Comparison between Transabdominal Preperitoneal Approach and the Totally Extraperitoneal Approach for Inguinal Hernia Repair on the Effect on Testicular Blood Flow

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ABSTRACT

Background: Inguinal hernia repairs are one of the most common procedures performed in general surgery departments. Various techniques have been used to repair inguinal hernias. But now only 3 methods are generally accepted as the best evidence-based treatment options for inguinal hernia repair: the Shouldice technique, Lichtenstein tension-free repair and laparoscopic repair either via the transabdominal preperitoneal (TAPP) approach or the totally extraperitoneal (TEP) approach. There is limited number of studies that have compared the effects of both techniques on the spermatic cord and testicular functions in long term. **Objective:** The aim of the current work was to compare the effect of laparoscopic inguinal hernioplasty either totally extraperitoneal (TEP) approach or transabdominal preperitoneal (TAPP) approach on testicular blood flow and volume on the same side of the hernia repair.

Patients and methods: This prospective study was performed on **47** male patients admitted to general surgery ward at Mansoura University Hospital between February 2019 and February 2020 with clinically diagnosed inguinal hernias and fulfilling the eligibility criteria. The study population was distributed into 2 groups by computer generating program; Group A that included **28** patients with inguinal hernia who were operated by laparoscopic techniques (TAPP) approach and group **B** that included **19** patients with inguinal hernia who were operated laparoscopically by (TEP) approach.

Results: There is non-statistically significant higher improvement in resistive index (RI) in TEP group than TAPP at levels of Testicular and Capsular Artery but the same percentage of improvement at the level of intratesticular artery.

Conclusion: It could be concluded that laparoscopic inguinal hernioplasty either TAPP or TEP approaches are safe regarding testicular blood flow but also, they improve it.

Keywords: Inguinal hernia, Hernioplasty, Lichtenstein, Tension-Free Repair, TAPP, PSV, EDV, RI.

INTRODUCTION

The whole life risk of the occurrence of inguinal hernia is estimated at 27% in men and 3% in women. Inguinal hernia repairs are one of the most common procedures performed in general surgical departments. Approximately 20 million hernia repairs are performed annually all over the world [(1)].

Various techniques have been used to repair inguinal hernias since the first reconstructive technique described by Bassini in 1887 [(2)]. Today, only 3 methods are generally accepted as the best evidence-based treatment options for inguinal hernia repair: the Shouldice technique, a form of suture repair, open anterior "tension free" flat mesh repair according to Lichtenstein, and laparoscopic/endoscopic posterior flat mesh repair, principally via the transabdominal preperitoneal (TAPP) approach and the totally extraperitoneal (TEP) approach[(3)].

Anatomy of the spermatic cord has been well studied because of its important role in testicular physiology and surgery. The testicular arteries arise from the abdominal aorta just below the renal artery and travel in the intermediate stratum of the retroperitoneum to reach the internal inguinal ring and become a component of spermatic cord. At the internal ring, the vessel are joined by the genital branch of the genitofemoral nerve, the ilioinguinal nerve, the cremasteric artery, the vas deferens and its artery. Each of these structures could have various effects on testicular perfusion [(4)]. Human testicular parenchyma is provided with approximately 9 ml of blood per 100 g of tissue per minute and interruption of the testicular blood supply may result in testicular atrophy [(5)].

The testicular veins (spermatic veins) form several highly anastomotic channels that surround the testicular artery as the pampiniform plexus. This arrangement allows countercurrent heat exchange, which cools the blood in the testicular artery [(6)].

High resolution Color Doppler Ultrasound (CDUS) is capable of imaging small vessels in superficial organs and non-invasively measuring flow in them. It reliably shows the testicular arterial anatomy by imaging intra-arterial blood flow and a knowledge of the normal CDUS appearance and waveform characteristic of the testicular artery aids in detecting alteration in blood flow[(7)].

The aim of all inguinal hernia repair techniques is to tighten the internal ring with a suture or a biomaterial such as polypropylene mesh. The matter has been raised whether or not the spermatic cord structures are compromised with these techniques [(4)].

Although some studies describe the laparoscopic approach as advantageous in terms of short-term perioperative outcomes. The open approach has been reported by other studies as a better overall choice in terms of intraoperative complications [(8)].

The impact of inguinal hernia and mesh repair on testicular functions, sexual functions and quality of life has not been very well studied. There has been an ongoing debate of the impact of groin hernia and its repair on testicular functions and sexual functions [(9)]. The limited number of studies that have compared the effects

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of both techniques on the spermatic cord and testicular functions in long term is another reason for the suspicions of some surgeons about laparoscopic repair techniques of conventional hernias[8].

This study was conducted aiming to compare the effect of laparoscopic inguinal hernioplasty either totally extraperitoneal (TEP) approach or transabdominal preperitoneal (TAPP) approach versus open Lichtenstein tension free inguinal hernia repair on testicular blood flow and volume on the same side of the hernia repair.

PATIENTS AND METHODS

This comparative study included a total of 47 male patients presented with inguinal hernia, attending at Department of General Surgery, Mansoura University Hospitals, Mansoura, Egypt. This study was conducted between February 2019 and February 2020.

Patients age ranged between 18 and 60 years and having American Society of Anesthesiologists ASA score I or II. They were divided into two groups as follows; group A included 28 cases who underwent the laparoscopic TAPP approach, and group B included 19 cases who underwent the laparoscopic TEP approach.

Exclusion criteria: Patients younger than 18 years, or older than 60 years, having hernia reaching scrotum, complicated hernia, recurrent hernia, or testicular atrophy. Also, cases who were unfit for laparoscopic surgery were excluded as well.

Ethical consent:

An approval of the study was obtained from Mansour University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

All cases were subjected to complete history taking, thorough physical examination, and routine preoperative laboratory investigations. Furthermore, Color Doppler Ultrasound (CDUS) evaluation of the testicular blood flow was performed for all patients by a single experienced radiologist before the operation. The patients were scanned in the supine position after 10 min of rest in a warm room using an ultrasound unit (LOGIQ P5, GE) with a 7-10 MHz linear array probe.

Real-time scans were obtained in standard longitudinal and transverse plains to identify testicular blood flow which was measured on testicular, capsular, and intratesticular artery levels. The following parameters were evaluated: peak systolic velocity (PSV), end-diastolic velocity (EDV), resistive index (RI), and testicular volume.

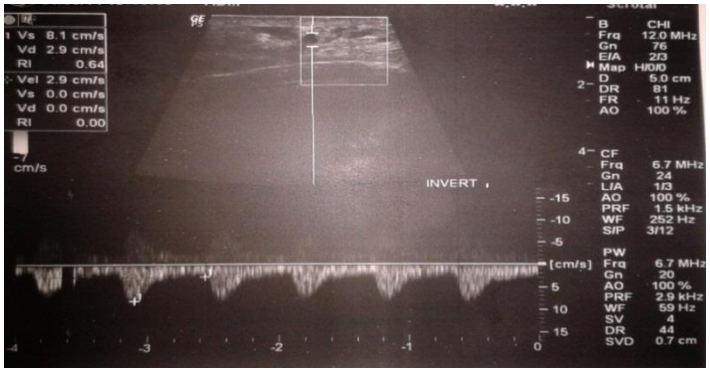

Figure (1): Preoperative CDUS on the RT testicular artery show RI.

In the laparoscopic group (TAPP), all patients were placed in the supine position in Trendelenburg position (10–20°) to move the bowel away from the operative field, with both arms tucked against their sides. A Veress needle through supraumbilical incision is used to create pneumoperitoneum up to 15 mmHg. A 10-mm port was inserted through the supraumbilical incision and the abdominal cavity was examined. Two 5-mm ports were placed as working ports, one on each side at the level of the umbilicus in the midclavicular line.

Peritoneal flap was prepared from the level of the anterior superior iliac spine to the lateral umbilical ligament 2 cm above the internal ring. Direct and small indirect hernia sacs were fully reduced. Larger indirect sacs were partially dissected and resected and its distal part left in situ. The dissection is carried to the symphysis medially.

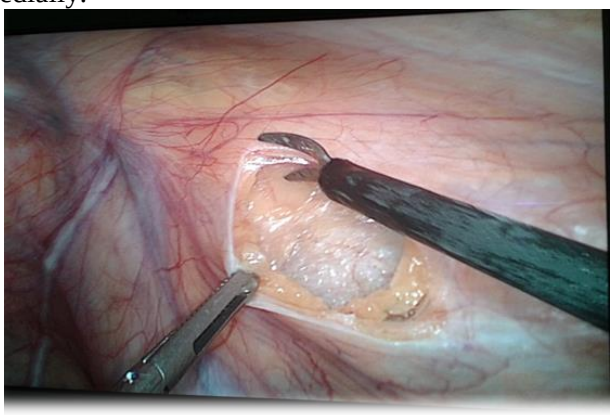

Figure (2): Creation of peritoneal flap.

A polypropylene mesh of 15×12 cm was used for the repair. The mesh was introduced into the operating field through the 10-mm umbilical port after removing the telescope to cover the entire myopectineal orifice and was fixed to Cooper's ligament and the anterior abdominal wall with tacks. The medial border of the mesh is adjacent to the symphysis pubis and the upper part is placed at least 2–3 cm over the hernia defect and internal ring. The peritoneum is then reapproximated with sutures. The carbon dioxide gas was evacuated to empty the abdominal cavity and scrotum. All trocars were removed; the 10-mm trocar site was closed with vicryl sutures. Skin incisions were closed with simple sutures. In TEP cases, the peritoneal cavity was not

entered and mesh was used to seal the hernia from outside the peritoneum using the same tools used for TAPP. After the procedure, all cases were transferred to the recovery unit then to the internal ward. Early ambulation was encouraged and patients were usually discharged on 1st or 2nd post-operative day. Regular follow up visits were scheduled for these cases, at which early (between 24 and 48 h after the operation) and late (between 90 and 100 days after the operation) assessment of testicular blood flow were also performed like before operation. The incidence of early and late post-operative complications was also recorded.

Statistical analysis:

Data were fed to the computer and analyzed using IBM SPSS software package version 22.0. Qualitative data were described using number and percent. Quantitative data were presented as mean and standard deviation, median and range after testing normality using Kolmogrov-Smirnov test. Significance of the obtained results was judged at the (0.05) level. For comparison of data, Chi-Square test (or Fisher's exact test) was used to compare two independent groups of qualitative data. For quantitative data, independent-Samples t-test and Mann-Whitney U test were used to compare two groups of parametric and non-parametric quantitative data respectively. For comparison of quantitative data between two related groups, paired-samples t-test. or Wilcoxon test were used for parametric and non-parametric data respectively. Receiver operating characteristic (ROC) analysis followed by determination of the optimal cutoff value using Youden index J were used to analyzed the diagnostic ability of different diagnostic parameters.

RESULTS

Out of 200 patients with unilateral inguinal hernia presented at Mansoura University hospitals, 47 patients had met the eligibility criteria for participation in the study to assess the effect of inguinal hernia repair on testicular blood flow and testicular volume.

The mean age of the patients was 42.21±13.4 in TAPP group and 36.16±12.18 in TEP group. There were no statistically significant differences between cases in both groups regarding their age, hernia side, types of hernia and medical history (data are not shown).

Table (1) illustrates that all parameters of blood low measured by scrotal US had statistically significant change during follow up except intra-testicular blood flow parameters (PSV, EDV &RI). The highest percentage of improvement is capsular artery EDV value followed by testicular artery EDV.

Table (1): changes in testicular blood flow during follow up pre and post- operative among cases with TAPP operation.

TAPP operation	Pre-operative	Immediate post-operative	Late post-operative	Test of significance	% of improvement
Testicular artery					
PSV	9.80±2.86	12.64±2.94	11.69±1.69	p1<0.001* p2=0.02* p3=0.03*	%1=28.9 %2=17.23
EDV	3.42±1.36	4.95±1.08	5.12±0.53	p1<0.001* p2<0.001* p3=0.718	%1=44.93 %2=45.31
RI	0.659±0.054	0.607±0.049	0.555±0.074	p1=0.001* p<0.001* p3=0.023*	%1=8.04 %2=15.6
Capsular artery					
PSV	7.839±1.05	9.08±1.60	9.608±1.33	p1<0.001* p2<0.001* p3=0.307	%1=15.9 %2=19.14
EDV	2.58±0.404	3.85±1.09	3.83±0.77	p1<0.001* p2<0.001* p3=0.704	%1=48.8 %2=47.4
RI	0.667±0.058	0.578±0.085	0.598±0.08	p1<0.001* p2=0.001* p3=0.448	%1=12.11 %2=7.63
Intra-testicular artery					
PSV	11.475±2.66	11.43±1.64	11.26±1.94	p1=0.901 p2=0.126 p3=0.056	%1=0.4 %2=5.6
EDV	5.37±1.14	5.32±0.86	5.39±0.98	p1=0.743 p2=0.377 p3=0.567	%1=0.85 %2=3.1
RI	0.529±0.05	0.529±0.078	0.518±0.065	p1=0.96 p2=0.50 p3=0.428	%1=0.19 %2=2.3
Volume/cm	22.14±4.16		26.54±7.28	p2=0.001*	%2=19.8%
P1&%1: difference between pre-operative and immediate post-operative, p2 & %2: difference between pre-operative and late post-operative, p3&%3: difference between immediate& late post-operative					

Table (2) illustrates that all parameters of blood low measured by scrotal US had statistically significant change during follow up except intra-testicular blood flow RI and PSV (between pre-operative and late post-operative & between immediate and late post-operative value). Volume also demonstrates a non-statistically significant difference during follow up. The highest percentage of improvement was testicular artery EDV.

Table (2): changes in testicular blood flow during follow up pre and post- operative among cases with TEP operation.

TEP	Pre-operative	Immediate post-operative	Late post-operative	Test of significance	% of improvement
Testicular artery					
PSV	8.07±3.40	12.0±2.22	9.94±1.13	p1<0.001* p2=0.001* p3=0.052	%1=32.9 %2=35.6
EDV	2.51±0.75	4.50±1.65	4.61±0.486	p1<0.001* p2<0.001* p3=0.04*	%1=87.2 %2=93.4
RI	0.657±0.118	0.645±0.09	0.526±0.101	p1=0.02* p2=0.007* p3=0.014*	%1=11.55 %2=21.94
Capsular artery					
PSV	8.032±1.38	10.29±1.77	10.28±1.37	p1=0.01* p2=0.003* p3=0.359	%1=17.5 %2=20.7
EDV	2.78±0.45	4.03±1.09	4.91±0.43	p1=0.003* p2<0.001* p3=0.283	%1=38.14 %2=68.69
RI	0.648±0.078	0.611±0.072	0.520±0.03	p1=0.008* p2=0.001* p3=0.015*	%1=8.3 %2=20.8
Intra-testicular artery					
PSV	9.65±3.40	12.04±2.42	12.78±0.97	p1=0.002* p2=0.512 p3=0.154	%1=9.2 %2=1.7
EDV	3.97±1.72	5.16±0.929	5.27±0.67	p1=0.04* p2=0.004* p3=0.027*	%1=13.8 %2=5.0
RI	0.597±0.073	0.564±0.071	0.589±0.033	p1=0.204 p2=0.065 p3=0.654	%1=6.17 %2=2.31
Volume/cm	24.09±3.01		24.59±1.03	p2=0.19	%2=3.9%
P1&%1: difference between pre-operative and immediate post-operative, p2 & %2: difference between pre-operative and late post-operative, p3&%3: difference between immediate& late post-operative					

Table (3) shows that there is statistically significant difference between TAPP & TEP technique for testicular artery EDV immediately after treatment and late post-operative with higher improvement among TEPP operation than TAP. Higher percent of improvement immediately after operation among TEP operation was detected for intra-testicular artery EDV.

Table (3): Comparison of percent of improvement of testicular blood flow by scrotal US between TAPP & TEP technique

	Percent of improvement immediately after treatment		Test of significance	Percent of improvement late post-operative		Test of significance
	TAPP operation	TEP operation		TAPP operation	TEP operation	
	%	%		%	%	
Testicular artery						
PSV	28.9	32.9	0.78	17.23	35.6	0.183
EDV	44.93	87.2	0.008*	45.31	93.4	0.002*
RI	8.04	11.55	0.711	15.6	21.94	0.61
Capsular artery						
PSV	15.9	17.5	0.897	19.14	20.7	0.90
EDV	48.8	38.14	0.516	47.4	68.69	0.19
RI	12.11	8.3	0.711	7.63	20.8	0.275
Intra-testicular artery						
PSV	0.4	9.2	0.13	5.6	1.7	0.55
EDV	0.85	13.8	<0.001*	3.1	5.0	0.76
RI	0.19	6.17	0.27	2.3	2.31	1.0
Volume/cm	0	0		19.8	3.9	<0.001*

DISCUSSION

The whole life risk of the occurrence of inguinal hernia is estimated at 27% in men and 3% in women. Inguinal hernia repairs are one of the most common procedures performed in general surgy departments. Approximately 20 million hernia repairs are performed annually all over the world [(1)].

The impact of inguinal hernia and mesh repair on testicular functions, sexual functions and quality of life has not been very well studied. There has been an ongoing debate of the impact of groin hernia and its repair on testicular functions and sexual functions [(9)].

This study was conducted to compare the effect of laparoscopic inguinal hernioplasty either totally extraperitoneal (TEP) approach or transabdominal preperitoneal (TAPP) approach on testicular blood flow and volume on the same side of the hernia repair.

Due to interdependence of flow within an arterial network, correct interpretation demands measurement on all levels. So we measured the flow in testicular, capsular and intratesticular arteries to avoid false normal results caused by partial measurement. Another reason for measurements of flow on intratesticular arteries was the fact that increased vascular resistance inside testicular tissue connected with spermatogenesis disturbance is of high clinical importance. **Pingger *et al.*** [(10)] compared intratesticular RI with sperm counts and found a significantly greater RI in patients with pathological sperm counts. They suggested that the intratesticular RI can be a reliable indicator to identify subfertile men in routine clinical use.

Aydede *et al.* [(11)] in their study on patients undergoing open mesh hernioplasty, demonstrated a significant increase in resistive index of testicular vessels in early postoperative period.

Akbulut *et al.* [(12)] in their study found that patients undergoing TEP repair had significant decrease in testicular volume as compared to open mesh repair. However, the testicular volume was within normal limits, but they did not study the testicular blood flow. They also reported testicular atrophy as a rare complication, but the number of cases (13 in each group) was a major limitation of their study.

Ersin *et al.* [(13)] reported no statistically significant difference in Doppler flow parameters preoperatively, very early (Day 1) and early postoperatively (Day 7). But differences in Doppler flow parameters of testicular artery compared to open group were found statistically significant between preoperatively and very early postoperatively. The major drawback of this study was that the testicular blood flow was assessed in the immediate postoperative period which is not appropriate as hypervascularity and edema of testes and epididymis are known to cause decrease in blood flow at this time.

Singh *et al.* [(14)] Showed that there was a significant impairment of testicular functions following open mesh repair as compared to laparoscopic inguinal hernia repair in terms of significant decrease in testicular volume, lesser improvement in resistive index. **Štula *et al.*** [(15)] comparing TAPP and open repair observed a significant increase the mean intra-testicular vessels and capsular vessels RI at 3 months, but this change was statistically insignificant after 6 months of surgery. Moreover, the increase in RI was not observed in the testicular vessels thereby ruling out the role of mesh and its incorporation with the surrounding tissue with the vascular impedance.

The increase in the RI was within the normal physiological range. However, this change in the testicular parameters was significantly higher in the

open repair when compared with TAPP repair. They concluded that the transient increase in the RI in the early postoperative period was due to the tissue and vessel handling during surgery and subsequent inflammation and transient breach in the blood testes barrier .

Bansal et al. found that there was an overall improvement in the testicular functions in terms of testicular volume and resistive index although not statistically significant and this change was comparable between TEP and TAPP groups. This improvement can be attributed to the fact there is minimal handling of tissue in laparoscopic repair and lesser fibrotic response contrary to the conventional beliefs [(9)].

When **Aguilar-García *et al.*** [(16)] compared the pre- and post-surgery values, there was a significant difference at the spermatic cord level ($p = 0.018$) and at the extra-testicular level ($p = 0.032$), but not at the intra-testicular level where the difference was not statistically significant.

In our study when we compared the testicular blood flow parameters between TAPP and TEP group we have found that the only statistically significant difference between TAPP &TEP techniques among studied cases in immediate post-operative data was capsular artery PSV with higher mean value among TAPP than TEP technique.

The late post-operative testicular blood flow PSV& EDV had a statistically significant higher mean among cases with TAPP technique than cases with TEP technique. Capsular artery RI had significantly lower value among TEP than TAPP. Intra-testicular artery RI had significantly higher value among TEP than TAPP

There is non-statistically significant higher improvement in RI in TEP group than TAPP at levels of Testicular and Capsular Artery but the same percentage of improvement at the level of intratesticular artery. Testicular Volume showed statistically significant difference between studied techniques but not clinically significant difference as it's within normal values.

CONCLUSION

It could be concluded that Laparoscopic Inguinal Hernioplasty is better than Lichtenstein tension-free repair in inguinal hernia repair regarding improvement in testicular blood flow. However, further large-scale studies are recommended to accurately determine its sensitivity and specificity.

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Author contribution: Authors contributed equally in the study.

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