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Successful outcomes in adolescent varicocele treatment with high-level laparoscopic varicocelectomy☆,☆☆

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ABSTRACT

Purpose: In this study, we aimed to compare the effects of testicular vein ligation level on complications encountered; i.e. high-level ligation cranial to the linea terminalis vs ligation caudal to the linea terminalis.
Methods: A total of 47 unilateral adolescent patients, treated with laparoscopic varicocelectomy between January 2004 and December 2017, were reviewed retrospectively. Patients were divided into two groups in terms of ligation level: caudal to the linea terminalis as group 1 and cranial to the linea terminalis as group 2. Symptoms, varicocele grades, preoperative testicular growth arrest, operative method, hydrocele formation, postoperative recurrence and testicular catch-up growth were recorded.
Results: The mean operation time was 38.6 ± 10.2 min (34–53 min) in group 1 and was 33.6 ± 6.4 min (29–42 min) in group 2. Single hydrocele occurred in the laparoscopic nonselective varicocelectomy in group 1 (4.5%) and was successfully treated with open hydrocelectomy. Single varicocele recurrence was observed in the laparoscopic selective varicocelectomy in group 1 (4.5%) and treated with laparoscopic nonselective varicocelectomy cranial to the linea terminalis.
Conclusions: The high-level ligation of the spermatic veins cranial to the linea terminalis during laparoscopic varicocelectomy, independent of the technique applied, may contribute to reasonable low hydrocele and recurrence rates.
Level of evidence: Level III.

The ideal site for testicular vein ligation during varicocelectomy is cranial to the internal inguinal ring, where the external pudendal vein is spared for the drainage of the testicle [1]. However, not only pudendal vein but also deferential vein and cremasteric vein should be protected for healthy testicular vascularization [2]. Ligation of testicular vein close to the renal vein is clearly the best choice for successful outcomes [3]. Ligation of testicular vein at this level needs an extensive surgery during open procedure. Laparoscopy allows ligation of the testicular vein at any level within the abdominal cavity.

During the last two decades, laparoscopic varicocelectomy (LV) emerged as the widely accepted method for adolescent varicocele (AV) treatment [4]. Operative treatment options in LV for AV are selective varicocelectomy (SV) and nonselective varicocelectomy (NSV). Both SV and NSV have been performed based on the principle of ligation of the dilated testicular veins. After 2012, we have started high-level testicular vein ligation more cranially in both SV and NSV for LV, i.e. mainly cranial to the linea terminalis of pelvic bone.

In the present study, we have compared the effects of ligation level on the complications encountered; i.e. high-level ligation cranial to the linea terminalis vs ligation caudal to the linea terminalis.

1. Material and methods

The Institutional Ethics Review Board for Clinical Research approved this study (2654-GOA-2016/11-22). A total 47 unilateral adolescent patients, treated with LV between January 2004 and December 2017, were reviewed retrospectively. The indications for surgical repair include grade 3 and grade 2 varicocele associated with chronic testicular pain and/or scrotal swelling and testicular growth arrest. Patients with bilateral varicocele, previous ipsilateral inguinal/scrotal surgery and grade 1 varicocele were excluded. Patients treated laparoscopically were divided into two groups in terms of ligation level. Caudal to the linea terminalis level was named as group 1 and cranial to the linea terminalis

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Table 1
Symptoms and findings.

	Caudal to the linea terminalis (2004–2012) ($n = 22$)	Cranial to the linea terminalis (2012–2017) ($n = 25$)
Chronic testicular pain	12	15
Grade 2 varicocele	9	7
Grade 3 varicocele	13	18
Scrotal swelling	14	19

level was named as group 2. These two groups were divided into four subgroups according to surgical technique performed. Symptoms, varicocele grades, preoperative testicular growth arrest, age at the operation, operative method, hydrocele formation, postoperative recurrence and testicular catch-up growth were recorded.

Dubin and Amelar grading system was used to classify AV [5].

Ultrasonographic testicular volume was assessed using Lambert formula (Volume = 0.71 × length × width × depth).

Testicular symmetry = [(contralateral testicular volume − ipsilateral testicular volume / contralateral testicular volume) × 100]. Preoperative testicular growth arrest was defined as ipsilateral testis at least 15% smaller than the contralateral testis. Postoperative catch-up growth was defined as at least 15% increase in size at the effected testis or ipsilateral testicular growth up to 85% of the contralateral testis during the follow-up period [6].

Testicular volumes were determined preoperatively and at the 6th and 12th postoperative months.

1.1. Operative procedure

Under general anesthesia with endotracheal intubation, ipsilateral abdomen was elevated 30° in supine position. Urinary bladder was catheterized. Insufflation pressure was kept in 10–12 mmHg. LV was performed with either classic three-port procedure or conventional single port procedure [7,8]. LV technique was based on the individual preference of surgeon. Between 2004 and 2012, parietal peritoneum covering the testicular vessels was incised caudal to the linea terminalis. During 2012–2017, parietal peritoneum covering the testicular vessels was incised cranial to the linea terminalis of the pelvic bone. During both techniques, we performed LV intraabdominally, without doing any intervention regarding inguinal channel. In NSV, all visible venous and arterial vessels were ligated laparoscopically according to Palomo technique. In SV, dilated testicular veins were separated from the testicular artery and ligated laparoscopically. Titanium or plastic clips were applied to the cranial and caudal sites of the dilated vein and then transected.

SPSS 21.0 (Statically Package for Social Sciences, Chicago, Illinois) was used for static analysis. Chi-square test were used for qualitative variables; one-way ANOVA and paired t-tests were used to compare quantitative variables.

2. Results

The mean age of the patients was 14.6 ± 1.7 in group 1 ($n = 22$) and was 14.8 ± 1.58 in group 2 ($n = 25$). All varicoceles were on the left side. Patient symptoms and findings are summarized in Table 1. The mean operation times were 38.6 ± 10.2 min (range 34–53 min) in group 1 and 33.6 ± 6.4 min (range 29–42 min) in group 2. There were no significant differences between two groups in terms of age, varicocele grade, operative time and follow-up period ($p > 0.05$). All operations were completed laparoscopically without conversion to open surgery. No intraoperative and early postoperative complications were encountered. Hydrocele was observed in one patient in the NSV subgroup in group 1 (4.5%) and it was successfully treated with open hydrocelectomy. Varicocele recurrence was observed in one patient in the SV subgroup in group 1 (4.5%) and it was treated with NSV high-level ligation cranial to the linea terminalis after 2012. In group 1, preoperatively, four patients had testicular growth arrest. In group 2, preoperatively, three patients had testicular growth arrest. In follow-up period, Catch-up growth was recorded postoperatively in three patients out of four in group 1 and in two patients out of three in group 2 ($p > 0.05$) (Table 2).

3. Discussion

Postoperative complications after LV in AV treatment include hydrocele, recurrence and decreased catch-up growth [9–12]. Hydrocele is the most common complication especially after the nonmicrosurgical varicocelectomy [11,13]. In the literature, hydrocele rate after NSV is between 3% and 13% [14–16]. However, one study demonstrates a 29% rate of hydrocele formation after NSV [4]. Deterioration of the lymphatic drainage has been accused for the increased hydrocele incidence after NSV [17,18]. Lymphatic vessel density has been shown to decrease from testicle in scrotum to inguinal area [19]. The 20% of lymphatic vessels in the spermatic cord has been shown to be located around the vas deferens and these lymphatic vessels may be important for lymphatic drainage [19]. However, the number of positive lymph nodes has been shown to be increased in ipsilateral paraaortic, paracaval, interaortacaval, hilar and through the gonadal vein in testis cancer. But the rate of positivity through the gonadal vein is relatively fewer than others [20]. Lymphatic vessels of left testicle separate from the blood vessels and deviate medially to terminate in precaval and aortic nodes after crossing ureter. Two-thirds of the lymphatic vessels end in the lateral aortic nodes up to the bifurcation and the other third ends in the preaortic nodes. The scrotal lymphatic vessels terminate in superficial inguinal nodes [21]. We performed LV with NSV or SV caudal to the linea terminalis before 2012 and we came across one hydrocele complication and it was successfully treated with open hydrocelectomy. After this complication, we started performing LV high-level cranial to the linea terminalis of pelvic bone to find a solution for hydrocele. There was no hydrocele that occurred with this method after 2012. Therefore, we think that vessel dissection in both SV and NSV cranial to the linea terminalis, independent of the technique performed, might cause significantly lower damage in lymphatic vessels compared to dissection in inguinal area, internal inguinal ring level and through the cord and vessels located caudal to the linea terminalis owing to aforementioned anatomical reasons. It may also contribute to preservation of the pelvic and retroperitoneal lymphatics. These intact lymphatic vessels and collaterals are likely to inhibit the formation of hydrocele by providing lymphatic drainage in the postoperative period.

Table 2
The effects of ligation level and operative technique on complications.

	Caudal to the linea terminalis (2004–2012) ($n = 22$)		Cranial to the linea terminalis (2012–2017) ($n = 25$)	
Operation technique	NSV ($n = 12$)	SV ($n = 10$)	NSV ($n = 11$)	SV ($n = 14$)
Reactive hydrocele	1	-	-	-
Recurrence	-	1	-	-
Growth arrest	1	3	2	1
Catch-up growth	1/1 (100%)	2/3 (67%)	1/2 (50%)	1/1 (%100)

Another postoperative LV complication is recurrence, which is seen in both SV and NSV. The incomplete interruption of collateral testicular vein branches has been accused for recurrence [3,22]. Testicular vein branches, i.e. medial and lateral branches, were observed in many radiographic reports in retroperitoneal area [1,23–25]. Testicular vein leaves the internal inguinal ring, ascends upwards as a single trunk cranial to the linea terminalis then divides into collateral branches [22]. However, the ideal ligation level should be just below the branching area of the testicular vein [22]. Originally, Palomo has ligated varicose vessels 2 cm above the internal inguinal ring [26]. As the use of laparoscopy became popular in AV treatment, different ligation levels between just cranial to the internal inguinal ring to 5 cm cranial to the internal inguinal ring have been defined in both SV and NSV [27–31]. Chen et al. suggested that the ligation level should be as high as possible, but they didn't specify the level in LV [32]. It is mandatory to section the vessels 3–4 cm cranial to the internal inguinal ring to save the healthy vascularization of the testes according to the Fowler–Stephens anatomic description [2]. Ligation levels defined in the literature for LV are caudal to the linea terminalis. Retroperitoneal dissection of testicular vessels cranial to the linea terminalis in both SV and NSV provides single testicular vein ligation. Thus, we think that high-level ligation of testicular vein cranial to the linea terminalis facilities determining the main branch worked against the high pressure. The interruption between systemic circulation and testicular vein at this site contributes to lower recurrence rates. In the present series, we have one recurrence. This patient was successfully treated with high-level NSV after 2012. We have no recurrences after 2012.

The majority of surgeons tend to preserve the testicular artery during LV regarding the fact that there is a potential association between artery ligation and decreased catch-up growth [9,27]. SV preserves testicular arterial blood, thus preventing testicular damage and testicular dysfunction [33–35]. Artery ligation is safe when it is performed at the level of the spermatic cord cranial to the internal inguinal ring where the vas deferens and its blood vessels have separated to be directed toward the prostate [27]. Recently, Kim and Fast, in a different research group, demonstrated that NSV procedure could result in the same catch-up growth rates compared to SV [36,37]. Chen et al. reported that the high ligation of both testicular artery and vein resulted in a satisfactory outcome with no incidence of testicular atrophy but they didn't specify the ligation level [32]. We think that three important conditions; arterial circulation, venous blood flow, and lymphatic drainage are the interfering parameters for the testicular well-being. High-level ligation of testicular vessels cranial to the linea terminalis contributes to testicular well-being via protection of lymphatics and blood circulation. We used high-level ligation in both NSV and SV in group 2. In group 1, four patients had testicular growth arrest. In group 2, three patients had testicular growth arrest. Catch-up growth was recorded in three patients out of four in the group 1 and in two patients out of three in group 2. In the present study, regarding catch up growth rate, no difference was found between two groups.

4. Conclusion

We conclude that high-level ligation of testicular vessels cranial to the linea terminalis helps to find single testicular vein in retroperitoneal area before branching collaterals, and protects superficial and deep lymphatics in inguinal region and adjacent internal inguinal ring area. In this study, we had encountered neither hydrocele nor recurrence with ligation cranial to the linea terminalis in both SV and NSV. The ligation of the spermatic veins cranial to the linea terminalis during LV, independent of the technique applied, may contribute to reasonably low hydrocele and recurrence rates.

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