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ORIGINAL ARTICLE

Anatomic mapping of the internal spermatic vein via subinguinal varicocelectomy with intraoperative vascular Doppler ultrasound

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Abstract

Background: Varicocele is believed to be a dilated vein of the pampiniform plexus along the spermatic cord. Surgical treatment should be considered in men with a symptomatic varicocele. To date, microsurgical varicocelectomy is the most effective method among various varicocelectomy techniques, according to the current evidence. This study aimed to evaluate the effectiveness of subinguinal varicocelectomy with intraoperative vascular Doppler for symptomatic varicocele and map the distributional trend of spermatic content simultaneously.

Methods: A total of 24 male patients underwent subinguinal varicocelectomy with intraoperative vascular Doppler ultrasound between March 2016 and October 2017, because of symptomatic varicocele or infertility. The numbers, sizes, and location of spermatic vessels in each site were recorded during operation. The visual analogue scale (VAS) score of scrotal pain was also obtained before and after surgery.

Results: The mean number of spermatic veins that were ligated in each spermatic unit was 4.70 (±2.06). The predominant distributional zone of spermatic veins was the medial upper zone on an axial view of the spermatic cord. Fifty-six (44.1%) spermatic veins were found in this zone. Normally, each spermatic cord has 1.33 (±0.61) spermatic arteries. The average VAS score prior to surgery was 1.95 (±0.89) and it decreased to 0.05 (±0.21) after the surgery. Complete resolution of pain was observed in almost all symptomatic patients (95.23%). A significant positive relationship between the number of veins ligated and improvement of VAS score was also noted ($p < 0.05$).

Conclusion: Subinguinal varicocelectomy with intraoperative vascular Doppler ultrasound is an effective treatment for symptomatic varicocele. The more the internal spermatic veins are ligated, the more the VAS scores are improved. Determining the distributional trend of spermatic content is of great importance in the prevention of iatrogenic injury to the spermatic vessels and vas deferens.

Keywords: Doppler; Spermatic cord; Varicocele; Varicocelectomy

1. INTRODUCTION

Varicocele is an abnormal condition involving enlargement of spermatic veins of the pampiniform plexus along the spermatic cord. The severity of varicocele is defined as grade I, grade II, and grade III on the basis of physical examination.[1] About 20% of adult male population has varicocele, and it is usually asymptomatic. However, 10% of patients with varicocele present with supra-testicular pain that may affect daily activities.[2]

Surgical treatment should be considered in men with symptomatic varicocele, oligospermia, and in couples with unexplained infertility.[3] Several methods are available for varicocele repair, such as retroperitoneal high ligation of the internal spermatic vein and subinguinal and laparoscopic varococelectomy.[4] To date, microsurgical varicocelectomy is the most effective method, with fewer complications and lower recurrence rate according to the current evidence.[3]

Only a few studies have investigated the relationship between the grade and number of internal spermatic veins.[5] However, no studies have mapped the anatomic distribution of internal spermatic veins. Therefore, this study aimed to evaluate the effectiveness of subinguinal varicocelectomy with the assistance of intraoperative vascular Doppler ultrasound for painful varicocele and to determine the relationship between the number of veins ligated and improvement in visual analogue scale (VAS) score. Mapping of the anatomic distribution of the internal spermatic vein within the spermatic cord was also performed in this study.

2. METHODS

2.1. Patient

Between March 2016 and October 2017, a total of 24 male patients who presented with scrotum pain or complained of infertility were diagnosed with symptomatic varicocele or varicocele with infertility. These patients were young adults without medical illness, drug usage, and smoking and drinking habits and came from military service hospital. Most of them performed regular exercise. The grade of varicocele was defined based on physical examination during the first outpatient department visit. Semen analysis was performed if the

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patient has a chief complaint of infertility. Other parameters such as height, weight, and VAS score were also recorded.

Concerning the surgical options, the benefits and disadvantages of retroperitoneal high ligation of internal spermatic veins, laparoscopic varicocelectomy, and subinguinal varicocelectomy with or without microscope assistance were explained to the patients. Before operation, comprehensive physical examination including digital rectal examination and careful palpation of the external genitalia was performed to exclude other concomitant causes such as prostatitis and epididymitis. Patients who underwent subinguinal varicocelectomy without microscope assistance were included in this study.

The study protocol was approved by the Institutional Review Board of Tri-Service General Hospital (TSGHIRB No.:1-107-05-104). Informed consent was waived due to the retrospective nature of the study.

2.2. Technique

Subinguinal varicocelectomy with intraoperative vascular Doppler was performed under spinal anesthesia by well-trained urologists. About 1.5-cm longitudinal incision was made between the external inguinal ring and supra-testicular region. Then, the spermatic cord was identified via fascia incision and blunt dissection. The spermatic cord was adequately separated from the peripheral tissue to decrease its tension and the spermatic cord is carefully manipulated with correct alignment during the operation. Penrose drain was placed below the spermatic cord for support, not to compress it, to keep the target above the incisional wound. With the looseness of the spermatic cord, we could map the location of the vessels precisely. Given the important role of the vas deferens in fertilization and its potential to obscure the detection of intraoperative vascular Doppler, the vas deferens was identified and initially looped with silk to prevent iatrogenic injury and achieve better ultrasound detection on other sites. To further distinguish the nature of uncertain vessels, a vascular Doppler (5 MHz, D.E. Hokanson, Inc.) was used intraoperatively by surgeon to detect the to-and-fro flow of the artery (Figure 1A, B). The vein size was measured using a sterile ruler and was defined as small, medium, and large. Veins with diameters of <1.0 mm, >1.0 mm and <2.0 mm, >2.0 mm were defined as small vein, medium vein, and large vein, respectively. The distribution of vessels was categorized into four quadrant zones on an axial view of the spermatic cord (Figure 2): lateral upper zone (Q1), medial upper zone (Q2), medial lower zone (Q3), and lateral lower zone (Q4). The diameter category, vessel distribution, and location of the vas deferens were recorded.

Patients were discharged on postoperative day 1. Outpatient department follow up was arranged 1 week later. VAS score alleviation was obtained by subtracting the postoperative VAS score from the preoperative VAS score. Improvement of scrotal pain and wound condition were also documented.

2.3. Statistical analysis

The results were expressed as mean ± one standard deviation. All data were recorded as continuous variants, and based on the number of groups, they were analyzed by Student's *t*-test or one-way ANOVA) with the least significant difference post hoc-testing method to compare the average values. Trend test was performed using one-way ANOVA with linear polynomial regression. Statistical analyses were performed using IBM SPSS Statistics version 18.0 (IBM Corp., Chicago, USA). All statistical tests and *p* values were two sided, and the level of significance was set to <0.05 (*), <0.01 (**), or <0.001 (***).

3. RESULTS

Between March 2016 and October 2017, 24 patients underwent subinguinal varicocelectomy, and 27 units of spermatic cords were recorded. Of the 24 patients, three patients underwent bilateral subinguinal varicocelectomy. Table 1 shows the demographics of patients with varicocele and distribution mapping of spermatic veins. The average age of patients was 28.07 ± 7.14 years. The average body mass index was 21.93 ± 2.18. Eighteen patients underwent subinguinal varicocelectomy because of grade III varicocele with supra-testicular pain. Other indications included infertility in five patients and both pain and infertility in one patient. The average preoperative VAS score was 1.95 ± 0.89, which decreased to 0.05 ± 0.21 postoperatively. Almost all symptomatic patients had complete resolution of pain (94.7%). No recurrent varicocele or surgical complication has been noted to date.

Table 1 also shows the distribution, number, and size of the spermatic veins in 27 units of the spermatic cord. The location of the vas deferens and spermatic artery was also recorded. There were 127 internal spermatic veins in these patients. The average count of spermatic vein from each spermatic cord was 4.7 ± 2.06. The dominant distribution zone of the spermatic veins was Q2; Fifty-six spermatic veins (44.1%) were located in this quadrant. The less distribution zone of spermatic vein was Q3, with only 17 internal spermatic veins (13.4%). In these 27 spermatic units, 25 (92.59%) vasa deferentia were located in Q4. Otherwise, we noticed that vas accompanied arteries often accompanied with the vas deferens in Q4. The average operative time required to complete subinguinal varicocelectomy of each spermatic unit was 72.56 ± 24.76 min.

Table 2 shows the relationship between VAS score alleviation and clinical parameters of patients with symptomatic varicocele. The VAS score alleviation was divided into three categories: VAS score alleviation of 1, VAS score alleviation of 2, and VAS score alleviation ≥3. Positive correlation with VAS score alleviation was found in vein numbers, vein numbers in Q2, and vein numbers in Q4 ($p < 0.05$).

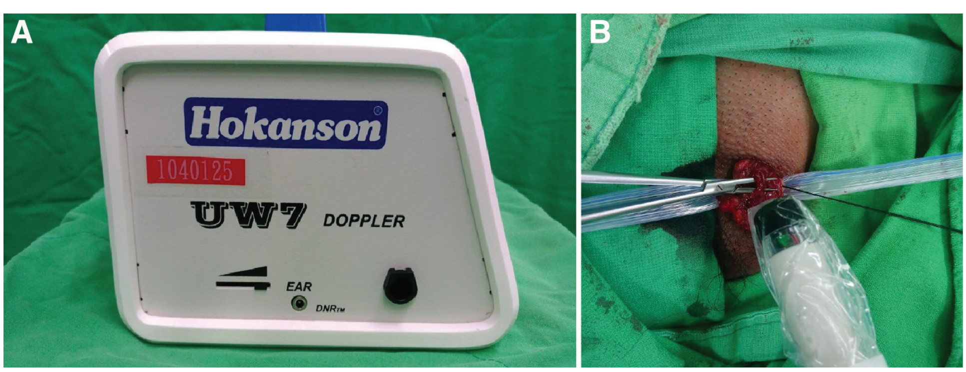

Fig. 1 A, Vascular Doppler ultrasound. B, Ultrasound was used to identify left internal spermatic artery under the supine position.

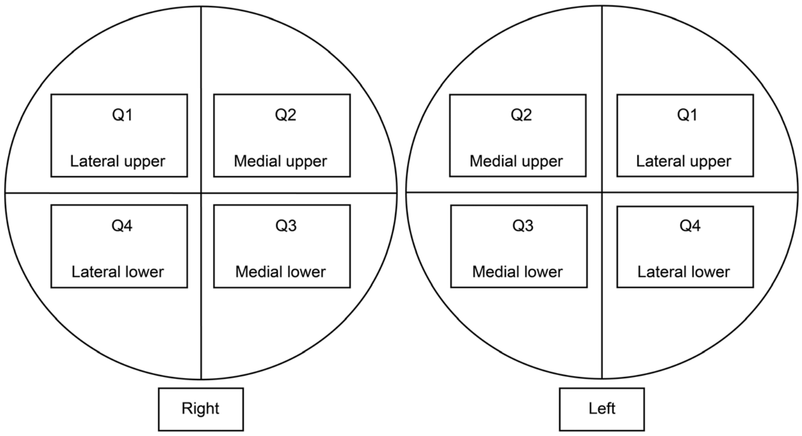

Fig. 2 Axial view of the bilateral spermatic cord.

Table 1

Demographics of patients with varicocele and distribution mapping of spermatic veins

Patient number	Age	Height/ Weight	BMI	Symptom	Grade	Location	VAS score (Pre/ Post/Alleviation)	Quadrant I	Quadrant II	Quadrant III	Quadrant IV	Operation minute	Vein number
1	22	183/70	20.9	Pain	3	Left	2/0/2		LV, LV	LV	VAS, A	57	3
2	36	168/61	21.6	Pain	3	Left	1/0/1		LV, LV	VAS,A	A	45	2
3	17	165/57	20.9	Pain	3	Left	1/0/1		LV, SV, A		VAS, A	51	2
4	27	170/65	22.5	Pain	2	Right	3/0/3	LV	SV, SV, SV	A	VAS, A	65	4
4	27	170/65	22.5	Pain	3	Left	3/0/3	LV	SV, SV, SV	SV	VAS, A	81	5
5	34	180/80	21.6	Pain	3	Left	3/0/3	LV	LV, LV, SV	A,A	VAS, A	73	4
6	19	172/63	21.3	Pain	3	Left	2/0/2	A,A	LV, LV, SV		VAS, A	60	3
7	24	180/65	20.1	Pain	3	Left	1/0/1	LV	LV, LV		VAS, A	39	3
8	36	185/80	23.4	Pain	3	Left	1/0/1		LV, LV	SV,SV	VAS, A	54	4
9	21	160/60	23.4	Pain	3	Left	3/0/3		LV, LV, SV, SV	SV	VAS, A, LV, SV	60	7
10	27	173/78	26.1	Pain	3	Left	1/0/1	SV	MV, SV	SV	VAS, A	104	4
11	19	176/58	18.7	Pain	3	Left	4/0/4	SV, SV, SV, SV	LV, LV	SV	VAS, A, MV, SV, SV, SV, SV	84	12
12	17	186/72	20.8	Pain	2	Left	4/1/3	MV, MV, MV			VAS, A, LV, LV, MV	126	6
13	40	179/55	17.1	Pain	3	Left	1/0/1	LV		SV	VAS, A, SV	53	3
14	22	173/64	21.4	Both	3	Left	1/0/1	SV	LV	SV,SV	VAS, A, LV	149	5
15	26	173/66	22.1	Pain	3	Right	2/0/2		LV, SV, SV	LV,SV	VAS, A	38	5
16	22	178/62	19.6	Pain	3	Left	2/0/2		LV, MV, SV		VAS, A, MV	100	4
17	23	171/74	25.3	Pain	2	Left	1/0/1	MV, SV, SV	A		VAS, A	80	3
18	36	178/75	23.7	Pain	3	Right	2/0/2	MV, MV, SV	SV, SV	VAS,A		68	5
18	36	178/75	23.7	Pain	3	Left	3/0/3	A	LV, LV, SV		VAS, A, SV, SV	82	5
19	35	169/61	21.4	Pain	2	Left	2/0/2		MV, MV, SV, SV		VAS, A	65	4
20	22	174/71	23.5	Infertility	2	Left	0/0/0	LV, SV, SV, SV	SV		VAS, A	63	5
21	33	172/64	21.6	Infertility	1	Right	0/0/0	LV	LV, SV		VAS, A, SV	64	4
22	28	182/75	22.6	Infertility	3	Left	0/0/0	SV, SV	MV, SV, SV, SV	SV	VAS, A, SV	93	8
23	38	175/60	19.6	Infertility	3	Right	0/0/0	MV, MV	SV	LV	VAS, A	58	4
23	38	175/60	19.6	Infertility	3	Left	0/0/0	SV	MV	MV,SV	VAS, A, SV	72	5
24	33	187/95	27.2	Infertility	3	Left	0/0/0	MV, MV, SV	MV	MV	VAS, A, SV, SV, SV	75	8
Vein number/percent								33/26.0%	56 / 44.1%	17 / 13.4%	21 / 16.5%	1959	127`

A = artery; LV = large vein; MV = medium vein; SV = small vein; VAS = visual analogue scale.

4. DISCUSSION

In this study, symptom resolution was reported in almost all patients (94.73%) who presented with supra-testicular pain. Internal spermatic veins were most often located in Q2 (44.1%). A positive correlation was found between VAS score alleviation and the number of intraoperative veins ligated ($p < 0.05$).

Three patients underwent bilateral subinguinal varicocelectomy, of which one patient had the same number of internal spermatic veins, bilaterally. The other two patients had four internal spermatic veins in the right spermatic cord and five internal spermatic veins in the left spermatic cord. In these three patients, 13 (46.43%) internal spermatic veins were located in Q2, and five vasa deferentia (83.33%) were located in Q4. The findings were similar as mentioned earlier.

There are several approaches for varicocele repair, which includes retroperitoneal, inguinal, and subinguinal.[6] Although microsurgical subinguinal varicocelectomy is the most effective method with fewer complications and lower recurrence rate, this procedure requires microsurgical training. Other therapeutic methods also have been suggested; however, recurrence and hydrocele development are more likely.[3]

Table 2

VAS score alleviation and clinical parameters of symptomatic varicocele

	VAS score alleviation			
	1 (n = 8)	2(n = 6)	≥3 (n = 7)	*p*
Vein numbers	3.25 ± 1.04	4.00 ± 0.89	6.14 ± 2.79	**0.006***
Q1	0.88 ± 0.99	0.50 ± 1.22	1.43 ± 1.51	0.403
Q2	1.38 ± 0.92	2.83 ± 0.75	2.57 ± 1.27	**0.035***
Q3	0.75 ± 0.89	0.50 ± 0.84	0.43 ± 0.53	0.431
Q4	0.25 ± 0.46	0.17 ± 0.41	1.71 ± 1.89	**0.024***
Age	28.13 ± 8.20	26.67 ± 7.20	23.86 ± 5.84	0.268
BMI	21.99 ± 2.90	21.50 ± 1.36	21.89 ± 1.72	0.929
Grade	2.88 ± 0.35	2.83 ± 0.41	2.71 ± 0.49	0.467
Operation minute	71.88 ± 37.72	64.67 ± 20.26	81.57 ± 21.58	0.522

*Trend test of analysis of variance with polynomial linear regression; statistical significance ($p < 0.05$) is shown in bold.

Intraoperative vascular Doppler ultrasonography demonstrated several benefits for subinguinal varicocelectomy. First, Morey and Joel showed that tiny internal spermatic arteries could be localized and identified using intraoperative vascular Doppler ultrasound, which may prevent damage to the small spermatic arteries and decrease the possibility of testis atrophy.[7] Second, Marcello et al. demonstrated that intraoperative vascular Doppler allowed more internal spermatic veins to be ligated during operation, and it was considered an excellent tool to improve operative result.[8] Third, Liqiang et al. reported that intraoperative vascular Doppler is an effective tool to improve semen quality in patients who underwent operation because of infertility. Compared with subinguinal microscopic varicocelectomy without vascular Doppler, the improvement in sperm motility was more significant in the intraoperative vascular Doppler group owing to the maximal preservation of arterial blood supply to the testis.[9]

In the present study, we employed subinguinal varicocelectomy without microscope assistance for symptomatic varicocele repair. The mean number of veins ligated was 4.7 ± 2.06. Compared with other studies that applied the microscopic method, the mean number of ligated veins was 6.9 in each spermatic cord.[1] This demonstrated that more veins can be ligated using microscopic subinguinal varicocelectomy because of the magnified surgical field that allowed more accurate identification of tiny veins.[6]

Nineteen patients underwent subinguinal varicocelectomy with intraoperative vascular Doppler ultrasonography because of symptomatic pain. Even without using a microscope, the mean VAS score improved after surgery. Symptom-free was noted in 18 symptomatic patients (94.73%). Furthermore, Min-Che et al. applied the modified subinguinal varicocelectomy in patients with painful varicocele and reported that 90% of their patients had painless status after operation and 10% experienced partial remission of pain.[10] In another study, 237 patients underwent microscopic subinguinal varicocelectomy due to scrotal pain, of which 85.6% experienced complete resolution of pain and 6.3% reported partial resolution.[11] Comparable therapeutic effect for scrotal pain was seen in both surgical techniques.

No studies have investigated the effect of the number of ligated veins in the improvement of pain score. The present study found a significant positive relationship between the numbers of ligated veins and improvement of VAS scores. To the best of our knowledge, this study is the first to reveal this finding. Haitham et al. demonstrated that the number of ligated veins during operation was not predictive of pain improvement after surgery.[2] However, their pain assessment was based on subjective complete resolution of symptoms after operation. In the present study, pain was investigated and assessed using VAS score. In addition, the present study revealed an interesting finding that the degree of VAS score improvement was significantly associated with the number of veins in Q2 and Q4. This meant that the numbers of ligated veins in these two quadrants were more important for symptom relief on the basis of the statistical result. Most engorged veins located in Q2 (44.1%) significantly affect pain relief after surgery. On the contrary, the influence of ligated veins in Q4 on pain relief requires further study. One possibility may be related to the role of veins adjacent to the vas deferens.

No study has investigated the anatomic mapping of spermatic contents. To our knowledge, this study is the first to evaluate the distribution of spermatic veins in Taiwanese patients and map the anatomic distribution of the internal spermatic veins within the spermatic cord. In this study, subinguinal varicocelectomy with intraoperative vascular Doppler was used for patients experiencing painful varicocele or infertility. We found that internal spermatic vein was mainly distributed in Q2 (44.1%). Q2 was the predominant zone of internal spermatic veins and was the main target for surgical repair. We also noticed that most internal spermatic arteries and vas deferens-accompanying arteries (86.11%) were often located in the lower quadrants including Q3 and Q4. The finding was compatible with Beck's study that the testicular artery was adherent to the posterior aspect of large spermatic veins.[12] Iatrogenic injury to internal spermatic artery may induce testicular atrophy.[8] Therefore, careful attention should be paid to the lower quadrants to prevent unexpected harm to testicular arteries. Moreover, the vas deferens was frequently located in Q4 (92.59%). This distributional property warned us to deal with each quadrant gently.

This study had some limitations. First, this study had a small sample size, which only included 27 spermatic units. Indeed, this was a preliminary study with randomization for limited cases. Although the number of cases was relatively small, this study presents novel and interesting findings, especially in the venous mapping of the spermatic cord. Further studies with more cases are necessary to support these findings. Second, because some infertile patients were lost to follow up, the change in the semen quality after operation was not analyzed.

Subinguinal varicocelectomy with intraoperative vascular Doppler ultrasonography was a reliable method for painful varicocele repair even without microscopic assistance. The more the numbers of internal spermatic veins are ligated, the more the VAS scores are decreased. Determining the distributional trend of spermatic structures helps us repair varicocele more effectively and decrease the probability of iatrogenic injury.

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REFERENCES

1. Belani JS, Yan Y, Naughton CK. Does varicocele grade predict vein number and size at microsurgical subinguinal repair? *Urology* 2004;**64**:137–9.
2. Elbardisi H, Agarwal A, Majzoub A, Said SA, Alnawasra H, Khalafalla K, et al. Does the number of veins ligated during microsurgical subinguinal varicocelectomy impact improvement in pain post-surgery? *Transl Androl Urol* 2017;**6**:264–70.
3. Jungwirth A, Diemer T, Kopa Z, Krausz C, Tournaye H. Male infertility. *European Association of Urology Guideline* 2017;**2017**:18–9.
4. Wang J, Xia SJ, Liu ZH, Tao L, Ge JF, Xu CM, et al. Inguinal and subinguinal micro-varicocelectomy, the optimal surgical management of varicocele: A meta-analysis. *Asian J Androl* 2015;**17**:74–80.
5. Lee JK, Ryu HY, Paick JS, Kim SW. Anatomical factors affecting the time required for microsurgical subinguinal varicocelectomy. *Springer Plus* 2016;**5**:1031.
6. Owen RC, McCormick BJ, Figler BD, Coward RM. A review of varicocele repair for pain. *Transl Androl Urol* 2017;**6**:S20–9.
7. Wosnitzer M, Roth JA. Optical magnification and Doppler ultrasound probe for varicocelectomy. *Urology* 1983;**22**:24–6.
8. Cocuzza M, Pagani R, Coelho R, Srougi M, Hallak J. The systematic use of intraoperative vascular Doppler ultrasound during microsurgical subinguinal varicocelectomy improves precise identification and preservation of testicular blood supply. *Fertil Steril* 2010;**93**:2396–9.
9. Guo L, Sun W, Shao G, Song H, Ge N, Zhao S, et al. Outcomes of microscopic subinguinal varicocelectomy with and without the assistance of Doppler ultrasound: a randomized clinical trial. *Urology* 2015;**86**:922–8.
10. Tung MC, Huang WJ, Chen KK. Modified subinguinal varicocelectomy for painful varicocele and varicocele-associated infertility. *J Chin Med Assoc* 2004;**67**:296–300.
11. Altunoluk B, Soylemez H, Efe E, Malkoc O. Duration of preoperative scrotal pain may predict the success of microsurgical varicocelectomy. *Int Braz J Urol* 2010;**36**:55–9.
12. Beck EM, Schlegel PN, Goldstein M. Intraoperative varicocele anatomy: A macroscopic and microscopic study. *J Urol* 1992;**148**:1190–4.