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Microsurgical varicocelectomy in pediatric and adolescent patients with varicocele: a single-center experience

Jurii Karibe, Shinnosuke Kuroda, Teppei Takeshima, Yasushi Yumura

Department of Urology, Center for Reproductive Medicine, Yokohama City University Medical Center, Yokohama, Japan

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Corresponding Author: Shinnosuke Kuroda, shin1014@yokohama-cu.ac.jp

ABSTRACT

Aims: Varicoceles, which can occur in children, are known to cause future male infertility, testicular pain, and testicular atrophy. Their treatment is primarily surgical—in adults, microsurgery is the standard treatment; however, in children, laparoscopic surgery is widely performed. This study aimed to evaluate the efficacy of microsurgery in patients with varicoceles aged ≤18 years.

Methods: The retrospective study was conducted from December 2016 to April 2025 and included male patients aged ≤18 years who underwent microsurgical varicocelectomy at Yokohama City University Medical Center. The summary statistics were calculated.

Results: The median age of this study's 36 participants was 15 years, and the most common symptoms were testicular pain (25 cases) and scrotal swelling (11 cases). The mean right and left testicular volumes were 15.3 ml and 14.2 ml, respectively, with no significant difference between them (p=0.09). There were 12 cases with a difference in testicular volume of ≥2 ml or ≥20% between the affected and unaffected sides. The median number of veins ligated was 11. Two arteries and the three lymphatic vessels as the median were preserved, respectively. The chief complaint—testicular pain or swelling—was resolved in all cases.

Conclusion: Varicoceles can develop in childhood and may cause scrotal pain, testicular atrophy, and male infertility. Microsurgical varicocelectomy may be a safe and effective treatment option for children with varicocele.

Keywords: Varicocele, pediatrics, adolescent, varicocelectomy

INTRODUCTION

Varicoceles are commonly encountered in adult males. The prevalence rate is reported to be 0.79% in aged 2-6 years, 0.96% at 7-10 years, 7.8% at 11-14 years and 14.1% at 15-19 years.[1] A varicocele is defined as the enlargement of the spermatic cord's pampiniform venous plexus. While some questions remain unanswered, a previous study has suggested three etiologies of varicoceles.[2] First, the left spermatic vein flows into the left renal vein at a right angle, predisposing it to increased pressure. Second, the left spermatic vein has a long path before it flows into the inferior vena cava, predisposing it to increased pressure during blood return. Third, the left spermatic vein may lack venous valves, predisposing it to reflux-induced pressure increments.

Varicoceles are known to cause male infertility, testicular pain, and testicular atrophy.[3] They can lead to seminal oxidative stress, which increases the likelihood of sperm functional and morphological abnormalities and apoptosis.[4] Furthermore, they cause increments in testicular temperature due to blood stasis in the venous plexus, leading to spermatogenic dysfunction.[5] Consequently, semen parameters are impaired, leading to male infertility. Although the mechanism underlying testicular pain is unclear, it has been reported to occur when dilated veins compress the surrounding nerve fibers.[3] As a person's fertility status cannot be evaluated before puberty, varicoceles are sometimes detected due to testicular pain in boys.[3] Varicoceles are graded in accordance with worldwide guidelines, which classify them into three grades.[3] Grade 3 can be diagnosed by visual examination. Grade 2 can be diagnosed by palpation in the standing position. Grade 1 can be diagnosed by palpation under the Valsalva maneuver in the standing position. Treatment is primarily surgical, with microsurgical varicocelectomy becoming the standard approach. According to the European Association of Urology guidelines, in children with varicoceles, a testis is considered to be hypotrophic if the volume discrepancy

between it and the contralateral testis exceeds 2 ml or 20%, and varicocelectomy is strongly recommended in such circumstances.[6]

There have been few reports on microsurgery in pediatric and adolescent patients. However, microsurgical varicocelectomy has been increasingly made available for children as medical technology is advancing and more sophisticated medical equipment is becoming more available. In this study, we retrospectively reviewed cases at our hospital to confirm the efficacy and safety of microsurgical varicocelectomy in patients aged ≤18 years.

METHODS

Ethics

The protocol for this research was approved by the Ethics Committee of Yokohama City University Medical Center (Date: 26.05.2021, Decision No: B210300044). The study was conducted following the provisions stipulated in the Declaration of Helsinki. Consent was obtained via the opt-out method; hence, patient consent was assumed.

Study Design

The study included male patients aged ≤18 years who underwent microsurgical varicocelectomy at the Department of Urology, Center for Reproductive Medicine, Yokohama City University between December 2016 and April 2025. Varicocele was diagnosed by physical examination with Doppler ultrasonography according to Dubin and Amela grading system.[7] In principle, varicocelectomy was indicated when the patient had clinical varicocele, and the testicular volume discrepancy between the affected testis and the contralateral testis exceeded 2 ml or 20%, or the patients had refractory scrotal pain.

The breakdown of indication for surgery, the patient's age, height, weight, testicular volume, laterality, grade of varicocele, and the number of vessels ligated or preserved during surgery were confirmed. After surgery, complications, recurrence, and symptom disappearance were evaluated.

Surgical Procedures: Microsurgical Subinguinal Varicocelectomy

All patients underwent surgery under general anesthesia. A 2–3-cm incision was made directly above the external inguinal ring, and the spermatic cord was identified and secured. Under a microscope, the external and internal spermatic veins were all ligated and resected while the artery and lymphatic vessels were preserved (**Figure**). All vessels were counted regardless of their thickness. A Doppler flowmeter was used in cases in which it was difficult to identify the arteries or distinguish them from veins.

Statistical Analysis

Continuous variables are presented as mean values with standard deviations when normally distributed or median values with interquartile ranges when skewedly distributed. Categorical variables are presented as frequencies with percentages. Comparisons between continuous variables were performed using Student's t-test or the Mann–Whitney U test for normally and skewedly distributed data, respectively. Categorical variables were compared using the Chi-square test or Fisher's exact test as appropriate. The threshold for statistical significance was set at $p<0.05$.

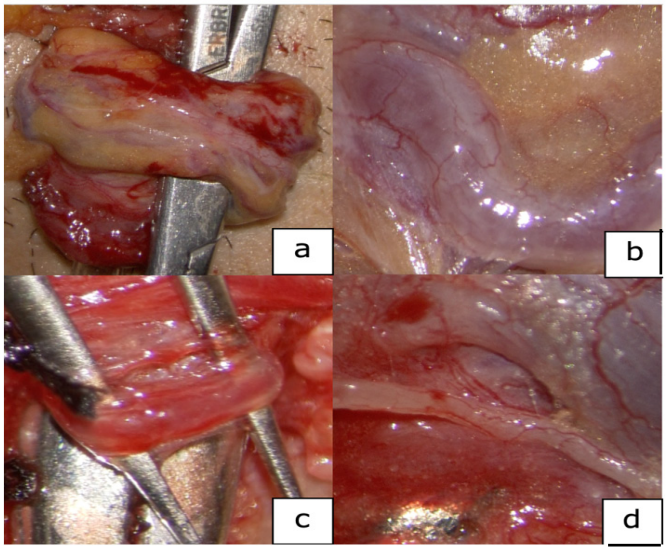

Figure. Vascular structures observed during microsurgical subinguinal varicocelectomy **a.** Spermatic cord contents after dissection of the external and internal spermatic fascia. **b.** Isolated spermatic vein. **c.** Isolated spermatic artery. **d.** Isolated lymphatic vessel

RESULTS

Among the 36 participants, the main complaint was testicular pain in 25 cases and scrotal swelling in 11 cases. Patient characteristics are shown in **Table 1**. The median age, height, and weight were 15 years, 169 cm, and 55 kg, respectively. The mean right and left testicular volumes were 15 ml and 14 ml, respectively. There was one case of bilateral varicocele, 34 cases of grade 3 varicocele, and two cases of grade 2 varicocele. The mean right and left testicular volumes were 15.3 ml and 14.2 ml, respectively, with no significant difference between them (p=0.09). There were 12 cases with a difference in testicular volume of ≥2 ml or ≥20% between the affected and unaffected sides. The median number of veins ligated was 11. Two arteries and the three lymphatic vessels as median were preserved, respectively (**Table 2**). Complications of surgery occurred in two cases—one case of hematoma and one case of recurrence. The chief complaint—testicular pain or swelling—was completely resolved in all cases postoperatively.

Table 1. Patient`s background

Variables	Median (mean±SD), number (%)
Age (years old)	15 (15.2±2.5)
Height (cm)	169 (167.1±9.3)
Weight (kg)	55 (55.1±11.4)
Right testicular volume (ml)	15 (15.3±3.3)
Left testicular volume (ml)	14 (14.2±3.3)
Bilateral	1 (2.8%)
Grade 3 varicocele	34 (94%)

SD: Standart deviation

Table 2. Operation findings

Variables	Median (mean±SD)
Resected vein	11 (12.7±4.4)
Preserved artery	2 (2.3±1.4)
Preserved lymphatic vessel	3 (4.1±2.3)

SD: Standard deviation

DISCUSSION

Varicoceles are known to cause male infertility and testicular pain in adults. In children, delayed development of the unaffected testis has been reported to occur due to the presence of varicoceles.[8] Therefore, the presenting complaints of children often differ from those of adults, with testicular pain, scrotal swelling, and scrotal asymmetry being common reasons for seeking medical care. In this study, testicular pain was reported in 69% of cases and scrotal swelling in 31%, suggesting that testicular pain is the more common presenting complaint in children with varicoceles.

In recent years, male infertility has become a major medical issue, and awareness of varicoceles in adults has increased dramatically as a result. The treatment of varicocele-induced testicular pain includes analgesics and surgery. The severity of varicocele-induced testicular pain varies widely, ranging from sudden and severe pain to mild discomfort. There was also significant individual variation in the duration and frequency of this pain. In some cases, the condition is self-limiting; for example, in approximately 15% of cases, there is spontaneous resolution of pain.[9] If sufficient improvement is not achieved with conservative treatment, surgery should be considered. Previous studies have reported that surgery improves testicular pain in approximately 80% of patients.[3] Cases in which pain was more likely to improve with surgery included those with low-grade varicoceles, those with chronic pain, and patients with a low body-mass index.[10-12]

In patients with varicoceles, there is a possibility of testicular atrophy on the affected side.[8] It is considered that varicoceles adjacent to the testicles create a high-temperature environment around them, leading to testicular atrophy. A previous study reported that in adolescent males, the rates of testicular volume asymmetry were 36% and 10% in patients with and without varicoceles, respectively.[8] The study followed changes in testicular volume in patients, and ultimately, 17% and 3% of patients with and without varicoceles had testicular volume asymmetry, respectively. The disappearance of the testicular volume discrepancy between the left and right sides was attributed not only to the catch-up growth of the affected testis but also to atrophy of the contralateral one.[8] On the other hand, according to some reports, the presence or absence of varicoceles in adults is not related to testicular volume discrepancies.[13] Therefore, careful judgment is required when deciding whether surgery is appropriate due to testicular atrophy. In addition, it is more important to discuss if the repair of varicocele and testicular asymmetry will result in an increase of paternity through improvement of testicular function. Cayan et al.[14] conducted long-term study including 408 adolescent patients between 12 to 19 years old with clinical varicocele and compared the effect of surgical intervention and conservative follow-up. The study showed the paternity rate was significantly higher in the microsurgical varicocele repair group than in control group (77.3% vs 48.4%, OR 3.63, p<0.005), and the time to conception was significantly shorter in the microsurgical varicocele repair group than in the control group (11.18±6.5 months vs 16.85±6.9 months, p<0.005). This study supports the benefit of varicocele repair for adolescent patients with varicocele. However, the number of studies with long-term follow-up is still few. More studies are needed to examine its efficacy for pediatric and adolescent patients in long-term benefit.

Several surgical techniques for varicocele management exist, each with its own advantages. The choice of technique depends on the location where the vein is ligated. The common method is retrograde gonadal vein ligation, which is performed via open surgery, laparoscopic surgery, or microsurgery. The open retroperitoneal approach has the advantages of fewer veins to ligate and minimal risk of arterial injury; however, it is highly invasive and associated with high complication and recurrence rates.[15] Laparoscopic high ligation is less invasive than open surgery and has fewer complications.[16-18] Microsurgery requires longer surgical procedures and skilled techniques; however, it is associated with low complication and recurrence rates.[19,20] It is often the first choice for adults and should also be considered for children. Recent meta-analyses of randomized controlled trials on varicoceles in children have shown that microsurgical varicocelectomy is highly effective but requires advanced technical skills.[21,22]

In this study, all patients presented with testicular pain or scrotal swelling as the primary complaint. Microsurgical varicocelectomy was performed under general anesthesia, and all patients reported improvement in their primary symptoms. Although objective assessment of testicular pain and scrotal swelling was difficult, based on the patient's subjective assessment, the symptoms completely resolved. When testicular volume asymmetry was defined as a volume discrepancy of ≥2 ml or ≥20% between the left and right testes, 12 cases were identified in which testicular volume asymmetry was incidentally detected. No patients underwent surgery for testicular atrophy, so catch-up growth was not followed.

While there are many studies reporting the efficacy of laparoscopic surgery for varicoceles in children,[18,23,24] studies on microsurgical varicocelectomy are scarce. Microsurgical varicocelectomy is minimally invasive and associated with low rates of complications and recurrence.[20] In previous study, it is reported that postoperative hydrocele occurred in 6.6% of cases and recurrence in 2.2% of cases following laparoscopic surgery.[25] On the other hand, although the total number of cases was small, no hydrocele occurred in this study and the recurrence rate was 2.8%. The reason for the absence of hydrocele is likely due to the lymphatic vessels being identifiable during surgery. The advantage of microsurgery is that it allows the precise identification and preservation of tissue and vessels. Our study demonstrated favorable outcomes of microsurgery in children and adolescents with varicoceles, although it entailed just short-term follow-up. Therefore, despite the requirement of advanced technical skills and learning curves, we believe that

it should be considered the first-choice surgical approach for both children and adults.

Limitations

This study has several limitations. First, testicular volume was not tracked, and catch-up growth could not be confirmed. No cases underwent surgery due to differences in testicular volume between sides; therefore, testicular volume was not tracked in this study cohort. After surgery, varicocele disappearance was confirmed, and follow-up was discontinued if no symptoms were present. Second, testicular pain was not evaluated objectively such as using pain scales. Changes in symptoms were confirmed by comparing the patient's subjective symptoms. Symptoms were compared by conducting interviews before and after surgery. Third, our hospital has a large number of microsurgical cases, allowing us to perform microsurgery on pediatric patients. However, it may not be feasible for all hospitals to consider it as the first-line procedure as microsurgery in pediatric patients is technically challenging.

CONCLUSION

Varicoceles can develop in childhood and may cause scrotal pain, testicular atrophy, and male infertility. Microsurgical varicocelectomy is safe and effective for children with varicoceles.

ETHICAL DECLARATIONS

Ethics Committee Approval

The protocol for this research was approved by the Ethics Committee of Yokohama City University Medical Center (Date: 26.05.2021, Decision No: B210300044).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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