Egyptian Journal of Surgery Vol.32, No.4, October 2013

ORIGINAL ARTICLE

A COMPARATIVE STUDY OF THE OUTCOME OF HIGH AND LOW LIGATION OF VARICOCELE

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Abstract

Introduction: Varicocele, defined as dilatation of the pampiniform plexus, has long been recognized as a treatable cause of male infertility. Varicocele results in generalized impairment of sperm production, loss of testicular volume as well as enzymatic impairment in the final stage of testosterone biosynthesis. This study aims to compare the outcome of varicocelectomy done by the open retroperitoneal high ligation (modified Palomo), the low ligation (subinguinal) and laparoscopic transperitoneal ligation as regard to: Semen parameter (sperm count, motility and percentage of abnormal sperm forms), serum levels of: Testosterone, FSH, LH and Prolactin and testicular volume measured by ultrasonography.

Patients and Methods: Between May 2006 to January 2008 a total of seventy-eight patients were chosen from the outpatient clinic of the Ain Shams University Hospitals to participate in this study. They were referred to surgery as varicoceles with either infertility (40 cases)or chronic scrotal pain (38 cases).All the patients were subjected to complete semen analysis ,blood sampling for hormonal assay (testosterone, FSH, LH and Prolactine)and underwent scrotal dopplex sonography. The 78 patients were randomly divided into three groups: 1st group: Open high retroperitoneal ligation (35 patients), 2nd group: subinguinal ligation (35 cases) and 3rd group laparoscopic transperitoneal ligation (8 patients).

Results: There was significant improvement in all semen parameter after high ligation and subinguinal ligation at 3 and 6 months postoperatively (p value <0.05). The postoperative change of serum level of testosterone was significant after each approach at 3 and 6 months (p value <0.05). On the other hand, serum levels of FSH, LH and Prolactin changed insignificantly after each approach at 3 and 6 months postoperatively (p value>0.05).There was no significant difference in the percentage of change among the different operations as regard to the impact on semen parameters, testicular volume as well as the mean serum hormone levels postoperatively for the infertile group. The open high ligation resulted in significant higher incidence of postoperative hydrocele and postoperative recurrence compared with other two approaches.

Summary: Both subinguinal and laparoscopic approaches are more preferable than open high ligation due to the lesser incidence of postoperative complications (hydrocele and recurrence).

Keywords: Varicocele, Infertility, Semen parameters, Hormone level, Testicular volume, Outcome assessment.

INTRODUCTION

Varicocele, defined as dilatation of the pampiniform plexus, has long been recognized as a treatable cause of male infertility. The incidence of varicocele in general population is estimated to be 15% while the incidence in men with primary infertility rises to approximately 30%.[1,2]

Varicocele results in generalized impairment of sperm production.[3-5]Varicocele also results in testicular damage reflected in loss of volume and consistency of the involved testicle.[6-8]

Testosterone biosynthesis is found to be decreased in varicocele patients possibly due to associated dysfunction of hypothalamo-pituitary-gonadal axis and enzymatic impairment of 17, 20-desmolase and 17-alpha-hydroxylase enzymes as a result of testicular hyperthermia,[9] in addition to impaired Leyding cell response to gonadotrophin stimulation.[10,11]

There are several approaches for surgical repair among them are the high (retroperitoneal, Palomo) and the low (subinguinal) ligation procedures.

This study aims to compare the outcome of varicocelectomy done by the open retroperitoneal high ligation (modified Palomo), the low ligation (subinguinal) and laparoscopic transperitoneal ligation as regard to:

- Semen parameters (sperm count, motility and percentage of abnormal sperm forms).
- Serum levels of: Testosterone, FSH, LH and Prolactin.
- Testicular volume measured by ultrasonography.

MATERIAL AND METHODS

Seventy-eight patients were chosen from the outpatient clinic of the Ain Shams University Hospitals, to participate in this study from May 2006 to January 2008.

They were referred to surgery as varicoceles with either infertility or chronic scrotal pain. Infertility is defined as failure to achieve pregnancy after at least one year marriage with normal sexual life [12].

Inclusion criteria:

I. Age between 19 – 46 years.

II. Presence of clinical left side varicocele as most varicoceles are left sided.[13] According to the size of varicocele, three grade were defined:[14]

- Small (grade I) varicoceles are palpable only with a concurrent Valsalva maneuver.
- Moderate (grade II) varicoceles are easily palpable without a Valsalva maneuver.

Large (grade III) varicoceles are visible through the scrotal skin.

Clinical grades of varicocele were distributed as follow:

Grade 1: 28 cases(6 infertile cases and 22 scrotal pain cases.

Grade 2: 19 cases(10 infertile cases and 9 scrotal pain cases).

Grade 3: 31 cases(24 infertile cases and 7 scrotal pain cases).

III. Complete semen analysis showing at least, two of the following abnormalities:

- Sperm count below 20 millions / cc.
- Forward progressive motility of less than 50% one hour after ejaculation.
- Normal forms less than 30% of the total sperm count.

Exclusion criteria:

- History of previous episodes of cryptorchidism.
- Hydrocele.
- Testicular trauma.
- Postpubertal mumps.
- Bladder neck surgery, either open or endoscopic as it may lead to retrograde ejaculation.
- Exposure to toxic substance or radiation.
- Certain medications such as sulfasalazine, cimetidine, and nitrofurantoin have been all implicated as potential spermatotoxic agent.
- Testicular cancer.
- Patients' work in hot environment as oven. Previous endocrinal or chronic diseases as TB.

All selected patients gave a history of normal wives as proved by the gynecological assessment.

Physical examination:

- General and local genital examination.
- All patients were subjected to semen analysis:

  At least two semen specimens collected by masturbation after 2 days of sexual abstinence were obtained from each patient before operation.Semen analysis was repeated at 3 and 6 months postoperatively.

- All patients were subjected to blood sampling for hormonal assay:

  Three morning samples (5 ml each) were taken 15 minutes apart for each patient before operation. The same procedure was repeated postoperatively at 3 & 6 months.

- All patients underwent scrotal dopplex.sonography:
  - It was performed using Esaote AU4 ultrasound unit with a 7.5 MHZ transducer.
  - Testicular volume was calculated using the prolate ellipsoid formula: Volume = Length x Width x Depth x 0.53.[15] scrotal dopplex sonography was repeated for testicular volume evaluation at 3 and 6 months postoperatively.

The 78 patients were randumly divided into three groups:

- 1st group:open high retroperitoneal ligation (35 patients).
- 2nd group subinguinal ligation (35 patients).
- 3rd group laparoscopic transperitoneal ligation (8 patients).

The techniques of the operative procedures used:

Open high retroperitoneal ligation: Incision at the level of the internal inguinal ring .Incision of the external oblique apponeurosis, Splitting of internal oblique muscle. Then exposure of the internal spermatic artery and vein retroperitoneally near the ureter. We isolate the internal spermatic veins proximally near the point of drainage into the renal vein. We ligate the spermatic vein by two ligature and cut between them.

Subinguinal ligation: 2-3cm incision over the external inguinal ring. The spermatic cord is delivered. The covering was incised and the cord was then dissected and all the internal spermatic veins were ligated. The vas deferens and its vessels were preserved. An attempt was made to identify and preserve the testicular artery and if possible the lymphatic. In addition, the cord was elevated and any external spermatic veins that were running parallel to the spermatic cord or perforating the floor of the inguinal canal were ligated and divided. The internal spermatic veins were freed for a short distance upwards and downwards and excised between ligatures placed 5 cm apart. Approximation of these ligatures shortens the cord so that the testis was suspended at a higher level.

Laparoscopic transperitoneal ligation: The initial 1cm incision is made subumbilically in the midline and carried down to fascia. A Veress needle is inserted into the peritoneal through this incision and directed towards the pelvis, and 0.5 to 1cc of sterile saline is dripped into the needle. The needle is then connected to positive flow carbon dioxide at a rate of 1 liter/minute to achieve pressure of 12–15 mmHg. Once adequate pneumoperitoneum has been attainedthe needle is removed and the 11 mm laparoscopic trocar with camera attached is introduced through the same site. The internal inguinal ring was identified by the appearance of the vas difference as it leaves the spermatic cord and enters into the deep pelvis. A second operating trocar (5.5 mm type) is placed laterally at the edge of the rectus muscle approximately 5 to 10 cm inferiorly. A third 11mm access port was placed through the lineaalba halfway between the umbilicus and the pubic symphysis. The posterior peritoneum was grasped 1 cm lateral and parallel to the testicular vessels and incised 3 cm cephalic to the internal ring. The internal spermatic vessels were separated from the underlying psoas major muscle with forceps. The spermatic artery can be easily identified as a pulsatile vessel up to 1 cm in diameter on the monitor. The veins and any collaterals are doubly clipped, proximally and distally, usually within 1-2 cm of the internal ring, then divided with scissors. After adequate hemostasis is obtained the pneumoperitoneum is aspirated. All trocars are removed and the fascial incision are closed with vicryle 2/0 sutures.

RESULTS

This prospective study was conducted on 78 patients with varicocele. According to the main complaint, they were divided into 2 groups:the group with infertility (40 cases) and the group with scrotal pain(38 cases).Patients characteristics of the two groups are shown in Table 1.The table reveals significant difference in all the characteristics between the two groups.

Table 1. Patient's characteristic for all cases (78 cases).

	Infertile (40 cases)	Scrotal pain (38 cases)	P value
Age (years)	30.46 ± 5.78	25.31 ± 7.55	0.001
Sperm Concentration (mill/ml)	28.17 ± 22.7	50.52 ± 29.58	0.000
Sperm motility (%)	32.74 ± 17.32	57.29 ± 20.19	0.001
Sperm abnormal forms (%)	50.55 ± 30.68	24.33 ± 21.38	0.008
Right testicular volume (ml)	10.4 ± 3.43	14.09 ± 3.86	0.000
Left testicular volume (ml)	9.47 ± 3.37	12.72 ± 3.55	0.000
FSH (µIU/ml)	6.67 ± 4.77	3.67 ± 3.16	0.002
LH (µIU/ml)	6.37 ± 3.59	4.19 ± 1.93	0.001
Prolactin (ng/ml)	9.27 ± 4.33	7.01 ± 2.69	0.007
Testosterone (ng/ml)	3.34 ± 1.39	4.51 ± 1.9	0.003
Clinical grade:			
Grade I	6 cases (15%)	22 cases (57.9%)	
Grade II	10 cases (25%)	9 cases (23.7%)	
Grade III	24 cases (60%)	7 cases (18.4%)	

However, there was no statistical significant difference in patient characteristics between patients with infertility distributed among the three operative groups. Similarly, there was no statistical significant difference in patients'characteristics between patients with scrotal pain distributed among the three operative groups.

There was statistically significant positive impact of varicocelectomy on semen parameters and serum testosterone level at 3 and 6 months postoperatively (p value <0.05).However,there was no statistically significant effect at the same duration for either testicular volume or serum hormones levels of FSH, LH and prolactin(p value>0.05).

As regard the different operative groups there was significant improvement in all semen parameter after high ligation and subinguinal ligation at 3 and 6 months postoperatively in comparison to preoperative value (p value<0.05). However, the only parameter that improved significantly in the laparoscopic varicocelectomy group was the percentage of abnormal forms (p value <0.05). (Tables 2,3).

Table 2. Comparison between either of semen parameters and testicular volumes 3-months after each approach and the preoperative values by paired T test for the infertile group.

Operation	Count (mill/ml)	Total motility (%)	Abnormal forms (%)	Testicular volume	
				R (ml)	L (ml)
High ligation (n = 19)					
Preoperative	27.2±24.47	34.95±18.24	50.53±33.0	10.16±3.63	8.77±3.1
Postoperative 3M	45.07±34.01	46.47±23.69	32.3±25.8	11.19±3.76	8.75±3.02
Difference	17.87±21.89	11.52±23.74	18.16±24.5	1.03±1.35	0.02±1.4
T	3.56	2.116	3.23	1.237	0.705
P	0.002	0.049	0.005	0.11	0.314
Subinguinal ligation (n = 12)					
Preoperative	29.58±24.03	29.25±17.85	44.29±30.29	10.0±2.99	9.71±2.93
Postoperative 3M	43.75±26.89	47.5±18.89	25.83±18.2	10.45±3.13	10.31±2.96
Difference	14.17±11.1	18.25±11.42	18.46±27.72	0.45±0.46	0.6±0.58
T	4.42	5.537	2.307	1.367	1.566
P	0.001	0.000	0.042	0.216	0.114
Laparoscopic ligation (n = 4)					
Preoperative	22.78±18.31	33.75±21.75	42.5±25.33	12.58±4.22	11.69±5.97
Postoperative 3M	35.13±33.74	46.25±18.87	23.75±15.48	10.75±1.6	7.95±2.45
Difference	12.35±16.74	12.5±20.21	-18.75±11.09	-1.83±4.63	-3.74±6.14
T	1.475	1.237	3.382	0.788	1.216
P	0.237	0.304	0.043	0.488	0.311

Table 3. Comparison between either of semen parameters and testicular volumes 6-months after each approach and the preoperative values by paired T test for the infertile group.

Operation	Count (mill/ml)	Total motility (%)	Abnormal forms (%)	Testicular volume	
				R (ml)	L (ml)
High ligation (n = 19)					
Preoperative	27.2±24.7	34.95±18.24	50.53±33.0	10.16±3.63	8.77±3.1
Postoperative 6M	44.6±31.28	46.74±21.92	31.0±23.51	9.74±3.19	8.78±3.1
Difference	17.4±16.09	11.79±21.84	-19.52±23.87	-0.42±1.87	0.01±0.006
T	4.715	2.353	3.565	0.965	0.23
P	0.000	0.030	0.002	0.348	0.65
Subinguinal ligation (n = 12)					
Preoperative	29.58±24.03	29.25±17.85	44.29±10.29	10.0±2.99	9.71±2.93
Postoperative 6M	45.42±27.34	45.42±19.48	29.33±24.06	10.63±3.01	10.63±3.01
Difference	15.84±16.07	16.17±19.23	-14.96±14.43	0.63±4.69	0.92±0.82
T	3.415	2.91	4.505	0.466	1.878
P	0.006	0.014	0.03	0.650	0.113
Laparoscopic ligation (n = 4)					
Preoperative	22.78±18.31	33.75±21.75	42.5±15.33	12.58±4.22	11.69±5.97
Postoperative 6M	40.18±36.26	56.25±15.48	30.0±14.14	8.24±2.5	8.24±2.5
Difference	17.4±18.53	22.5±17.56	-12.5±4.9	4.34±4.67	3.45±6.29
T	1.878	2.563	5.2	1.86	1.097
P	0.157	0.083	0.05	0.161	0.353

The postoperative change of serum levels of testosterone were significant after each approach at 3 and 6 months in comparison to the preoperative value (p value < 0.05). On the other hand, serum level of FSH, LH and prolactin changed insignificantly after each approach at 3 and 6 months postoperatively(p value >0.05) (Tables 4,5).

Table 4. Comparison between serum hormone values 3-months after each approach and the preoperative values by paired T test for the infertile group.

Operation	FSH (mIU/ml)	LH (mIU/ml)	Prolactine (ng/ml)	Testosterone (ng/ml)
High ligation (n = 19)				
Preoperative	6.78±4.67	5.97±3.44	7.6±2.85	3.49±1.42
Postoperative 3M	6.52±4.35	5.72±2.91	7.34±3.08	4.25±1.86
Difference	-0.26±1.53	-0.25±1.51	-0.26±2.82	0.76±1.12
T	0.741	0.731	0.407	2.946
P	0.468	0.474	0.689	0.009
Subinguinal ligation (n = 12)				
Preoperative	6.86±5.16	5.65±3.84	8.12±4.07	3.77±1.39
Postoperative 3M	6.18±4.5	4.77±3.05	7.57±3.41	4.15±1.21
Difference	-0.68±1.74	-0.88±3.04	-0.55±1.77	1.48±0.13
T	1.35	0.996	1.084	3.615
P	0.205	0.34	0.302	0.04
Laparoscopic ligation (n = 4)				
Preoperative	7.28±4.58	7.98±3.29	7.83±2.32	4.03±1.84
Postoperative 3M	6.75±3.93	7.25±3.25	7.23±0.903	4.78±2.05
Difference	-0.53±1.55	-0.73±1.24	-0.6±1.92	0.75±0.4
T	0.679	1.165	0.624	3.712
P	0.546	0.328	0.577	0.034

Table 5. Comparison between serum hormone values 6-months after each approach and the corresponding preoperative values by paired T test for the infertile group.

Operation	FSH (mIU/ml)	LH (mIU/ml)	Prolactine (ng/ml)	Testosterone (ng/ml)
High ligation (n = 19)				
Preoperative	6.78±4.67	5.97±3.44	7.6±2.85	3.49±1.42
Postoperative 6M	6.38±4.37	5.96±3.68	7.36±2.92	4.47±2.02
Difference	-0.4±1.67	-0.01±2.89	-0.24±2.89	0.98±1.27
T	1.05	0.029	0.376	3.367
P	0.306	0.977	0.711	0.003
Subinguinal ligation (n = 12)				
Preoperative	6.86±5.16	5.65±3.84	8.12±4.07	3.77±1.39
Postoperative 6M	6.06±4.51	4.6±2.92	7.79±3.59	4.48±1.49
Difference	-0.8±1.37	-1.05±2.7	-0.33±1.17	0.71±0.16
T	0.203	1.347	0.967	3.869
P	0.067	0.205	0.354	0.038
Laparoscopic ligation (n = 4)				
Preoperative	7.28±4.58	7.98±3.29	7.83±2.32	4.03±1.84
Postoperative 6M	7.0±4.07	7.4±3.76	7.4±1.28	5.08±1.91
Difference	-0.28±0.87	-0.58±1.42	-0.43±1.94	1.05±0.3
T	0.63	0.807	0.439	7.0
P	0.573	0.479	0.69	0.006

There was no significant difference in the percentage of change among the different operations as regard to the impact on semen parameters and testicular volume achieved at 3 and 6 months postoperatively for the infertile group (Tables 6,7).

Table 6. Comparison between the percentage of change in semen parameters and testicular volume achieved by the three different operations assessed 3-months postoperatively for the infertile group.

Operation	Count (mill/ml)	Total motility (%)	Abnormal forms (%)	Testicular volume	
				R (ml)	L (ml)
1- High ligation (n = 19)					
Preoperative	27.2±24.47	34.95±18.24	50.53±33.0	10.16±3.63	8.77±3.1
Postoperative 3M	45.07±34.01	46.47±23.69	32.37±25.8	11.19±3.76	8.75±3.02
Difference	17.87±21.89	11.52±23.74	-18.16±24.5	10.3±1.35	0.87±1.4
%	65.7	32.96	35.94	10.14	9.92
2- Subinguinal ligation (n = 12)					
Preoperative	29.58±24.03	29.25±17.85	44.29±30.28	10.0±2.99	9.71±2.93
Postoperative 3M	43.75±26.89	47.5±18.89	25.83±18.2	10.45±2.13	10.31±2.96
Difference	14.17±11.1	18.25±11.42	-18.46±27.72	0.45±0.46	0.6±0.58
%	47.9	62.39	41.68	4.5	6.18
3- Laparoscopic ligation (n = 4)					
Preoperative	22.78±18.31	33.75±21.75	42.5±25.33	12.58±4.22	11.69±5.97
Postoperative 3M	35.13±33.74	46.25±18.87	23.75±15.48	10.75±1.6	7.95±2.45
Difference	12.35±16.74	12.5±20.21	18.75±11.09	1.83±4.63	-3.74±6.14
%	54.21	37.04	44.12	14.55	32
P between groups	0.986	0.368	0.745	0.462	0.088
P for 1 & 2	0.54	0.21	0.95	0.89	0.76
P for 1 & 3	0.89	0.67	0.795	0.52	0.718
P for 2 & 3	0.72	0.76	0.61	0.65	0.63

Table 7. Comparison between thepercentage of change in semen parameters and testicular volume achieved by the three different operations assessed 6-months postoperatively for the infertile group.

Operation	Count (mill/ml)	Total motility (%)	Abnormal forms (%)	Testicular volume	
				R (ml)	L (ml)
1- High ligation (n = 19)					
Preoperative	27.2±24.47	34.95±18.24	50.53±33.0	10.16±3.63	8.77±3.1
Postoperative 6M	44.6±31.28	46.74±21.92	31.0±23.51	9.74±3.19	8.78±3.1
Difference	17.4±16.09	11.79±21.84	-19.53±23.87	0.42±1.87	0.96±0.8
%	63.97	33.73	38.65	4.13	10.95
2- Subinguinal ligation (n = 12)					
Preoperative	29.58±24.03	29.25±17.85	44.29±10.29	10.0±2.99	9.71±2.93
Postoperative 6M	45.42±27.34	45.42±19.48	29.33±24.06	10.63±3.01	10.63±3.01
Difference	15.84±16.07	16.17±19.23	-14.96±14.43	0.63±4.69	0.92±0.82
%	53.55	55.28	33.78	6.3	9.47
3- Laparoscopic ligation (n = 4)					
Preoperative	22.78±18.31	33.75±21.75	42.5±25.33	12.58±4.22	11.69±5.97
Postoperative 6M	40.18±36.26	56.25±15.48	30.0±14.14	8.24±2.5	8.24±2.5
Difference	17.4±18.53	22.5±17.56	-12.5±11.9	-4.34±4.67	-3.45±6.29
%	76.38	66.67	-29.41	34.5	29.51
P between groups	0.783	0.361	0.679	0.381	0.931
P for 1 & 2	0.84	0.41	0.913	0.55	0.63
P for 1 & 3	0.91	0.50	0.82	0.35	0.85
P for 2 & 3	0.82	0.85	0.64	0.56	0.86

Similarly, there were no significant differences in the percentage of changes among the three approaches as regard to the impact on the mean serum hormone values assessed at 3 and 6 months postoperatively for the infertile group (Tables 8,9).

Table 8. Comparison between the percent of change in the mean serum hormone values achieved by the three different operations assessed 3-months postoperatively for the infertile group.

Operation	FSH (mIU/ml)	LH (mIU/ml)	Prolactine (ng/ml)	Testosterone (ng/ml)
1- High ligation (n = 19)				
Preoperative	6.78±4.67	5.97±3.44	7.6±2.85	3.49±1.42
Postoperative 3M	6.52±4.35	5.72±2.91	7.34±3.08	4.25±1.86
Difference	-0.26±1.53	-0.25±1.51	0.26±2.82	-0.76±1.12
%	3.84	4.19	3.42	21.78
2- Subinguinal ligation (n = 12)				
Preoperative	6.86±5.16	5.65±3.84	8.12±4.07	3.77±1.39
Postoperative 3M	6.18±4.5	4.77±3.05	7.57±3.41	4.25±1.21
Difference	-0.68±1.74	-0.88±3.04	-0.55±1.77	0.48±0.13
%	9.91`	15.58	6.77	4.77
3- Laparoscopic ligation (n = 4)				
Preoperative	7.28±4.58	7.98±3.29	7.83±2.32	4.03±1.84
Postoperative 3M	6.75±3.93	7.25±3.25	7.23±0.9	4.78±2.05
Difference	-0.525±1.55	-0.73±1.24	-0.6±1.92	0.75±0.4
%	7.21	9.15	7.66	18.61
P between groups	0.93	0.731	0.849	0.529
P for 1 & 2	0.93	0.623	0.65	0.44
P for 1 & 3	0.29	0.454	0.40	0.59
P for 2 & 3	0.40	0.729	0.34	0.58

Table 9. Comparison between the percent of change in the mean serum hormone values achieved by the three different operations assessed 6 months postoperatively for the infertile group.

Operation	FSH (mIU/ml)	LH (mIU/ml)	Prolactine (ng/ml)	Testosterone (ng/ml)
1- High ligation (n = 19)				
Preoperative	6.78±4.67	5.97±3.44	7.6±2.85	3.49±1.42
Postoperative 6M	6.38±4.37	5.96±3.68	7.36±2.92	4.47±2.02
Difference	-0.4±1.67	-0.01±2.89	-0.24±2.89	0.98±1.27
%	5.9	0.32	3.29	28.08
2- Subinguinal ligation (n = 12)				
Preoperative	6.86±5.16	5.65±3.84	8.12±4.07	3.77±1.39
Postoperative 6M	6.06±4.51	4.6±2.92	7.79±3.59	4.18±1.49
Difference	-0.8±1.37	-1.05±2.7	-0.33±1.17	0.71±0.16
%	11.66	15.58	4.06	8.22
3- Laparoscopic ligation (n = 4)				
Preoperative	7.28±4.58	7.98±3.29	7.83±2.32	4.03±1.84
Postoperative 6M	7.0±4.07	7.4±3.76	7.4±1.28	5.08±1.91
Difference	-0.27±0.87	-0.58±1.42	-0.43±1.94	1.05±0.3
%	3.71	7.27	5.49	26.05
P between groups	0.944	0.577	0.845	0.373
P for 1 & 2	0.91	0.34	0.37	0.38
P for 1 & 3	0.31	0.22	0.21	0.59
P for 2 & 3	0.61	0.67	0.19	0.95

The laparoscopic ligation achieved complete scrotal pain resolution assessed 6 months postoperativly in all patients in this group (100%). In addition, subinguinal ligation resulted in much greater incidence of scrotal pain resolution (81.8%)as compared with open high ligation (66.7%). However, the figures were too small to allow statistical comparison.

The open high ligation resulted in significant higher incidence of postoperative hydrocele and postoperative recurrence assessed at 6 months after the operation as compared with subinguinal or laparoscopic ligation (p value <0.05).

However, there was no significant difference between the subinguinal and laparoscopic ligation concerning the postoperative incidence of hydrocele or recurrence assessed at 6 months after operation (p values 0.44 and 0.6 respectively).

DISCUSSION

Varicocele is often cited as the most common cause of male factor infertility. Arguments in support of this statement are that varicocele has been found in 15% of the normal male population and up to 40% of patients with primary infertility. Furthermore, it is the underlying cause in 70% of patients with secondary infertility.[16] Moreover, the association of varicocele with abnormal semen parameters, and the improvement in semen parameters and/or pregnancy rates after varicocele repair have been reported.[17-22] However, on the contrary to the above, Evers and Collins[23] in their metanalysis found that varicocele repair is not effective in trials restricted to male subfertility with clinical varicocele.

The aim of this study was to compare the three main techniques of varicocele management which are the high retroperitoneal approach with preservation of testicular artery (modified Palomo), the subinguinal ligation and the laparoscopic ligation as regard their impact on sperm count, motility, percentage of abnormal forms, serum hormonal levels (FSH, LH, prolactin and testosterone), testicular volume, postoperative pregnancy rates and the postoperative resolution of scrotal pain. In addition, the drawback of each approach was demonstrated.

Our study revealed that varicocelectomy, in general, had a significant positive impact on semen parameters (sperm concentration, motility, percentage of abnormal forms) in the infertile group (35 cases) at 3 and 6 months postoperatively. This finding was also reported by Agrawal et al.[20] and Baazeem et al.[24] in their metanalysis studies. Our results showed significant improvement in all semen parameters after each of high and subinguinal ligation (P < 0.05) at 3 and 6 months postoperatively (Tables 2,3). However, the only significant improvement after laparoscopic ligation was in the percentage of abnormal forms and this may be attributed to the limited number of cases in this group (4 cases only) (Tables 2,3). The above mentioned results in our study, go in harmony with Pierik et al.[25] and Avila-Vergara et al.[26] who performed varicocelectomy via retroperitoneal high approach and found significant improvement in sperm concentration and progressive motility. Moreover, Kibar et al.[27] and Hsiao et al.[28] stated similar results when they performed varicocelectomy (by subinguinal ligation) and found significant improvement in semen parameters. Furthermore, Tan et al.,[29] Al-Hunayan et al.[30] and Agrawal and Manish[31] found significant improvement in semen parameters after laparoscopic

varicocelectomy.On comparing between the percentage of change achieved by the three surgical approaches of varicocele management, in our study, as regard sperm count, motility and percentage of abnormal forms assessed at 3 and 6 months postoperatively in the infertile group, our results did not reveal any statistically significant differences (Tables 6,7).Similar results were also reported by Khan et al.;[32] who compared 98 cases underwent retroperitoneal high ligation versus 115 cases subjected to subinguinal ligation and, Ghanem et al.[33] also compared 109 patients subjected to retroperitoneal high ligation versus 304 patients underwent subinguinal varicocelectomy and Shin & Lim[34] who compared 37 cases subjected to retroperitoneal high ligation versus 44 cases treated by subinguinal varicocelectomy .All those authors found no significant difference between the two groups as regard the degree of improvement in semen parameters. Moreover, Al-Kandari et al.[35] found similar results by comparing open inguinal, subinguinal and laparoscopic ligation each done for 30 patients and the three approaches had comparable improvement in sperm concentration and motility. Simforoosh et al.[36] found no differences in the degree of improvement in semen parameters when comparing laparoscopy and open retroperitoneal repair (50 cases for each operation).

Testicular volume didn't change significantly after varicocelectomy in the infertile group (35 cases) in our study (Tables 2,3). The absence of significant effect of varicocelectomy on testicular volume were also found by Papanikolaou et al.[37] and Younes.[38] However, Srini and Veerachari[39] found significant improvement in testicular volume after subinguinal microsurgical technique in 100 infertile men with mean age 30.04 ± 4.9 years from 8.16 ± 3.49 before surgery to 9.65 ± 3.51 cc after surgery ($P < 0.001$). The absence of any significant effect of adult varicocelectomy on testicular volume may be due to the fact that testicular volume is largely composed of germ cell precursors and therefore changes in testicular volume are primarily due to changes in the germ cell precursors population. Adult varicocele repair does not result in a significant increase in germ cell population in the testis despite an increase in total motile sperm count.[37] Furthermore, Cayan et al.[40] clarified that testicular growth is mostly completed at the age of 14 years and only interstitium of the testes may partially develop to produce testosterone. This later finding can be confirmed by the significant effect of varicocelectomy on testicular volume in children and adolescents as in the study of Lund et al.,[41]Fisch et al.;[42] and more recently, Huk et al.,[43] Poon et al.,[44]Spinelli et al.,[45] Van Batavia et al.[46] and Li et al.[47] who all found significant increase in hypotrophic testicular volume in children and adolescent after varicocelectomy.

In the present study, there was a statistically significant increase in serum testosterone at 3 and 6 months after varicocelectomy in the infertile group (35 cases) (Tables 4,5). Similar results were also reported by Younes et al.,[38]Srini&Veerachari,[39] Su et al.,[48]Cayan et al.[49]and Hurtado de Catalfo et al.[50] who found significant increase in serum testosterone after varicocelectomy. This finding supports the concept that varicocelectomy can improve Leyding cell function in men with varicocele based on the measured increase in serum testosterone postoperatively. However, Resorlu et al.[51] failed to demonstrate any change in serum total testosterone levels following varicocelectomy in 96 patients treated for infertility. It has been shown that a varicocele is associated with impaired function of the terminal step of testosterone synthesis, that is conversion of 17-alpha-hydroxyprogesterone to testosterone by 17-alpha-hydroxyprogesterone aldolase.[9,52] The activity of this enzyme is temperature-dependent and may be adversely affected by the high intratesticular temperature in patients with varicocele.[53] Thus, the physiological effect of varicocelectomy is to relieve the inhibition of 17-alpha-hydroxyprogesterone aldolase enzyme.[48] In the present study there was no significant difference between the three approaches as regard the percent of change in serum testosterone assessed at 3 and 6 months postoperatively in the infertile groups (Tables 8,9).Our results revealed the absence of significant change in serum level of FSH, LH and prolactin after each approach at either 3 or 6 months postoperatively (Tables 4,5).These results go in harmony with reports of Podesta et al.[10] and Zarrilli et al.[54] In addition, Cayan et al.[55] found insignificant drop in serum FSH level after varicocelectomy. More recently, similar results were proved by Srini and Veerachari[39] who found insignificant drop in serum LH and serum FSH after microsurgical subinguinalvaricocelectomy .

Varicocele is associated with chronic scrotal pain. It is evaluated that the prevalence of painful varicoceles is 2-10%. This pain is described as a dull, throbbing pain, worsening with exercise and strain.[56] There was a distinct significant resolution in scrotal pain assessed 6-months postoperatively after each of the three techniques applied in our research .These results cope with those of Biggers and Soderdahl[57] and Yeniyol et al.[58] who achieved complete pain resolution in 48% and 82% of their cases respectively after high retroperitoneal ligation. Similarly, Yaman et al.,[56] Peterson et al.[59] and Karademir et al.[60] found complete pain resolution in 86%, 88% and 61.1% of cases respectively after subinguinal varicocelectomy. More recently, Altunoluk et al.;[61] Kim et al.[62] and Kim et al.[63] reported complete pain resolution in 85.6%, 71.6%, 91.2% of cases respectively after microsurgical subinguinal varicocelectomy. Meanwhile, Maghraby[64] and Link et al.[65] who operated upon 58 and 9 cases respectively (by laparoscopic ligation) found complete resolution of pain in 84.5 and 100% of the cases respectively.In the present study, the open retroperitoneal high ligation caused the least incidence of scrotal pain resolution (~ 66.7%) as compared to subinguinal (81.8%) and laparoscopic (100%) techniques. This fact can be explained by the inability of high ligation to ligate the external spermatic vein that can be accomplished by subinguinal approach

as reported by Karademir et al.[60] Meanwhile, the complete resolution of pain in our laparoscopic ligation group could be attributed to the ability of laparoscopy to ligate as many venous channels as possible.[65]

The postoperative incidence of hydrocele occurrence in our study was significantly higher after open high retroperitoneal ligation as compared to the other two procedures [30% in high ligation versus 6.9% in subinguinal ligation (P = 0.04) and zero% in laparoscopic ligation (P = 0.05)]. This finding is in agreement with the results of Bebars et al.[66] who reported higher postoperative incidence of hydrocele after open high retroperitoneal ligation (4.6%, 3 out of 65 cases) compared with laparoscopic ligation (2.3%, 3 out of 125 cases). Ghanem et al.[33] reported also significantly higher incidence of postoperative hydrocele after open high ligation (6.4%, 7 out of 109 cases) versus subinguinal ligation (1.6%, 5 out of 304 cases). More recently, Watanabe et al.[67] also found significantly higher postoperative incidence of hydrocele after open high ligation 10% (5 out of 50 cases) compared with laparoscopic ligation (9.1%, 3 out of 33 cases) and subinguinal ligation (0%). Furthermore, McManus et al.[68] reported that lower incidence in laparoscopic en masse ligation compared with open high ligation (mass ligation) could be attributed to the ability of laparoscopic dissection to skeletonize the cord more than in open high ligation and so some lymphatics are likely left behind. However hydrocele formation was higher in laparoscopic ligation group as compared with the other two approaches in the following studies; Al-Kandari and associates[35] who found that hydrocele formation was none, 13% and 20% in microscopic, open, and laparoscopic groups, respectively, and Al-Said and colleagues[69] who found hydrocele formation was none, 2.8% and 5.4% in those groups, respectively.

Our results showed statistically significant higher postoperative incidence of recurrence after open high retroperitoneal ligation when compared with either of the two other approaches [10 cases in high ligation (32.26%) versus one case (3.4%) in subinguinal ligation (P = 0.003) and one case (12.5%) in laparoscopic ligation (0.05%)].This goes in harmony with the report of Bebars et al.[66] who reported recurrence rates of 10.8% (7 out of 65 cases) in open high ligation versus 3.9% (5 out of 128 cases) in subinguinal ligation. Ghanem et al.[33] found recurrence rate of 7% (8 out of 109 cases) after open high retroperitoneal ligation versus zero% in subinguinal ligation (P < 0.05). Watanabe et al.[67] reported recurrence rate of 12% (6 out of 50 cases) after open high ligation versus 6.1% (2 out of 33 cases) in laparoscopic ligation and zero% in subinguinal ligation (P < 0.05). The higher incidence of recurrence after high ligation can be explained by the inability of this approach to ligate external spermatic vein.[67] In addition, the periarterial venous plexus is left intact and seems to be one of the causes of high incidence of recurrence observed after open high retroperitoneal ligation.[70]

In conclusion from this study we can conclude that varicocelectomy is recommended for infertile cases with oligoasthenoteratozoospermia regardless of the type of operation. Both subinguinal and laparoscopic approaches are more preferable than open high ligation due to the lesser incidence of postoperative complications (hydrocele and recurrence). The subinguinal approach is an efficient procedure in treating varicocele patients presented with chronic scrotal pain due to the ability to ligate the external spermatic vein. The laparoscopic approach is a successful approach in treating varicocele patients complaining of chronic scrotal pain due to the ability to ligate the minute veins but further studies are needed with large number of cases to verify this finding.

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