International Surgery Journal
Rashid T et al. Int Surg J. 2018 Jan;5(1):174-180
http://www.ijsurgery.com
pISSN 2349-3305 | eISSN 2349-2902

DOI: http://dx.doi.org/10.18203/2349-2902.isj20175890

Original Research Article

A comparative study of three-dimensional mesh (3D mesh) and polypropylene mesh in laparoscopic inguinal hernia repairs in adults

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Received: 13 October 2017
Revised: 01 November 2017
Accepted: 24 November 2017

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ABSTRACT

Background: Polypropylene mesh gives risk of recurrence, owing to overall decrease in the size of mesh and increased subjective foreign body feeling from contracture and scarring. An anatomically contoured 3D mesh for laparoscopic inguinal hernia repair often requires no fixation, with minimal risk of postoperative pain and recurrence rate.
Methods: This was a prospective comparative study conducted over a period of 2.5 years. The study enrolled 60 patients, 30 patients in each group. The end points of the study were mesh fixation time, post-operative pain, seroma formation, hospital stay, chronic groin pain, sensory impairment, and cost and affordability. Follow up period was 18 months.
Results: The mesh fixation time was less in 3D mesh, 10.6±4.31 minutes (p value- 0.0002). The incidence of severe immediate postoperative pain was higher in polypropylene mesh 10% (p value of 0.612). The postoperative seroma was less in 3D mesh, 3.3% (p value of 1.00). The mean hospital stay was shorter in 3D, 1.7±0.69 days (p value–0.005). Postoperative sensory impairment was more in polypropylene mesh, 6.6% (p value-1.00). The incidence of chronic groin pain was less in 3D (p value- 0.612). We found a higher recurrence rate at 18 months in both groups (p-value-1.00).
Conclusions: The use of three-dimensional mesh for laparoscopic inguinal hernia repair is a safe and viable option. It offers many advantages in terms of less fixation time, shorter hospital stays, decreased chronic groin pain and morbidity. Elimination of tacks and shorter hospital stay may reduce the cost of 3D mesh.

Keywords: Inguinal hernia, Tacks, Three-dimensional mesh

INTRODUCTION

The word hernia comes from the Latin for 'Rupture' and the Greek for 'Bud'.[1] A hernia is defined as an abnormal protrusion of a viscera or tissue through a defect in its surrounding wall. Hernias of the groin comprise approximately 75% of all hernias and 95% are hernias of inguinal region. Inguinal hernias are 9 times more common in men. Over all inguinal hernia is the most common hernia in women.[2] Indirect hernias represent the most common type of hernia in both men and women.[3] Direct hernias are more common in elderly.

The most common presenting symptom for a groin hernia is a dull feeling of discomfort in the groin region that is exacerbated by straining the abdominal musculature, lifting heavy objects, or defecating. These manoeuvres worsen the feeling of discomfort.[4] Factors favouring surgery include symptomatic hernia, the size of the hernia defect and the risk of incarceration. The treatment of all

hernias, regardless of their location or type, is surgical repair. The approach to inguinal hernia can be open or laparoscopic.

Ralph Ger demonstrated the first laparoscopic hernia repair.[5] Laparoscopic approaches are:

- *Trans-Abdominal Preperitoneal Procedure (TAPP):* In 1993, Arregui and colleagues described the trans-abdominal preperitoneal prosthetic (TAPP) procedure.[4] The TAPP repair involves laparoscopy with access into the peritoneal cavity and placement of a mesh along the anterior abdominal wall in the preperitoneal space.[6]
- *Totally Extraperitoneal Procedure (TEP):* In 1993, McKernan and Laws introduced the totally extraperitoneal (TEP) repair. The TEP repair involves creation of a potential space between the peritoneum and the transversalis fascia or space of Bogros.[4] This allows a prosthetic mesh to be placed in this space.[7]

Usher, in 1958 advocated the use of Marlex mesh.[8] The only exception when mesh is not used is the paediatric hernia or a contaminated surgical site.[9]

Figure 1: Polypropylene mesh.

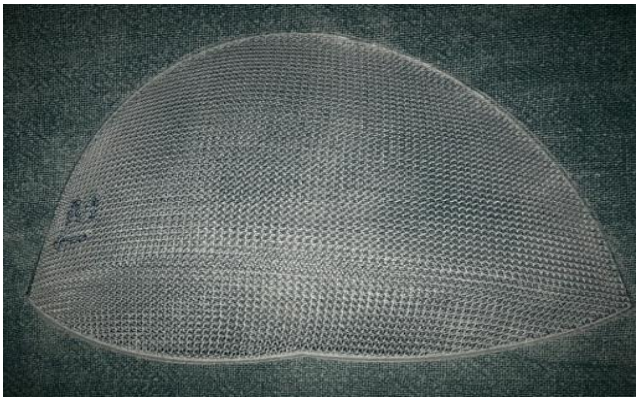

Figure 2: Three-dimensional mesh.

Polypropylene mesh

These are made of prolene fibres arranged in a network with pores of differing sizes. PPM is classified on the basis of density of the material and its surface area as heavyweight (90gm/sq meter to 100gm/sq metre); middle weight (45gm/sq metre to 50gm/sq metre) and light weight (less than 45gm/sq metre).[9,10]

Three-dimensional mesh

Dr. Pajotin in 1998, came to the realization that a flat sheet of mesh may not be the ideal configuration for a laparoscopic repair. He developed what he believed to be the ideal prosthetic, the three-dimensional mesh.[11] The key benefits of 3D mesh are: anatomically designed, easy positioning, fixation free and reduced pain.[12]

METHODS

After ethical clearance from the Institutional Ethical Committee, the study was conducted over a period of 2.5 years in the Department of General and Minimal Access Surgery, Government Medical College, Srinagar, as a part of single centre comparative study. The study compared the outcomes of three-dimensional mesh and polypropylene mesh in laparoscopic inguinal hernia repairs. Patients were given free choice regarding the mesh to be used. Patients in the age group of 20 to 60 years, of either sex having either unilateral or bilateral groin hernia. Patients were included in the study with complicated hernias, recurrent hernia, associated malignancies, immunosuppression, bleeding diathesis, pregnant females and patients requiring concomitant surgical procedures other than hernia repair. Patients were excluded from the study admitted one day before surgery. A detailed history and physical examination was performed. Baseline investigations were performed. An intravenous antibiotic was administered one hour before surgery in all cases.

Operative technique

- Laparoscopic TEP Repair
- Position - Supine
- Anaesthesia - General

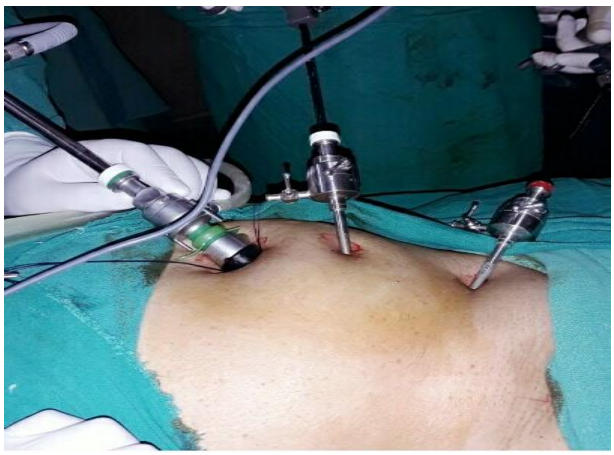

Figure 3: Port sites (TEP).

With a single video monitor at the foot end of the patient, a 2cm transverse infraumbilical incision is made extending from the midline to the opposite side of the hernia. Blunt dissection is performed to expose the anterior rectus sheath. A 15mm incision is made in the anterior sheath. Once the rectus abdominis muscle is exposed, it is swept laterally to expose the posterior rectus sheath. This is followed by finger dissection. A 10mm, 0^0 laparoscope is inserted and used to bluntly dissect the areolar tissue in the preperitoneal space. Low-pressure pneumoperitoneum is created. Two 5mm trocars are placed in the midline. The first, 1cm cephalad to the pubic symphysis and the second between the suprapubic and infraumbilical trocar (Figure 3).

The next step is to identify the Cooper ligament on the affected side and development of lateral space. The peritoneum typically comes into clear view during the lateral dissection. Dissection of the hernia sac begins and once the hernia sac has been completely reduced, we used either a 10X15cm polypropylene mesh or a 3D Mesh. The mesh is tightly rolled in the grasper and passed through the 10mm infraumbilical trocar. The laparoscope is replaced into the trocar and the mesh is unrolled in the preperitoneal space. We do not routinely use any tacking device (Figure 4).

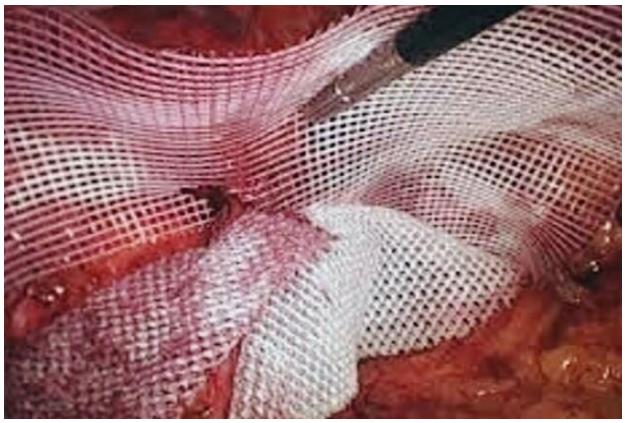

Figure 4: Intraoperative PPM (TEP).

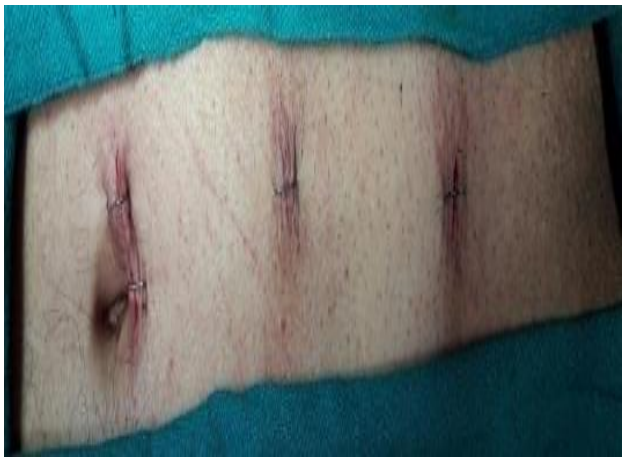

Figure 5: Port sites closed (TEP).

Once the mesh is in place, the pneumoperitoneum is released. The infraumbilical trocar site is closed with a 1 - 0 Vicryl (Figure 5).

- Laparoscopic TAPP Repair
- Position: Supine
- Anaesthesia: General

With a single video monitor at the foot end of the patient, pneumoperitoneum is created by closed technique via a 10 mm infraumbilical port. Two additional 5mm ports are made on either side of the rectus muscle. The defect is visualized from within the peritoneal cavity.

After bilateral inguinal inspection, the median and medial umbilical ligaments, and the lateral umbilical folds are identified. The parietal layer of peritoneum is incised superior to the hernia defect and reflected inferiorly. The cord structures are dissected free of peritoneal attachments and sac reduced back to peritoneal cavity. A polypropylene or a 3D mesh is placed between the peritoneum and transversalis fascia (Figure 6).

The mesh is stapled or tacked. The incised peritoneal flap is anchored over the mesh using tacks. Pneumoperitoneum is released gradually. The infraumbilical trocar site is closed with a 1-0 Vicryl.

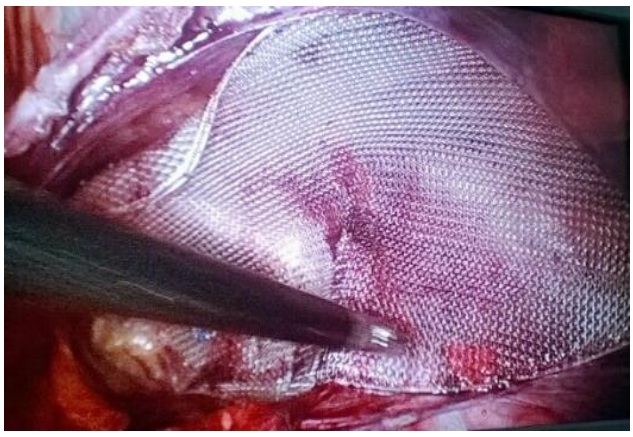

Figure 6: Intraoperative 3D mesh (TAPP).

Postoperatively patients were monitored in the ward. For immediate postoperative pain relief, injectable diclofenac sodium 75mg was used. Early ambulation was encouraged, and orals were allowed in the evening on the same day of operation.

Patients were discharged from the hospital as soon as the patients became ambulatory and were called for follow-up at 1week, 2weeks, 4weeks, 3months, 6months, 12 months and 18 months.

Data was entered in Microsoft Excel and was expressed as average, percentage and mean±SD, median (range) as appropriate. Appropriate statistical tests were used for data analysis.

RESULTS

All patients in present study were males, age ranging from 23-60 years with mean of 48.9years. Almost all patients had unilateral hernia, 43 patients had indirect and 17 patients had direct hernia. TAPP was performed in 25 patients and TEP in 35 patients. Mean operative time was less in 3D mesh, 42.7±13.01 (p value-0.525). The mesh fixation time was less in 3D mesh, 10.6±4.31 minutes (p value- 0.0002). The incidence of severe immediate postoperative pain was higher in polypropylene mesh 10% (p value- 0.612). The postoperative seroma was less in 3D mesh, 3.3% (p value-1.00). The mean hospital stay was shorter in 3D, 1.7±0.69 days (p value- 0.005). Postoperative sensory impairment was more in polypropylene mesh, 6.6% (p value- 1.00). The incidence of chronic groin pain was less in 3D (p value- 0.612). We found a higher recurrence rate at 18 months in both groups (p value- 1.00) (Table 1). In present study we found 3D mesh to be costly compared to polypropylene mesh in all patients.

Table 1: Comparison of results between 3D mesh and polypropylene mesh in present study.

Parameter	3D mesh	PP mesh	P value
Mean operative time (minutes)	42.7±13.01	45.1±15.57	0.525
Mesh fixation time (minutes)	10.6±4.31	14.4±2.74	0.0002*
Post-operative pain (no. of patients) (minutes)	3.3	10	0.612
Seroma (Percentage)	1	2	1.00
Hospital stay (days)	1.7±0.69	2.2±0.55	0.005*
Sensory impairment (no. of patients)	1	2	1.00
Chronic groin pain (no. of patients)	1	2	1.00
Recurrence (no. of patients)	1	2	1.00

*p value <0.05 significant

DISCUSSION

The goals of hernia repair include minimizing intraoperative and postoperative complications, achieving effective repair, lowest possible recurrence, and early return to normal life, cost effectiveness and better cosmetic results.

The introduction of biomaterials for inguinal hernia repair has become an integral component of hernia surgery. The advent of prosthetic materials has decreased the recurrence rate.[13] The choice of the type of the mesh is often left to the surgeon's preference and cost factor.[14] In international studies, it has been mentioned that choice of the prosthesis in hernia repair is far more important than technique as a determinant of outcome.[15] It is described that polypropylene meshes, cause some degree of contraction and scar formation in the long-term follow-up.[16] In a systematic review of patients who had laparoscopic inguinal hernia repair, the use of a lightweight mesh, as opposed to a heavyweight mesh, was associated with a lower incidence of chronic groin pain, groin stiffness, and foreign body sensations without any increased risk for hernia recurrence.[17] An anatomically contoured 3D mesh for laparoscopic inguinal hernia repair often requires no fixation, with minimal risk of postoperative pain and less than 0.5% patient year recurrence rate. Recovery is excellent even with bilateral repair or some fixation.[18]

The mesh fixation time in 3D mesh was 10.6±4.31 minutes and 14.4±2.74 minutes in PP mesh. The difference was statistically significant (p value- 0.0002). B Adil et al, reported a mesh fixation time of 21.3±4.8 minutes for polypropylene mesh in TAPP repair.[19] We believe that this difference in fixation time in present study is attributed to easy insertion through the port, easy intraoperative handling, and easy unfolding of 3D mesh. Further the placement of 3D mesh over the defect is easy owing to its preformed configuration. Placement of tacks or sutures in 3D mesh may or may not be needed. Polypropylene mesh, on the other hand, being flat in shape and softer is slightly difficult to insert through the port, needs extensive intraoperative manipulation for unfolding and often needs some form of fixation.

Author experience less incidence of severe immediate postoperative pain in 3D mesh as assessed by the need of intravenous analgesics per day. But the difference did not attain any clinical significance (p value -0.612). Pain is a very subjective experience, as the pain thresholds vary significantly among various individuals and sexes. We encountered no or mild pain in maximum number of patients in both groups which responded well to oral analgesics. Chalkoo M et al, in their study of TEP repair using polypropylene mesh observed postoperative pain in 9.23%.[20] Mir I.S et al, in their study of 3D mesh in laparoscopic inguinal hernia reported immediate severe postoperative pain rate of 1.88%.[21] The reduced post-operative pain in case of 3D mesh is supported by the fact that the use of 3D mesh eliminates the use of sutures or tacks as is needed with the flat mesh thereby avoiding nerve entrapment.[22] However an increased incidence of immediate severe postoperative pain with the use of 3D mesh in present study can be attributed to small cohort and lack of extensive research data.

In present study, postoperative seroma developed in 3.3% patients in 3D mesh and 6.7% patients in PP mesh, however the difference was not found to be statistically significant (p value- 1.00). This is in consistency with the studies published in the literature. Ayiomamitis et al, in their study on 32 patients using an anatomic 3D lightweight mesh with peritoneal suturing by TAPP procedure reported a 3.1% seroma formation

postoperatively.[23] Mir I.S et al, in their study of short term outcomes of laparoscopic inguinal hernioplasty using 3D mesh on 53 consecutive patients, reported a postoperative seroma development rate of 3.77%.[21] With regard to seroma formation in polypropylene mesh in laparoscopic inguinal hernia repairs, B Adil et al, conducted a study on 192 patients using composite polypropylene mesh and lightweight polypropylene mesh in TAPP repair for inguinal hernias. The frequency of seroma formation was higher in the composite polypropylene group (6.25%).[19] Chalkoo M et al, conducted a prospective study on laparoscopic trans-abdominal preperitoneal mesh hernioplasty. A 15cm×12cm polypropylene mesh was used in all cases in their study. They reported a rate of 4.62% of postoperative seroma development.[20] Patients who developed postoperative seroma in present study were effectively managed conservatively.

In present study, the mean hospital stay in 3D mesh was 1.7±0.69 days and 2.2±0.55 days in polypropylene mesh. The difference was small (0.5days), but proved to be clinically significant (p value-0.005). Whether this was secondary to less postoperative pain or early ambulation in case of 3D mesh is hard to analyse by the existing data and this demands further research with a larger cohort.

Sensory impairment defined as anaesthesia, paraesthesia or hyperesthesia is one of the complications of all hernia repairs including laparoscopic inguinal repairs. In present study one patient (3.3%) in 3D mesh and two patients (6.7%) in PP mesh developed postoperative sensory impairment. The difference was not clinically significant (p value- 1.000). All these patients had a small area of anaesthesia in the groin medially. No patients had paraesthesia or severe sensory impairment. Study of laparoscopic inguinal hernia repair using 3D mesh reported a sensory impairment incidence of 1.8%.[21]

The study of laparoscopic inguinal hernia repair using a flat polypropylene reported no neuralgia or sensory impairment on follow up.[20] The higher incidence of sensory impairment in polypropylene mesh in present study could be attributed to the method of intraoperative mesh fixation, usually spiral tacks. This is supported by a study conducted by Brugger L et al. They in their study found that the prevalence of sensory impairment was significantly higher at all postoperative times in the spiral tack group of patients.[24]

Chronic pain is one of the most serious long-term complications following groin hernia repair. Surgical dissection, mesh fixation, and mesh-induced entrapment have been cited as the potential causes of groin pain.[25] Several studies have shown that minimally invasive hernia repair (TEP, TAPP) are associated with significantly less early and chronic pain as compared with open hernia repair.[26,27] In present study, the incidence of chronic groin pain was less in 3D mesh. The difference was not significant (p value- 0.612). This is consistent with the findings of Mir I.S et al, who found an incidence 3.77% of chronic groin pain using 3D mesh during a mean follow up period of 12 months.[21] It was found the incidence of chronic groin pain at 3.7% in lightweight poylpropylene mesh and 7.1% in heavyweight polypropylene mesh.[28]

Authors have reported pain scores in patients receiving lightweight polypropylene mesh were consistently lower than the control group receiving heavyweight polypropylene mesh over a follow up of 1 year.[29]

The pain following TEP/TAPP repairs is most commonly somatic which differs from the pain seen after open repairs, which is usually neuropathic. If the somatic pain observed following TEP/TAPP relates to fixation, then alternatives to staple fixation such as tissue glue or non-fixation may further reduce chronic pain. Such alternatives, however, would require further investigation to ensure that reduced fixation does not come at the expense of increased recurrence.[21,30]

In the present study authors have found a higher recurrence rate at 18 months in both groups with a recurrence rate of 3.3% in 3D mesh and 6.7% in polypropylene mesh. The difference in present study failed to reach any statistical significance (p-value-1.00), however it needs further investigation. Maximum of the meshes in present study were placed without any form of stapling or suturing to the abdominal wall. Therefore, particular attention needs to be paid to providing proper fixation of the mesh in large hernias either by increasing the mesh size and consequent overlap or by mesh fixation by suturing/ stapling devices. Fibrin glue may be used to fix the mesh.[31]

Patients in present study were explained the cost of both meshes and were given free choice regarding the use of mesh. No doubt, the unique shape of 3D mesh is designed to conform to the inguinal anatomy, contour minimizes buckling and design reduces the need for fixation, [18] still in comparison to polypropylene mesh, 3D mesh was found to be costly in present study, as is obvious by the fact that the cost of 3D mesh is twice than that of the flat mesh. We assume that, elimination of tacks and shorter hospital stay may reduce the overall cost of laparoscopic inguinal hernia repair using 3D mesh.

CONCLUSION

The use of three-dimensional mesh (3D mesh) for laparoscopic inguinal hernia repair is a safe and viable option. It offers many advantages in terms of less fixation time, shorter hospital stays, decreased chronic groin pain and decreased postoperative morbidity. Whereas in present study recurrence rate was found to be higher in both groups against the published literature, attention needs to be paid to the proper fixation of the mesh with a larger cohort. Further, elimination of tacks for fixation and shorter hospital stay may reduce the cost of 3D mesh.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Rashid T, Reshi FA, Mir IS, Bhat SN, Nazir I, Viqar S, Hajini MF, Akbar A. A comparative study of three-dimensional mesh (3D mesh) and polypropylene mesh in laparoscopic inguinal hernia repairs in adults. Int Surg J 2018;5:174-80.