular volume was not affected by varicocele laterality and varicocele grade.

Testicular volume has traditionally been clinically determined using orchidometers.[9, 22] More recently scrotal ultrasonography has been used for testicular measurement.[23, 24] There are some conflicting results in comparison of orchidometer and ultrasonography to measure testicular volumes. Diamond et al reported a strong linear relationship between testicular volume measurements using orchidometer and ultrasonography.[23] However, they concluded that although the orchidometer remains valuable in assessing size of the individual testis, it was too insensitive to volume differentials relative to ultrasound to be used routinely to determine growth impairment. In our previous study the testicular volumes measured with ultrasonography and the Prader orchidometer were statistically significantly consistent, and this correlation remained highly consistent regardless of age or testicular volume on both sides of the subjects.[24] Gershbein et al used the Takihara orchidometer to measure postoperative testicular volumes[14] but chose to monitor testicular volume with the Prader orchidometer.

While we did not include the stages of pubertal development in boys with varicocele, testicular development may be determined according to the Marshall and Tanner system.[25] The Tanner method of describing the stages of pubertal development is widely accepted, objective and clinically useful. Kass et al correlated testicular size with Tanner stage in boys with a palpable left varicocele.[26] They reported that patients with a grade 2 varicocele had a significantly smaller left testis than the controls at Tanner stages 4 and 5, while patients with a grade 3 varicocele had a significantly smaller left testis than controls at each Tanner stage and significantly smaller right testis than controls at Tanner stages 4 and 5. Tanner staging rather than age likely would be of

TABLE 2. *Increase in testicular volume after varicocelectomy between boys younger than 14 years and 14 years old or older*

Testis Vol. (ml.)	Mean ± SD		95% CI	p Value
	Age Younger Than 14 Yrs.	Age 14 Yrs. or Older		
Lt. testis	4.77 ± 1.9	3 ± 2.74	−0.26–3.74	0.037
Rt. testis	5.22 ± 2.2	1.89 ± 2	1.69–4.96	0.000
Av.	5 ± 1.8	2.46 ± 2	0.96–4.11	0.002

more predictive value in determining the possibility for catch-up growth. We look forward to future studies on age and Tanner stage as predictors for catch-up growth.

CONCLUSIONS

Inguinal or subinguinal varicocelectomy is safe for children and adolescents with varicocele with low recurrence and complication rates. Testicular consistency achieves normal firmness after varicocelectomy in all boys with preoperative soft testis. While there is catch-up growth in comparison to the contralateral testis in children and testicular consistency improves, testicular volume may not increase significantly after varicocele repair at age 14 years or older. However, in these adolescents semen parameters and serum hormone values may significantly improve postoperatively regardless of testicular volume. Therefore, boys with varicocele and their families should be fully informed in light of these findings. To our knowledge this is the first study to review the effect of varicocelectomy on testicular volume according to age in the pediatric and adolescent population.

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