



A PROSPECTIVE STUDY COMPARING LAPAROSCOPIC TRANSABDOMINAL PREPERITONEAL (TAPP) AND TOTALLY EXTRAPERITONEAL (TEP) INGUINAL HERNIA REPAIR WITH MODIFIED ANTERIOR PRE PERITONEAL (MODIFIED APP) INGUINAL HERNIA REPAIR

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ABSTRACT

BACKGROUND: In literature, there are only limited studies available that have been done comparing the results of laparoscopic (TAPP and TEP) inguinal hernia repair with open anterior pre peritoneal inguinal hernia repairs. The aim of this study is to compare the laparoscopic transabdominal preperitoneal (TAPP) and totally extraperitoneal (TEP) inguinal hernia repair with modified anterior pre peritoneal (Modified APP) inguinal hernia repair, which is a novel method of approaching the pre peritoneal space, anteriorly via the deep inguinal ring. **METHODS:** Prospective analysis of medical documents of 135 patients operated during 2015-2017 at MLB Medical College, Jhansi, India was done. Outcome parameters included operation time, postoperative complications, acute postoperative pain and chronic pain, hospital stay, recurrence and cost effectiveness of the two procedures. **RESULTS:** 75 patients underwent laparoscopic repair and 60 patients underwent Modified APP. Modified APP took considerably lesser time as compared to laparoscopic repair (26.70 ± 1.174 vs 36.45 ± 1.898 (mean); $p < 0.0001$). Post operative complications, were more in laparoscopic group as compared to Modified APP group (Seroma-3 in laparoscopic group, 0 in open group; chronic groin pain-1 in open group, 0 in the laparoscopic group). Laparoscopic repair had lesser acute post operative pain, shorter hospital stay, was more expensive. There were no recurrences in both the groups. **CONCLUSIONS:** Laparoscopic repair of inguinal hernia offers various advantages over modified app but in a country like India where patients usually come from a poor background, Modified APP seems to offer all the benefits of laparoscopic repair at a reasonable price.

KEYWORDS : Hernia, Laparoscopy**INTRODUCTION**

Inguinal hernia repair has undergone revolutionary changes since the times of Eduardo Bassini. Right from herniorrhaphy to different types of hernioplasty to laparoscopic repairs, various methods of groin hernia repairs are being practised worldwide. Each one has its own advantages and disadvantages. One of the approaches to the inguinal region is the posterior approach which is carried out by means of laparoscopic intervention. Here the prosthetic mesh is placed in the preperitoneal space. This space can be accessed through an anterior approach as well (Modified Kugel[1]/Ugahary[2] repair) but only a handful of general surgeons are doing it. In this study we are comparing the results of laparoscopic inguinal hernia repairs (TAPP/TEP/SI-TAPP/SI-TEP) with MODIFIED APP[3,4] (a new and modified approach to preperitoneal space via the deep inguinal ring using conventional instruments and mesh). We believe that this method is better than the above mentioned approaches to the preperitoneal space and this study will give further impetus to the advancement of anterior preperitoneal approach to the inguinal hernia repairs.

MATERIAL AND METHOD

All eligible cases underwent open mesh repair (Modified Anterior Pre Peritoneal repair[3]) and laparoscopic TEP mesh repair or SI-TEP, TAPP mesh repair or SI-TAPP for inguinal hernia in the Department of Surgery, M.L.B. Medical College, Jhansi, Uttar Pradesh, India, during the study period of January -2015 to January-2017.

All patients admitted at M.L.B. Medical College, Jhansi who met the inclusion and exclusion criteria were taken up for the study. All the data were analysed prospectively.

After getting informed consent for either of the two procedures, the patients were investigated and were randomly assigned to either of the two groups.

- Group-A: Laparoscopic repair (TAPP, TEP, SI-TAPP, SI-TEP)*
- Group-B: Open repair (Modified Anterior Pre Peritoneal repair)

Pre-operative evaluation included ECG, pulmonary function test and ultrasound of abdomen and pelvis. All the procedures were done by the same surgeon, who happens to be one of the pioneers of laparoscopic surgeries in the country, under spinal anesthesia, irrespective of the type of procedure. All the data were analyzed prospectively. Patients were followed up for one year.

Adult patients above 18 years of age of both genders who underwent inguinal hernia repair (direct and indirect) were included in the study. Only patients with irreducible scrotal hernia, femoral hernia or incarcerated hernia, requiring emergency surgery were excluded.

*SI stands for "Single Incision"

The following parameters were evaluated for both laparoscopic and open procedures:

1. Operative time
2. Intra-operative complications
3. Post-operative complications
4. Post-operative pain based on pain scale.
5. Post-operative recovery/ hospital stay.
6. Time to return to work
7. Recurrence
8. Chronic post-operative inguinal pain
9. Cost effectiveness

The analysis was done using Prism 7 (graphpad) software by using "Unpaired t-test with Welch's correction[5]". Each p-value < 0.05 represents a statistically significant result.

LAPAROSCOPIC TAPP

All patients were placed in the supine position in trendelenburg position (10-200) to move the bowel away from the operative field, with both arms tucked against their sides. A verses needle through supraumbilical incision was 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.

The hernia was inspected and its type confirmed and any contralateral asymptomatic hernial sac was identified and dealt with. The contents of the inguinal hernia were reduced whenever present. 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 hernial sacs were fully reduced. Larger indirect sacs were partially dissected and resected and its distal part left in situ. The anatomy then was clear (Cooper's ligament, inferior epigastric vessels and the spermatic cord). The iliac vessels were not dissected but their positions were clearly identified. The dissection was carried to the symphysis medially. A polypropylene mesh of 15x12 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 was placed adjacent to the symphysis pubis and the upper part was placed at least 2-3 cm over the hernial defect at the internal ring. The peritoneum was then re-approximated with the tacks. The carbon dioxide gas was evacuated to empty the abdominal cavity. All trocars were removed; the 10-mm trocar site was closed with vicryl sutures. Skin incisions were closed with simple sutures.

MODIFIED ANTERIOR PRE PERITONEAL REPAIR[3,4] (MODIFIED APP)

We made a 3- to 4-cm oblique incision centered over the deep inguinal ring, starting half way across the line between the superior iliac spine and the pubic tubercle Gallaudet's fascia and the external oblique aponeurosis were opened classically without any extended dissection. First, the cord was located and checked for indirect and direct hernia. The ilioinguinal nerve was identified and gently placed internally behind the retractor. In cases of indirect hernia, the sac was separated from the cord by a bloodless dissection using peanut gauze up to the internal ring. In cases of direct hernia, associated indirect hernia was checked for.

In cases of indirect hernia, the internal ring was dilated and offered easy access to the preperitoneal space where the epigastric vessels were found medially. These vessels were retracted medially and index finger was introduced into the preperitoneal space. For a direct hernia, the preperitoneal space was dissected through the dilated fascia transversalis. Blunt dissection was done with the index finger above the pubic tubercle and the peritoneum was pushed up and medially. For good positioning of the mesh, the dissection was performed until Cooper's ligament and the pubis bone could be palpated. At this time, an eventual undiagnosed femoral hernia could be identified and treated using the same procedure. Dissection of the sac and cord was performed up to the point where the spermatic cord and spermatic vessels separate, so that the cord could be easily parietalized. We used a monofilament knitted polypropylene mesh 6x4 inches, which was folded in its length at the junction of two third and one third length and then at the junction of two third and one third breadth.

A small quadrant of the mesh was cut from the common end and the mesh was laid open resulting in a key hole defect with the circular end being towards the centre of the mesh. The cord was then wrapped around, with the circular portion of the defect encircling it. Prolene suture was used to approximate the free end of the defect around the cord, with the larger section of the mesh being directed medially and inferiorly. The ends of the mesh were held with long curved artery forceps in a criss cross manner and inserted into the preperitoneal space via the deep ring covering the entire groin

area including indirect, direct, and femoral orifices. Once the mesh was in place, its position was checked by inserting the index finger into the preperitoneal space between the inguinal ligament and mesh with boundaries of mesh covering Coopers ligament caudally, iliac vessels laterally, and the rectus abdominis medially. If the deep ring was dilated then Lytle's repair was done. After closure of the external oblique and Gallaudet's fascia with a running 1-0 vicryl suture, the skin incision was closed with Ethilon 2-0.

RESULTS

Our study was carried out on 135 patients in all. Out of which 75 patients were included in group A (Laparoscopic Group) & 60 patients were included in group B (Modified APP[3,4] group). The mean age in the laparoscopic group came out to be 52.77 ± 2.258 years and in the modified APP group it came out to be 48.45 ± 2.198 years ($P=0.1724$) (Statistically insignificant).

As far as the sex distribution was concerned none of the patients in group A were female. Only 2 patients i.e. 3% patients in group B were females.

The most common complaint was bulge in the inguinoscrotal region in both the groups (87% vs. 83%) followed by aching sensation in the groin (56% vs. 63%).

None of the patients presented with nausea or vomiting. Pain in the groin was reported by 19% patients in group A & 18% patients in group B, which was comparable in both groups.

Out of all the patients 47% underwent TAPP repair & 8% underwent TEPP repair. 44% patients underwent modified APP repair.

Majority of the hernias were right sided in group A. In group B the incidence of right & left sided hernias was equal.

Indirect hernia came out to be the most common variety in all the three types of hernia whether it was bubonocoele (27% vs. 30%) or funicular (29% vs. 35%) or Scrotal type (19% vs. 17%).

The duration of surgery in minutes was 36.45 ± 1.898 (mean) in the laparoscopic group and 26.7 ± 1.174 (mean) in the modified APP group ($p < 0.0001$). This difference is statistically significant. It means that the modified APP repair takes lesser time as compared to TAPP/TEPP repair.

The pain score (VAS score) during the first 24 hrs after surgery were 2.547 ± 0.05787 in the laparoscopic group & 2.85 ± 0.08174 in the modified APP group with P-value being 0.0031, which suggests that the difference in pain score was significant, so we can conclude that in the 1st 24 hours patients in the laparoscopic group had lesser pain as compared to modified APP group.

In the next 24 hours, the pain scores were 1.267 ± 0.0548 in the laparoscopic group & 1.55 ± 0.08378 in modified APP group (P value= 0.0056). The difference is statistically significant. Thus, in both the initial 24 hours & next 24 hours pain was much less in the laparoscopic group as compared to modified APP group.

The mean duration of stay (in days) postoperatively in the hospital was 2.16 ± 0.07113 in the laparoscopic group as compared to 3.033 ± 0.07504 in the modified APP group. This difference ($p < 0.0001$) is statistically significant and shows that patients undergoing laparoscopic hernia repair are discharged earlier from the hospital than their counterparts in the modified APP group.

The time taken to return to work was lesser in the laparoscopic group as compared to modified APP group. The mean time taken to return to work in the laparoscopic group was 7.973 ± 0.184 days and in the modified APP group was 16.65 ± 0.543 days with p value < 0.0001 (statistically significant).

As far as the cost of surgery is concerned laparoscopic procedures cost approximately 8134 ± 213.7 INR (mean) in comparison to

modified APP which costs around 2850 ± 52.08INR. The difference between the two is statistically significant. (p<0.0001)

In our study 3 patients in the laparoscopic group had intra-operative complications. In one of these patients, who was undergoing TAPP repair, the inferior epigastric artery was injured which was immediately cauterized. The other two patients were undergoing TEP repair, when in both the cases the peritoneum was breached. The breach was < 1cm in both the cases and the surgery could be completed without conversion. In the modified APP group none of the patients had any intraoperative complication.

Post operative complications in our study included 3 patients who developed seroma in the laparoscopic group. All these patients were managed conservatively. The incidence of seroma formation was more in the TAPP group as compared to TEP group. (3% VS 2%).

None of the patients developed seroma in the modified APP group. One patient reported chronic inguinal pain at 6 months in the modified APP group & none reported the same in the laparoscopic group.

In both the groups no patient had any recurrence over a 12 month followup period. One patient presented with wound infection in the postoperative period in the modified APP group about ten days after surgery.

This patient was managed conservatively on i.v. antibiotics and regular washing with hydrogen peroxide and povidone iodine was done. There was no wound infection in the laparoscopic group.

Table-1: Pain Score (1st 24 hours)

Pain Score	LAP COLUMN A		M-APP COLUMN B	
	No.	%	No.	%
1-2	34	45.3	17	28.3
3-4	41	54.7	43	71.7
Total	75	100	60	100
Mean ± SEM	2.547 ± 0.05787		2.85 ± 0.08174	

Unpaired t test with Welch's correction
 P value-0.0031 (Two tailed)
 Significantly different (P < 0.05)?-YES
 Welch-corrected t, df- t=3.029 df=110.8
 Difference between means-0.3033 ± 0.1001
 95% confidence interval-0.1049 to 0.5018

Table-2: Pain Score (Next 24 hours)

Pain Score	LAP COLUMN A		M-APP COLUMN B	
	No.	%	No.	%
1-2	74	98.7	5	91.7
3-4	1	1.3	5	8.3
Total	75	100	60	100
Mean ± SEM	1.267 ± 0.0548		1.55 ± 0.08378	

Unpaired t test with Welch's correction
 P value-0.0056 (Two tailed)
 Significantly different (P < 0.05)?-YES
 Welch-corrected t, df- t=2.83 df=105
 Difference between means-0.2833 ± 0.1001
 95% confidence interval-0.08483 to 0.4818

Table-3: Duration of stay (in days)

Duration (in days)	LAP COLUMN A		M-APP COLUMN B	
	No.	%	No.	%
1-2	58	77.3	9	15
3-4	17	22.7	51	85
Total	75	100	60	100
Mean ± SEM	2.16 ± 0.07113		3.033 ± 0.07504	

1-2	58	77.3	9	15
3-4	17	22.7	51	85
Total	75	100	60	100
Mean ± SEM	2.16 ± 0.07113		3.033 ± 0.07504	

Unpaired t test with Welch's correction
 P value-<0.0001 (Two tailed)
 Significantly different (P < 0.05)?-YES
 Welch-corrected t, t=8.447 df=129.4
 Difference between means-0.8733 ± 0.1034
 95% confidence interval-0.6688 to 1.078

Table-4: Duration of surgery (in minutes)

Duration (in minutes)	LAP COLUMN A		M-APP COLUMN B	
	No.	%	No.	%
15-25	19	25.3	36	60
26-35	27	36	14	23.3
36-45	15	20	7	11.7
46-55	3	4	2	3.3
56-65	4	5.3	1	1.7
66-75	6	8	0	0
76-85	-	0	0	0
86-95	1	1.3	0	0
Total	75	100	60	100
Mean ± SEM	36.45 ± 1.898		26.7 ± 1.174	

Unpaired t test with Welch's correction
 P value-<0.0001 (Two tailed)
 Significantly different (P < 0.05)?-YES
 Welch-corrected t, t=4.37 df=119.5
 Difference between means- -9.753 ± 2.232
 95% confidence interval- -14.17 to -5.334

Table-5: Time taken to return to work (days).

Time taken to return to work (in days)	LAP COLUMN A		M-APP COLUMN B	
	No.	%	No.	%
0-10	59	8.67	0	0
11-20	16	1.33	49	81.67
21-30	0	0.00	10	16.67
31-40	0	0.00	1	1.67
Total	75	100	60	100
Mean ± SEM	7.973 ± 0.184		16.65 ± 0.543	

Unpaired t test with Welch's correction
 P value-<0.0001 (Two tailed)
 Significantly different (P < 0.05)?-YES
 Welch-corrected t, t=15.13 df=72.57
 Difference between means- 8.677 ± 0.5733
 95% confidence interval- 7.534 to 9.819

DISCUSSION:

Tension free hernia repair using a prosthetic mesh is the primary surgical method for treating groin hernias. There are various methods for tension free herniorrhaphy, with mesh placement in different locations. Apart from placing the mesh in the premuscular position sublay to the external oblique, it can also be placed in the periperitoneal space. The mesh is sandwiched between the peritoneum and fascia transversalis and secured over the myopectineal orifice with the help of intra-abdominal pressure.

The preperitoneal mesh reinforces the whole myopectineal orifice including the anatomical structures like the internal inguinal ring, the Hesselbach'S triangle and annulus femoralis, where the groin hernia sac originates. Therefore, theoretically, preperitoneal repair can treat the three most common types of groin hernias i.e. indirect,

direct and femoral hernia.

Preperitoneal repair has been associated with low recurrence rates [1,7].

It also prevents postoperative occurrence of any of the types of hernia, especially femoral hernia, which can't be achieved by premuscular & inlay repair procedure like Lichtenstein repair.

The preperitoneal space can be accessed through various approaches, including laparoscopic and open procedure. The laparoscopic procedure of TAPP & TEP, are widely practiced for preperitoneal repair.

The open preperitoneal repair (tension free) which was introduced earlier i.e. Stoppa-Wantz technique is now less frequently used.

Other procedures are Kugel [1] posterior preperitoneal herniorrhaphy, Ugahary [3,4] gridiron incision anterior preperitoneal approach & modified anterior preperitoneal repair [3,4] (in our study).

In our approach of modified APP [3,4], the incision is oblique and about 3-4 cm in length centred over the deep inguinal ring i.e. approximately 1.5 cm above the midinguinal point. The preperitoneal space is reached via the deep inguinal ring. The deep inguinal ring is not violated in this approach and no special prosthesis is required as in Kugel repair. The procedure is carried out as mentioned on page..

In Kugel hernia repair [1] too, the incision is obliquely placed and is about 3-4 cm in length and about 2-3 cm above the deep inguinal ring, with the incision oriented in such a manner that the junction of lateral one third and medial two thirds coincides with a line drawn perpendicular to the midinguinal point. The incision is deepened through the external oblique fascia and the internal oblique is bluntly spread apart. The fascia transversalis is vertically opened for about 3 cm but the deep inguinal ring is not violated. A special mesh is used which is introduced into the preperitoneal space and mesh is sutured to the pubic tubercle.

In Ugahary approach [2], the incision is obliquely placed as in the above mentioned approaches. It is about 5-6 cm in length and is made about a finger breadth lateral and above the deep inguinal ring and doesn't cross the lateral margin of the rectus muscle. External oblique aponeurosis is incised as usual and gridiron approach is used down to the peritoneum. It doesn't require a special mesh as required in Kugel repair. It is a purely preperitoneal approach as it doesn't open the inguinal canal.

The Kugel approach [1] and Ugahary approach [2] to the preperitoneal space is by incising the fascia transversalis. But in our method of modified APP [3,4] we approach the space via the deep inguinal ring by lifting the inferior epigastric artery and as a result the fascia transversalis. So there is no need to incise the fascia transversalis and thus we can avoid another potential site of herniation. Our approach can be considered as a unilateral modification of Stoppa's technique [8] but is much better as compared to it in terms of the length of the incision taken and the morbidity involved.

A randomized multicentre showed low cumulative recurrence rate after laparoscopic (TEP) & open (Lichtenstein) repair [9] but there are very few studies done comparing laparoscopic repair with anterior preperitoneal repair. One such study was published which compared LAP (TAPP & TEP) with open anterior preperitoneal repair (Modified Kugel). The researchers concluded that both laparoscopic & anterior open preperitoneal repairs were equally safe & effective, as well as had comparable low recurrence rates [10]. In our study, too, there was no recurrence in both the groups. In our study the operative time in the modified APP group was shorter as compared to laparoscopic group.

Some previously published reports have cited that intraoperative and post operative complications were more frequent in the laparoscopic repair group than in the open group i.e. Lichtenstein repair group [11,12]

However some studies published depicted similar results in both the groups i.e. Laparoscopic repair group and Lichtenstein repair group [13]. In our study the overall complication rate was more frequent in the laparoscopic group than in the modified APP group. As such, no visceral injury occurred in our study neither during the laparoscopic procedure nor during the modified APP procedure. One patient undergoing TAPP repair had his inferior epigastric artery on the right side, injured, in which bleeding was controlled by cauterization. In two cases being approached as TEP repair there was peritoneal breach but the surgery could be completed without conversion.

In our comparison of postoperative complications between the laparoscopic repair group and modified APP repair group, the laparoscopic procedure resulted in lesser post operative pain & lower incidence rates of wound infection (0% in laparoscopic group as compared to 1.67% in modified APP group).

The mean of VAS for pain scoring in the 1st 24 hrs after surgery was 2.547 ± 0.50 in the laparoscopic group & 2.85 ± 0.633 in the modified APP group ($P = 0.0023$). This difference was statistically very significant. Similarly in the next 24 hrs it was 1.267 ± 0.48 in the laparoscopic group and 1.55 ± 0.65 in modified APP group ($P = 0.0040$). This difference too was statistically significant. So these findings are suggestive of the fact that acute pain is lesser in the laparoscopic repair group as compared to modified APP group. This result is similar to results obtained in similar comparative studies done in the past [14,15].

In our study only one patient developed chronic groin pain in the modified APP group (incidence of 1.67%) and none of the patients developed chronic groin pain in the laparoscopic group (0% incidence) over a follow up period of twelve months. ($z = 1.1222$; p value - 0.13136). This difference is statistically insignificant at $p < 0.01$. Although there have been similar studies done in the past showing that the incidence of chronic groin pain is lesser in the laparoscopic group as compared to open group (Shouldice and Lichtenstein [16]) but studies comparing modified Kugel repair or Ugahary repair (both anterior pre peritoneal repairs) with laparoscopic repair are not there in the literature. Moreover, the incidence of chronic groin pain is lesser in anterior pre peritoneal repairs (modified Kugel and Ugahary repairs) as compared to other open methods of hernia repair, which holds true in our case as well (1.67% vs 36% in Shouldice and 31% in Lichtenstein) [1]

Several reasons for chronic groin pain (defined as pain in the post operative period persisting for more than six months) have been suggested. Koninger et al [16], concluded that the incidence of post-operative groin pain differed according to the type of surgical approach but the presence of a prosthetic mesh was not the source of long-term chronic pain. Groin dissection via an open anterior approach is liable to cause more trauma to the peripheral nerves & scarring of the abdominal wall, whereas laparoscopic procedure avoids such risk.

The infection rate was a bit higher in the modified APP group (1.67%) as compared to none in the laparoscopic group [17] ($z = 1.1222$; p value - 0.13136). This difference is statistically insignificant at $p < 0.01$. This complication too was a mesh related infection that presented after ten days of being operated. The patient was managed conservatively on iv antibiotics & regular peroxide washing of the wound.

According to our study, besides less pain & a lower incidence of wound infection, other significant advantages of the laparoscopic procedure were earlier recovery, shorter post-op stay. Only the operative time was a bit longer in the laparoscopic group. The

duration of surgery in minutes was 35.93 ± 15.91 (mean) in the laparoscopic group and 26.70 ± 9.09 (mean) in the modified APP group ($p = 0.0001$). The mean duration of stay (in days) postoperatively in the hospital was 2.16 ± 0.61 in the laparoscopic group as compared to 3.033 ± 0.58 in the modified APP group ($p < 0.0001$) [1]. Our approach when compared to Kugel's approach to the preperitoneal space takes lesser time during surgery (26.70 ± 9.09 vs 67.52 ± 39.25 min.) and post op stay is also a day less (3.033 ± 0.58 vs 4.03 ± 2.49). But to establish significant difference between these figures requires further comparative studies between the two procedures.

The time taken to return to work was lesser in the laparoscopic group as compared to modified APP group [18]. The mean time taken to return to work in the laparoscopic group was 7.97 ± 1.59 days and in the modified APP group was 16.65 ± 4.21 days. As far as the cost of surgery is concerned laparoscopic procedures cost approximately 8134 ± 1850.53 INR (mean) in comparison to modified APP which costs around 2850 ± 403.38 INR. In terms of US dollars it turns out to be $125\$ \pm 28.5\$$ in the laparoscopic group and $43.83\$ \pm 6.3\$$ in the modified APP group. So the laparoscopic surgery is almost three times as costly as the open surgery for hernia repair in our setup [19].

Our study demonstrated that the modified APP & laparoscopic procedures are both effective & safe for preperitoneal hernioplasty, which in our study did not show recurrence in both the groups. There were no life threatening complications over a period of 12 month follow-up in both the groups.

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