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Comparison of different ligation techniques in laparoscopic varicocelectomy*

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Aim: To evaluate the effects of different intracorporeal ligation techniques with titanium clips, Plasma Trisector (Gyrus, USA) (PTG), and surgical silk on bilateral laparoscopic varicocelectomy (LPVx).

Materials and methods: Between May 2009 and August 2012, 100 patients who underwent bilateral LPVx were evaluated. The demographic parameters of patients, preoperative radiological findings, semen analysis, operative data, and follow-up were recorded. All of the patients were divided into 3 groups, randomized prospectively. The patients whose veins were ligated by 5-mm titanium clips were included in group I, those whose veins were ligated by PTG were included in group II, and those whose veins were ligated by surgical silk were included in group III. The recorded data of the groups were analyzed.

Results: Mean follow-up time was 18.8 ± 1.1 months. According to the demographics of age, body mass index, spermiogram, and diameter of veins before surgery, there were no statistical differences between any of the groups ($P > 0.05$). However, operation time was longer in group III ($P < 0.0001$), while total numbers of ligated veins did not differ among the groups ($P > 0.05$). Additionally, hospital stay, oral intake, and complications were not different among the groups ($P > 0.05$). In follow-up the sperm count analysis was higher than the preoperative count analysis for all of the groups ($P < 0.05$).

Conclusion: PTG may provide a shorter operation time than using titanium clips and/or surgical silk in LPVx. Additionally, PTG may increase sperm count with fewer complications than the other ligation techniques in LPVx. Therefore, PTG may be the new candidate electrosurgical standard device for LPVx in the nearby future.

Key words: Complications, electrosurgery, laparoscopy, ligation techniques, varicocele, varicocelectomy

1. Introduction

One of the most common causes of male infertility is described as varicocele. When clinical varicocele occurs, it is vital that it is treated (1). Treatment options for varicocele include varicocelectomy. It can be performed at various anatomical levels. Many methods for performing varicocelectomy have been described in the existing literature (2); laparoscopic varicocelectomy (LPVx) is one of these methods. Aaberg et al. reported the first LPVx in 1991 (3). After that report, many studies were performed to evaluate the feasibility and safety of LPVx (4). During LPVx, different ligation techniques can be used for ligating varicose veins, such as ligation by electrosurgical devices, surgical silk, and titanium clips.

In this study, we aimed to evaluate the effects of different surgical ligation techniques on surgical outcomes during LPVx in a multicenter study. We used titanium clips, Plasma Trisector (Gyrus, USA) (PTG), and surgical silk for ligation.

2. Materials and methods

Between May 2009 and August 2012, 1223 patients were diagnosed and operated on for varicocele. Bilateral laparoscopic varicocelectomy was performed on 132 patients who were diagnosed with bilateral varicocele. Of these, 100 were included in the study. Signed consent was obtained from all patients and the institutional board approved the study.

All the patients were examined and diagnosed with bilateral varicocele in the urology outpatient clinics. Following this, the patients were randomized prospectively and divided into 3 groups. The exclusion criteria were azoospermia, secondary varicocele, peripheral venous circulation disease, and morbid obesity.

* This was a multicenter study. This study was conducted in the urology outpatient clinics of Erzincan University, Akdeniz University, and Afyon Kocatepe University.

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Patients whose veins were ligated by 5-mm titanium clips were included in group I, veins ligated by PTG were included in group II, and veins ligated by surgical silk were included in group III.

The following prospectively documented data were investigated: preoperative data consisted of age, body mass index (kg/m^2) (BMI), operation history, physical examination, spermiogram, and diameter of veins in colored Doppler ultrasound (CDUS); operative data consisted of ligation device, number of ligated veins, operation time, and intraoperative complications; postoperative data consisted of hospital stay, oral intake, spermiogram, and complications 3, 6, and 12 months after surgery.

Indications for laparoscopic bilateral varicocelectomy were scrotal pain, primary or secondary infertility, softening in the tissue of the testes, and abnormalities in spermiogram parameters. Furthermore, additional pathologies, such as possible mass or pressure on the gonadal vein in the right retroperitoneum, were definitely ruled out in all patients by radiological evaluations.

The operation time was calculated including trocar insertion with docking. Additionally, all of the complications were classified according to modified Clavien complication classification (5).

2.1. Surgical technique

Under general anesthesia, the patient was secured in the mild Trendelenburg position while lying in a supine position. A 1-cm transverse midline incision was then made immediately above the umbilicus. A 10-mm trocar was introduced into the peritoneal cavity by the Hasson technique (6). Following this, the abdomen was inflated with carbon dioxide gas (14 mmHg) and a 10-mm telescope was inserted into the abdominal cavity. The second and third trocars (both 5 mm) were bilaterally introduced through the incisions located at two-thirds of the internal distance from the umbilicus to the anterior superior iliac spine.

An endodissector and scissors were used to make 2 perpendicular incisions in the peritoneum overlying the internal spermatic veins. The vessels were lifted to separate the arterial and lymphatic components from the veins. The veins were then ligated by 5-mm titanium clips, PTG, or surgical silk, and all ligated or sealed veins were cut. At the end of the surgery, the peritoneum was sutured by Vicryl. Marcaine was injected into the fascia where trocars were placed. No urethral catheter was used in order to empty the bladder.

2.2. Statistical analysis

Descriptive results were reported for all studied parameters. Paired t-test and Kruskal–Wallis tests were used for statistical analysis. All statistical analysis tests were performed with Prism Version 5.01 (GraphPad Software Inc., USA). The statistically significant P-value was $P < 0.05$.

3. Results

Out of the 132 bilateral LPVx procedures that were performed, 100 patients who regularly came to the outpatient clinic or made contact by telephone were included in the study. The mean age was 25 ± 4.1 years and the mean follow-up time was 18.8 ± 1.1 months. There were 35 patients in group I, 34 patients in group II, and 31 patients in group III. The groups were created by prospective randomization. There were 29, 24, and 25 married patients and 11, 8, and 12 infertile patients in groups 1, 2, and 3, respectively.

According to the demographics of age, BMI, spermiogram, and diameter of veins before surgery, there were no statistically significant differences between any of the groups ($P > 0.05$; Table 1).

Operation time was longer in group III than in other groups ($P < 0.001$). The total number of ligated veins did not differ among groups ($P > 0.05$; Table 2).

However, hospital stay and oral intake did not vary among groups. Additionally, all of the patients were discharged 1 day after the surgery and all of the patients began oral intake 6 h after the surgery.

There were minimal indirect inguinal hernias diagnosed during surgery in 5 patients (2 in group I, 1 in group 2, and 2 in group III). The hernias were fixed by prolene mesh graft and sutured by 5-mm Tacker (Tacker™

Table 1. Descriptive data of patients.

Parameter	Group I (n = 35)	Group II (n = 34)	Group III (n = 31)	P-value
Mean age (years)	24.5 ± 0.7	25.2 ± 0.7	25.2 ± 0.7	0.5
Mean BMI¶ (kg/m^2)	26.2 ± 0.5	27.1 ± 0.5	26.2 ± 0.4	0.2
Mean follow-up (months)	32.3 ± 0.5	31.5 ± 0.6	32.3 ± 0.7	0.5
Preoperative spermiogram (10^6/mL)	17 ± 1.7	18 ± 1.8	21 ± 2.1	0.2
Mean maximum diameter of veins (mm)	4.9 ± 0.1	5.1 ± 0.2	5 ± 0.1	0.7

BMI¶: Body Mass Index

Table 2. Operative data of patients.

Parameter	Group I (n = 35)	Group II (n = 34)	Group III (n = 31)	P-value
Number of total ligated veins	7.4 ± 0.2	7.6 ± 0.2	6.8 ± 0.3	0.2
Operation time (min)	45.5 ± 1.6	40.3 ± 1.2	74.3 ± 1.6	P < 0.001*

*: Statistically significant P-value.

5-mm fixation device, Covidien, USA). In these patients, scrotal emphysema occurred. In the follow-up period, emphysema was decreased. No additional complications occurred. Furthermore, bridectomies were performed in 7 patients (3 in group I, 2 in group II, and 2 in group III) due to a previous appendectomy on the right side of the peritoneum. In the follow-up period there was no ileus and patients who were administered bridectomies were discharged the day after surgery.

There were 2 intraoperative hemorrhages: 1 patient in group I and 1 patient in group II. These complications occurred due to epigastric vein injury while inserting the trocar. Bleeding was controlled by monopolar electrocautery and an endodissector in both cases. However, epigastric vein injuries occurred in earlier cases; in later periods there was no epigastric vein injury or intraoperative hemorrhage.

Postoperative hydrocele occurred in 2 patients: 1 in group I and 1 in group II. In accordance with the requests of the patients, hydroceles were operated on with spinal anesthesia. Additionally, wound infection occurred in 2 patients: 1 in group I and 1 in group III. The infections were treated with antibiotics and the patients recovered within 1 week. Scrotal pain continued for 6 months after surgery in 1 patient in group II. There were recurrences in 4 patients: 1 in group I, 1 in group II, and 2 in group III. Recurrences were treated with open varicocelectomy with spinal anesthesia and microscope. There was no testicular atrophy in the follow-up period. All complications are listed in Table 3.

In the follow-up period, semen analysis was performed at 3-month intervals during the first year after surgery. The postoperative (third month of surgery) sperm count in semen was statistically significantly higher than preoperative results for all of the groups (Table 4). Although sperm morphology and motility were increased, there were no statistically significant differences among the groups. Additionally, the rate of increase in sperm count was not statistically significant among the groups.

4. Discussion

In our series we investigated the outcomes of different ligating devices in LPVx. Varicocele is present in 15% of men and is described as a collection of enlarged veins in the scrotum (7). Additionally, most patients who seek a medical opinion are aged between 15 and 30 and these patients are asymptomatic. The precise mechanism by which varicocele develops is poorly understood; however, the clinical condition is acknowledged to result from venous reflux. The absence of valves in the testicular veins is more common on the left side; thus, around 90% of varicocele incidences are left-sided (8). It is the most common cause of infertility (9).

There were 1223 patients with varicocele and 132 of these cases were bilateral. In our series, the rate of bilateral varicocele was similar to reports in the literature

Table 3. Complications of laparoscopic varicocelectomy.

	Parameter	Group I (n = 35)	Group II (n = 34)	Group III (n = 31)	Clavien classification	P-value
Intraoperative	Hemorrhage (n)	1	1	-	1	Not assessed
	Scrotal emphysema (n)	2	1	2		Not assessed
Postoperative	Wound infection (n)	1	-	1	1	Not assessed
	Scrotal pain (n)	-	1	-	2	Not assessed
	Pain in trocar insertion area (n)	1	-	-	2	Not assessed
	Hydrocele (n)	1	1	-	3a	Not assessed
	Recurrence (n)	1	1	2	3a	Not assessed
	Overall complications (n)	7	5	5		P > 0.05, P = 0.8

Table 4. Sperm count: statistically significant increase after surgery.

Parameters	Preoperative	Postoperative	P-value
Group I (n = 35)			
Sperm count (10^6/mL)	28	38.7	P = 0.0003*
Sperm motility (%, ±SD¶)	35.6 ± 13.9	38 ± 14.8	P = 0.18
Sperm morphology (%, ±SD)	37.8 ± 19.6	39 ± 19.3	P = 0.09
Group II (n = 34)			
Sperm count (10^6/mL)	35.6	41.4	P < 0.0001*
Sperm motility (%, ±SD)	36.9 ± 17.4	39.5 ± 16.1	P = 0.11
Sperm morphology (%, ±SD)	44.5 ± 14.5	45.7 ± 17.4	P = 0.52
Group III (n = 31)			
Sperm count (10^6/mL)	32.4	37.5	P = 0.0003*
Sperm motility (%, ±SD)	35.9 ± 16.9	38.1 ± 16.6	P = 0.07
Sperm morphology (%, ±SD)	35.2 ± 18.6	39.7 ± 18.8	P = 0.10

¶SD: Standard deviation. *: Statistically significant P-value.

(8). Moreover, 4 patients in group I and 1 patient in both groups II and III had children in the follow-up period of 18 months after surgery. These results are in agreement with the literature (8). There is no doubt that varicocelectomy contributes to conception (8,9).

Varicocele was diagnosed by physical examination in which dilated and tortuous veins could be palpated easily in the scrotum. We were usually able to use ultrasound to identify the nature of the palpated mass when there was pain, sensitivity, infertility, and bilateral varicocele. In the presence of varicocele, many enlarged veins along the spermatic cord and epididymis could be seen on CDUS examination (10). In a standing position, the diameter of the largest vein was measured by CDUS while the patient performed the Valsalva maneuver (11). Additionally, reflux in the veins could be seen during the Valsalva maneuver. It was difficult to see normal pampiniform veins in CDUS. Therefore, after unusually enlarged veins were seen in CDUS, a diagnosis of varicocele could be made. In this context, those veins that were larger than 3 mm in diameter were considered to be varicose (12). Although varicocele was diagnosed by physical examination, CDUS was performed on all of the patients in our series. The mean diameter of the largest veins was greater than 3 mm in CDUS. In addition, pathologies that might cause varicocele in the right retroperitoneum were excluded by ultrasound examination.

Only 1 or 2 large veins presented and hence a fewer number of veins were ligated in LPVx. In addition, the testicular artery, which is often distinctly separated from the internal spermatic veins, had not yet branched out and was often distinctly separate from the internal spermatic veins (13,14). In our series, there was no statistical difference among groups in the number of ligated veins. Additionally, the mean number of ligated veins was 7.33 and ranged between 4 and 9 as to the total of right and left sides. Furthermore, the persistence and/or recurrence rate of LPVx ranged between 6% and 15% (15,16). Failure was usually due to preservation of the periarterial plexus of fine veins along with the artery. In the existing literature, some studies reported that artery preservation during LPVx results in higher recurrence and/or persistence rates (3.5%–20%) than when the spermatic vessels were ligated (17,18).

In this study, the recurrence rate was 4%. The patients with recurrence underwent open varicocelectomy. This rate was lower than most rates in the literature but similar to a report by Cayan et al. (15). During open varicocelectomy of recurrent patients we did not see any veins outside the spermatic cord.

The mean operation time was significantly lower in group I and group II than in group III. PTG and 5-mm titanium clips provided the shorter operation time. Although there was no statistical significant difference between group I and II, the operation time may be reduced 1.214 times by using PTG. Rapid development in minimally invasive techniques has driven the need for concomitant advances in instrumentation. Currently, available instruments with tissue-sensing technology can seal blood vessels with supraphysiological burst pressures equal to those obtained with surgical clips or ligatures (19,20). PTG is one of the new electrosurgical devices that can provide vessel sealing. However, other than PTG, which was used in this series, other new electrosurgical devices may be used for sealing tortuous veins, such as the harmonic scalpel (Ethicon Endosurgery Incorporated, USA) and/or

the LigaSure Atlas device (Valleylab, USA). In our series, using PTG provided shorter operating times. In addition, PTG is safe and has a lower complication rate than titanium clips and/or surgical silk. However, PTG is a new cautery device and there was no cautery effect in the surrounding tissues. There were 2 patients with hydrocele in the follow-up period and they required surgery. Al-Kandari et al. reported an occurrence of 20% hydrocele with LPVx (21). Our findings were not in concordance with the report of Al-Kandari et al. In our series, hydrocele occurred in 2% of all patients (21). Schwentner et al. reported hydrocele after varicocelectomy in 3% of all cases in experienced hands with the conventional open microscopic method (22). In our series, the rate of hydrocele was low compared with that reported for open microvaricocelectomy in the literature (22). In addition, there was no testicular atrophy in the postoperative follow-up period. Huk et al. reported a statistically significant increase in testicular volume after varicocelectomy (23). In our study groups there was no increase in testicular volume.

All of these findings showed that PTG is a safe electrosurgical device for LPVx. Furthermore, we fixed 5 inguinal hernias during LPVx. Scrotal emphysema occurred and healed within 7 days after surgery. There was no additional inguinal hernia after LPVx.

There was a statistically significant increase in sperm count in semen for all of the groups. This finding is parallel to the report of Song et al. (24). However, they reported a statistically significant increase in sperm, sperm count, morphology, and motility after surgery, whereas we only determined a statistically significant increase in sperm count. This may be related to the time of sperm counting; we could only evaluate the third month's spermiogram because of the missing data. If we had been able to perform analyses of the data of spermiograms in the 6th and 12th months after surgery, a statically significant increase in sperm morphology and motility might have been determined.

Despite having limited experience of LPVx with just 132 cases, the complication rate of our series in the follow-up period was low. Additionally, the low complication rate included differing ligation techniques. According to the modified Clavien classification, there was no statistical difference for complications among the groups. Furthermore, the rates of complications were acceptable.

Despite there being some reports on the usage of electrosurgical devices, PTG being the one that was used in this series for LPVx, to the best of our knowledge, no study comparing the surgical outcomes of different ligation techniques in LPVx has yet been performed (25,26). Therefore, our study, in which different ligation techniques for LPVx were evaluated, is unique. Further, complications were classified according to the modified Clavien classification.

There were some limitations in this series. We only had the semen parameters of all patients in the first 3 months after surgery. Varicocelectomy can be performed with various techniques, such as open, laparoscopic, and radiological. Our series could be compared with open techniques (27–29). This could be explored in future studies. It is a fact that the conventional open microscopic technique is the most commonly performed and cost-effective surgical method for varicocelectomy (30). Our aim was not to discuss this well-established truth but merely to compare the surgical outcomes of different ligation techniques in LPVx that we obtained in the study.

Varicocele is the most common reason for infertility in males and varicocelectomy can be performed in many ways. However, LPVx may not be the most effective method of administering varicocelectomy treatment; the complication rates are acceptable and surgical outcomes are nearly similar to open conventional microscopic varicocelectomy. Furthermore, the usage of PTG makes the operation times shorter than using titanium clips and/or surgical silk in LPVx. PTG was also safe and had a low complication rate. However, the increase in sperm count provided by using PTG was similar to that of other techniques. In this series, faster, safe LPVx could be performed by PTG. Randomized, controlled studies are required with large groups of patients at multiple centers all over the world to evaluate the best methods of performing varicocelectomy.

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