The Egyptian Journal of Hospital Medicine (July 2019) Vol. 76 (2), Page 3556-3563

Comparative Study between Heavy-Weight Mesh and Light-Weight Mesh in Ventral Hernia Repair

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ABSTRACT

Background: Ventral hernia may be spontaneously (primary ventral hernia) or at the site of a previous surgical incision (incisional hernia). Ventral hernias are classified according to their location and etiology, a primary ventral hernia is classified as a (para-) umbilical, epigastric or Spigelian hernia (between the muscles of the abdominal wall).

Objective: This work aims to study and compare the use of the heavy-weight mesh and light-weight mesh in ventral hernia repair.

Patients and Methods: This study was conducted on patients (male and females) suffering from ventral hernia "primary or incisional" admitted to the General Surgery Department, at Nasser Institute Hospital and Al-Azhar University Hospital during the period from June 2018 to May 2019.

Results: Quality of life (QOL) values in the 3rd postoperative month were not statistically significant higher in the LW group than that of the HW group. QOL values of the both groups in the 3rd postoperative month were significantly higher when compared to the baseline (preoperative values). Foreign body sensation was significantly less frequent in the LW group than that of the HW group.

Conclusion: The lightweight mesh offers benefits over heavyweight mesh for ventral hernia repair by reducing the incidence of chronic pain and foreign body sensation.

Keywords: Heavy-Weight Mesh, Light-Weight Mesh, Ventral Hernia Repair.

INTRODUCTION

Ventral hernias may cause a varying degree of discomfort and cosmetic concern. Symptoms such as pain and the size of the protruding bulge may be aggravated by daily living activities and especially by coughing and straining. Hernias have the potential for incarceration (constriction of intestine), which is a threat. Therefore, surgical repair is recommended for most ventral hernia and mesh can be used to strengthen the repair. The relatively high recurrence rate after open suture repair - up to 54% - has been significantly lowered by the use of mesh [(1)].

One of the biomaterials most widely used to repair an abdominal wall defect is polypropylene (PP) in the form of a reticular, macroporous mesh. The classic PP meshes have been modified in an effort to create a prosthesis containing less material by enlarging pore size and reducing the spatial reorganization of the filaments [(2)].

Light-weight composite mesh is the result of incorporating an absorbable component into a reduced polypropylene mass. The objectives of LW prostheses are essential to try to reduce the amount of foreign material that remains in the recipient after their implant and thus generate the least fibrosis possible. Although the post implant repair process induced by LW varies from one recipient to the next, it is clear that reducing the extent of fibrosis will prevent the formation of a very compact scar tissue [(3)].

One study was designed to compare the behavior of three types of PP prostheses, a HW and two LW meshes, differing in the spatial arrangement of their filaments and their porosity. Its aim was to establish whether the interfilament distance and structure of LW prostheses are determining factors for recipient tissue incorporation during the repair process and to examine effects on tensile strength. This will allow the abdominal wall to act as the dynamic structure, maintaining its flexibility and avoiding the abdominal stiffness sometimes observed in patients operated on using a conventional HW type of PP mesh [(4)].

It is important to use an appropriate-sized mesh that overlaps the hernia gap by at least four to five centimeters. Different techniques can be used for fixing the mesh to the abdominal wall. These techniques may lead to different rates of recurrence, intensity of pain or health-related quality of life (HRQOL) in general [(5)].

The mesh can be placed using the onlay, sublay or inlay technique. In the onlay technique, the mesh is positioned between the subcutaneous tissues of the abdominal wall and the anterior rectus sheath. In the sublay technique the mesh is positioned below the rectus muscle, either between the posterior rectus sheath and the rectus muscle (subfascial), or above the peritoneum between the peritoneum and posterior rectus sheath or muscle (preperitoneal). Both the onlay and sublay positioning of the mesh are techniques that reinforce the abdominal wall and also close the defect surgically. In the inlay technique the mesh is placed between the edges of the fascia (the layer of abdominal fibrous tissue in which the defect

Received:14/4/2019
Accepted:13/5/2019

(gap) is located). This technique does not close the defect, instead the mesh is sutured to the edges of the defect to bridge the gap [6].

The prevalence of chronic pain after hernia repair was noted in up to two-thirds of patients. Chronic pain is thought to occur due to excessive inflammatory response to the synthetic mesh with reduction in tissue compliance and entrapment of neural structures. Heavy-weight meshes contain high concentrations of foreign material and cause excessive inflammatory response. Light-weight meshes have larger pores and they encourage collagen production with integration of the mesh into the abdominal wall with adequate inflammatory response [7].

Flexible light-weight mesh with similar elasticity to the abdominal wall, can deal with the increased pressure than heavy-weight meshes with low elasticity. Restriction of the abdominal wall elasticity is one consequence of the implantation of heavy-weight meshes with low elasticity [8].

AIM OF THE WORK

This work aims to study and compare the use of the heavy-weight mesh and light-weight mesh in ventral hernia repair.

PATIENTS AND METHODS

This study was conducted on patients (males and females) suffering from ventral hernia "primary or incisional" admitted to the General Surgery Department, at Nasser Institute Hospital and Al-Azhar University Hospital during the period from June 2018 to May 2019.

Patients:

The patients were divided into group A and Group B, having 20 patients in each group. Randomization was achieved by computer-generated random numbers in sealed envelopes to ensure balanced recruitment.

Group A: was subjected to ventral hernia repair using LW partially absorbed mesh, ultrapro®. The mesh characteristic are:

- Structure: Monofilament with large pores (3 to 4 mm)
- Polymer: PP and Polyglecaprone
- Weight: 28 g/m^2 (part of the PP that is not absorbed)
- Dimensions: 15 cm x 20 cm

Group B: was subjected to ventral hernia repair using HW non-absorbable polypropylene mesh, prolene ®. The mesh characteristics are:

- Structure: Monofilament with small pores
- Polymer: PP
- Weight: 80 to 85 g/m^2
- Dimensions: 15 cm x 20 cm

All patients who fulfilled the selection criteria were subjected to:

A. Pre-procedural work up:

- Each patient signed an informed consent for participation in the trial.
- **An approval of the study was obtained from Al- Azhar University academic and ethical committee.**
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- Full evaluation for each patient was done according to the following sheet:

1. Patient demography: age, BMI, occupation and residence.
2. Medical history: co-morbidities, medications and smoking
3. local examination: primary or incisional ventral hernia
4. Investigations: Laboratory and radiological.
5. Measuring preoperative pain scores on a NRS in all patients at rest.
6. Preoperative QOL assessment using the VAS.

B. Procedural work up

1. Anesthesia and Positioning

- Patients received 1.0 g intravenous (i.v.) ceftriaxone after induction of anesthesia before skin incision as antibiotic prophylaxis.
- All patient had general anesthesia. Spinal block was achieved with 4 ml bupivacaine hydrochloride (Marcaine spinal 0.5 percent heavy; AstraZeneca Pharma, Sodertalje, Sweden) using a pencil point needle (27G).
- Patient was lying in a supine position.
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2. Operative details

The established technique of surgical treatment of ventral abdominal hernia is the prefascial prosthetic implantation.

The following technique of onlay implantation was done:

1. Excision of the skin scar (if present).
2. Dissection of the hernial sac with broad preparation of the fascial edge.
3. Opening of the hernial sac.
4. Inspection of the abdomen to identify adhesions and additional fascial gaps.
5. Detachment of adherent gut tissue.
6. Closure of the hernia gab by fascia adaptation with continuous polypropylene suture (prolene No. 1, Ethicon) with stitch (tissue bite) intervals of approximately 1 cm.

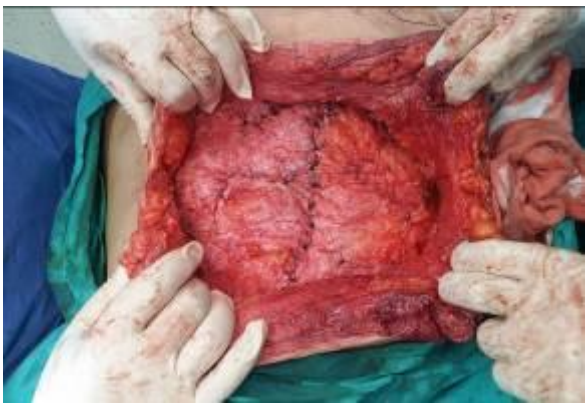

Figure (1): Closure of the fascial defect

7. Onlay implantations of the prepared polypropylene mesh (prolene mesh). The distance from suture line in all directions is 5 cm. The implant is fixed to the aponeurosis without tension, with interrupted non-absorbable suture (prolene 2-0). The technique of fixation is a circular suture after fixing the four edges of the implant.

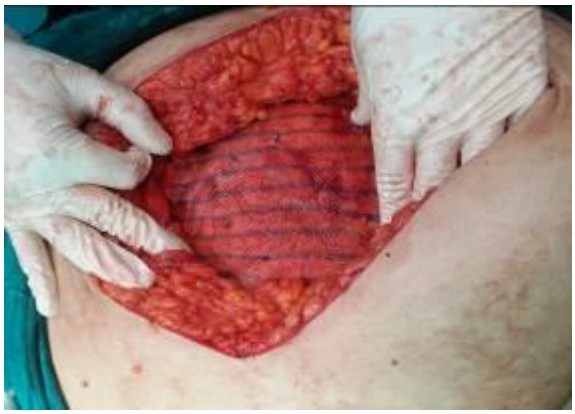

Figure (2): Onlay mesh positioning and fixation.

Use of one or two suction drains, careful subcutaneous closure, and skin closure using skin stapler.

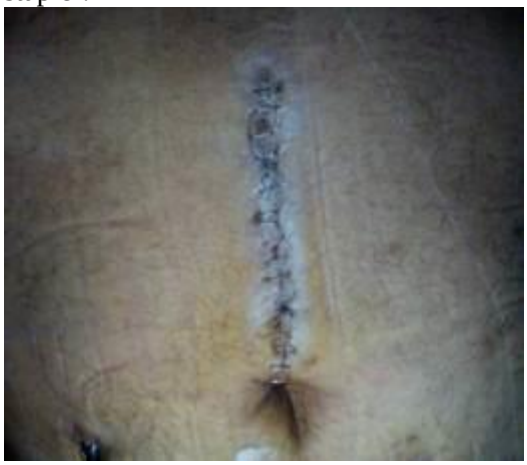

Figure (3): Skin closure using skin stapler

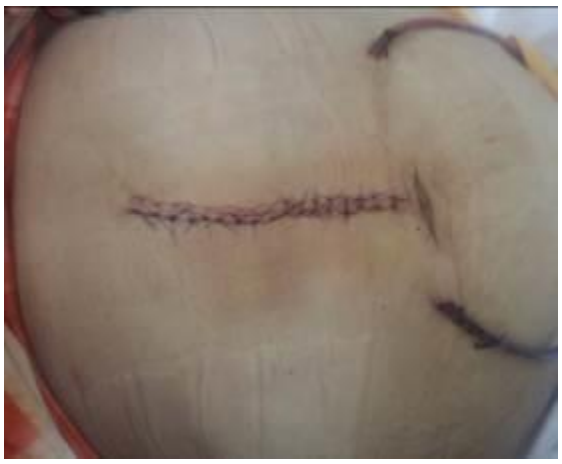

Figure (4): Skin closure using interrupted suture

C. Post procedural care and follow up

- ***Early post procedural follow up***
  - Medical treatment in the form of analgesics (paracetamol I.V. every 8 hours).
  - Detection of urine retention and need for catheterization.
  - Detection of early hematoma.
- At discharge, patients were advised to:
  - Take analgesics (paracetamol orally) and to record the duration of analgesia used in a pain diary.
  - Avoid strenuous physical activity (lifting, sports) during the first 3 months.
- Drains were removed after 5 days
- On 7th postoperative day (POD)
  - Stitches were removed.
  - Dressing was done.
  - Wound assessments were completed to detect:
    - The presence of superficial or deep infection.
    - The presence of wound seroma using ultrasound, its amount and aspiration if needed.
  - The duration of analgesia used during the first postoperative week were recorded.
  - Pain assessment using NRS.
- Clinical follow-up: Patients attended for clinical follow-up at 3 months after surgery.
  - QOL assessment was done using the VAS.
  - Pain assessment-using NRS.
  - Foreign body sensation at the operation site was recorded.
- At 6 months; patients of both groups were telephoned to detect recurrence.

Statistical analysis

Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

The following tests were done:

- Independent-samples t-test of significance was used when comparing between two means.

- Chi-square (x^2) test of significance was used in order to compare proportions between two qualitative parameters.
- The confidence interval was set to 95% and the margin of error accepted was set to 5%. The p-value was considered significant as the following:
- Probability (P-value)

- P-value <0.05 was considered significant.
- P-value <0.001 was considered as highly significant.
- P-value >0.05 was considered insignificant.

RESULTS

Table (1): Age distribution

Patients	LW group Age (years)	HW group Age (years)
1	36	52
2	45	18
3	27	36
4	18	70
5	31	62
6	18	44
7	31	33
8	26	36
9	58	28
10	50	41
11	34	24
12	18	37
13	32	19
14	26	39
15	57	45
16	53	56
17	32	31
18	26	26
19	56	40
20	36	31
Range	18-58	18-70
Mean	35.5	38.4
SD	13.22	13.66
P value	0.325	

The difference between the ages of the two groups wasn't statistically significant.

Type of hernia:

Seventeen patients had primary hernia, 23 patients had incisional hernia.

- LW group: 8 patients had primary hernia, 12 patients had incisional hernia.
- HW group: 9 patients had primary hernia, 11 patients had incisional hernia.

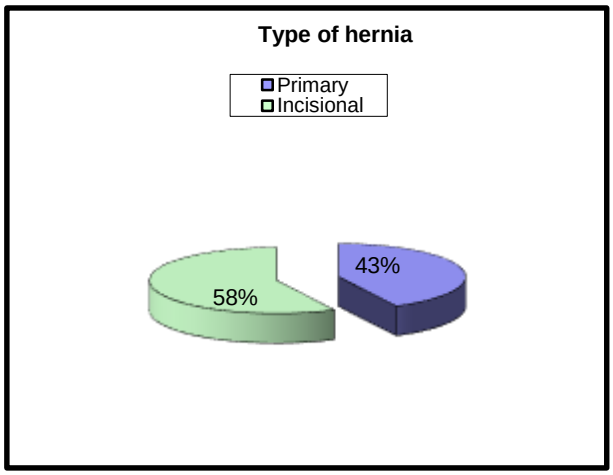

Fig. (5): Type of hernia.

Urine retention:

Three patients suffered from urine retention as a complication of spinal anesthesia and the bladder was evacuated once by a nelaton catheter under complete aseptic condition. No urinary tract infection was noted as a result of the catheter insertion.

- LW group: 1 patients suffered from urine retention.
- HW group: 2 patients suffered from urine retention.

Postoperative hospital stay:

All the patients were discharged on the 1st POD.

Foreign body sensation:

18 patients had foreign body sensation.

- LW group: 4 patients had foreign body sensation.
- HW group: 14 patients had foreign body sensation.

The percentage of patients with foreign body sensation was higher in the HW group (70%) than that of the LW group (20%). The difference between the two groups was statistically significant (p=0.001).

Seroma:

11 patients had seroma:

- LW groups: 3 patients had mild seroma which did not require intervention and shows complete resolution on ultrasound examination after 1 week.
- HW group: 8 patients had seroma:
  - Four patients (out of 8) had marked seroma on ultrasound examination on the 7th POD which required ultrasound guided aspiration under complete aseptic condition. Only one of them required another aspiration after 1 week.
  - Four patients (out of 8) had mild seroma which did not require intervention had showed complete resolution on ultrasound examination after 1 week.

The percentage of patients with seroma was higher in the HW group (40%) than that of the LW group (15%). The difference between the two groups was statistically significant (p=0.024).

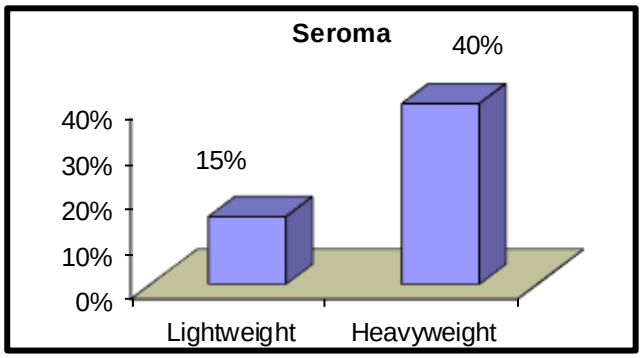

Fig. (6): Seroma and foreign body sensation

Preoperative NRS:

Sixteen patients had a score of (1) and 24 patients had a score of (2).

- LW group: 7 patients had a score of (1) and 13 patients had a score of (2).
- HW group: 9 patients had a score of (1) and 11 patients had a score of (2).

Table (2): Preoperative NRS values for both LW and HW groups.

	Preoperative NRS values	
	LW group	**HW group**
Range	1-2	1-2
Mean	1.65	1.55
SD	±0.489	±0.510
P value	0.531	

Postoperative NRS:

I. 7th POD:

Twenty-one patients had a score of (3) and 19 patients had a score of (4) score.

- LW group: 12 patients had a score (3) and 8 patients had a score of (4).
- HW group: 9 patients had a score (3) and 11 patients had a score of (4).

Table (3): NRS values on 7th POD for both LW and HW groups

	NRS values on 7th POD	
	LW group	**HW group**
Range	3-4	3-4
Mean	3.40	3.55
SD	±0.50	±0.51
P value	0.354	

The mean of the NRS values on the 7th POD was insignificantly higher in the HW group than that of the LW group.

II. 3 months postoperative:

Thirsty patients had no pain and 10 patients had pain; 3 patients in the LW group, 7 patients in the HW group.

- LW group: 17 patients had a score of (0), 1 patients had a score of (2), 1 patient had a score of (3) and 1 patient had a score of (4).
- HW group: 13 patients had a score of (0), 3 patients had a score of (2), 3 patient had a score of (3) and 1 patient had a score of (4).

Table (4): NRS values in 3rd postoperative month for both LW and HW groups

	NRS values on 3rd postoperative month	
	LW group	**HW group**
Range	0-4	0-5
Mean	0.45	1.30
SD	±1.14	±0.186
P value	< 0.001*	

The mean of the NRS values on the 3rd postoperative month was significantly higher in the HW group than that of the LW group.

As a comparison between the LW and the HW group regarding the preoperative VAS values:

Table (5): QOL assessment using VAS for both HW and LW groups preoperatively

	Preoperative VAS values	
	LW group	**HW group**
Range	51.6-85.2	49.8-88.9
Mean	63.5	58.3
SD	10.68	8.47
P value	0.096	

The mean of the preoperative VAS values was insignificantly higher in the LW group than that of the HW group.

As a comparison between the LW and the HW group regarding the 3 months postoperative VAS values:

Table (6): QOL assessment using VAS for both HW and LW groups 3 months postoperatively

	Postoperatively VAS values	
	LW group	**HW group**
Range	59-95.8	55.6-95.8
Mean	88.15	65.21
SD	8.20	8.41
P value	< 0.001*	

The mean of the VAS values in the 3rd postoperative month was significantly higher in the LW groups than that of the HW group.

Table (7): Comparison between LW group regarding the preoperative VAS value and postoperative VAS value

	LW group	
	Preoperative VAS values	**Postoperative VAS values**
Range	51.6-85.2	59-95.8
Mean	63.5	88.15
SD	10.68	8.20
P value	< 0.001*	

The mean of VAS value 3rd postoperative month was significantly higher in the LW group than preoperative of LW group.

Table (8): Comparison between HW group regarding the preoperative VAS value and postoperative VAS value

	HW group	
	Preoperative VAS values	**Postoperative VAS values**
Range	49.8-88.9	55.6-95.8
Mean	58.3	65.21
SD	8.47	8.41
P value	< 0.014*	

The mean of VAS value 3rd postoperative month was significantly higher in the HW group than preoperative of HW group.

Recurrence: At 6 months follow up, none of the patients of both groups showed recurrence.

DISCUSSION

In our study, there was no significant difference in the duration of postoperative hospital stay when comparing the LW group to the HW group.

All the patients were discharged on 1st POD. Our results are consistent with the results reported by Post et al. [12] in which there was not significant difference between the two groups in the hospital stay as the mean of the hospital stay for the LW group was (2.3) days and that for the HW group was (2.4) days. Also, our results are consistent with the results reported by **Smietanski** [9] in which the mean of the duration of hospital stay was 48 (range 12-168) hours for the LW group and 48 (range 3-264) hours for the HW group, which is not significantly different (p = 0.444).

In our study, seroma was significantly less frequent in the LW group than that of the HW group. The percentage of patient with seroma was higher in the HW group (40%) than that of the LW group (15%). The difference between the two groups was statistically significant (p =0.024). Our results are not consistent with the results of the meta-analysis reported by **Uzzaman *et al.*** [10] in which 6 randomized controlled trials assessed the development of postoperative seroma. There was no significant difference in the use of LW or HW mesh on seroma formation (p = 0.15). Our results are also not consistent with what is reported by **Zhong *et al.*** [11] in which seroma was reported in 2 studies. The analysis comparing LW and HW meshes was not significantly different (OR = 0.89; 95% CI - 0.44-1.79). There was relative increase in the diagnosis of seroma incidence in our work because routine ultrasound was used for all patients as evaluation on the 7th POD. But clinical seroma which required intervention was only found in 4 (representing 20%) patients in the HW group (seroma of the residual hernia sac). Also, the large number of long standing ventral hernia may be another cause of these seromas.

In our study, the pain intensity (PI) values on 7th POD showed no significant difference between the LW group and the HW group. The mean of the NRS values was higher in the HW group (3.55) than that of the LW group (3.40). The difference between the two groups was not statistically significant (p= 0.354). Our results are consistent with the results of the meta-analysis reported by **Uzzaman *et al.*** [10] in their randomized controlled trials comparing LW and HW mesh for ventral hernia repair. There were 3 trials that assessed the postoperative pain scores at 1 week. They found no significant difference in pain scores on the first postoperative week between patients with LW mesh compared with HW mesh (p= 0.14).

In our study, the number of patients complaining of pain in the 3rd postoperative month was significantly lower in the LW group (3 patients representing 15%) than that of the HW group (7 patients representing 35%), the difference between the two groups was statistically significant (p= 0.047). Our results are consistent with the results reported by **Smietanski *et al.*** [9] in which the percentage of patients complaining of pain at 3 months in the LW group was (9.8%) while that for the HW group was (17.1%). The difference between the two groups was statistically significant (p=0.033). Our results are also similar to the results of the meta-analysis reported by **Uzzaman *et al.*** [10] in which 5 randomized controlled trials assessed the incidence of chronic pain after ventral repair. There were 144 patients (20.3%) complaining of chronic pain in the HW group compared to 111 patients (14.3%) in the LW group. This difference was statistically significant (p < 0.01).

As regard the PI values of our patients in the 3rd postoperative month, the mean of the NRS values was lower in the LW group (0.45) than that of the HW group (1.30). The difference between the two groups was statistically significant (p < 0.001). Our findings are similar to the results of the meta-analysis

reported by **Uzzaman *et al.*** [10] in which 3 randomized controlled trials assessed pain in the 3rd postoperative month. The patients with LW mesh had significantly less pain scores on the 3rd postoperative month compared with those receiving HW mesh ($p < 0.0001$). Our results also coincided with the data of the meta-analysis reported by **Zhong *et al.*** [11] as chronic pain was significantly lower with LW mesh implants, regardless of whether they were partially absorbable or non-absorbable (Odds Ratio (OR)= 0.64; 95% Confidence Interval (CI)= 0.51-0.82 $p<0.05$). Our results also agreed with the results reported by **Post *et al.*** [12] in which the mean of the VAS at 6 months in the LW group was (0.16) while that for the HW group was (0.79) with significant difference between the two groups ($p=0.042$). The nature of the alloplastic mesh may be related to the development of chronic pain after Lichtenstein hernia repair. There are several reasons why LW mesh may result in less long-term pain than HW mesh. HW mesh consists of a greater quantity of non-absorbable material and has an increased surface area compared with LW mesh. These characteristics may result in a more intense foreign body reaction (FBR). The lower amount of material present in LW mesh may also lead to better tissue ingrowth and decreased FBR and fibrosis. This may result in less nerve entrapment and irritation to the surrounding tissues. The finding of reduced chronic pain with LW mesh contrasts with the results of another meta-analysis that showed no difference in chronic pain with the use of the LW Vypro II mesh compared with HW mesh in ventral repair [13]. This meta-analysis, however, only studied one particular type of LW mesh and included studies of laparoscopic ventral repair which made their results to somewhat different[10].

The other primary outcome measure was the foreign body sensation, which was found to be significantly less frequent in the LW group than that of the HW group when it was assessed at the 3rd postoperative month. The percentage of our patients with foreign body sensation was higher in the HW group (70%) than that of the LW group (20%). The difference between the two groups was statistically significant ($p =0.001$). Our results are consistent with the results of the meta-analysis reported by **Uzzaman *et al.*** [10] in which 2 randomized controlled trials assessed the feeling of foreign body sensation at 6 months after ventral repair. There were 76 patients (26.1%) reporting foreign body sensation in the HW group compared to 47 patients (15.2%) in the LW group. The difference between the two groups was statistically significant ($p = 0.001$). Also the meta-analysis done by **Zhong *et al.*** [11] including 4 studies, reported significantly lower sensation of a foreign body with a LW mesh (OR = 0.56; 95% CI = 0.40-0.78). Foreign body sensation was reported to occur in up to 44% of patients. The fibroblast ingrowth and chronic inflammatory reaction that alloplastic mesh induces result in the formation of a scar plate. It is unsurprising that a greater amount of material in a HW mesh results in a greater degree of FBR and scar formation. HW mesh also tends to shrink more than LW mesh and is stiffer, and can therefore make normal abdominal movements difficult and uncomfortable [10].

In this work, QOL values of the both groups in the 3rd postoperative month were significantly higher when compared to the baseline (preoperative values). In the LW group; the mean of the postoperative VAS values (88.15) was higher than the mean of the preoperative VAS values (63.5). The difference between the two groups was statistically significant ($p < 0.001$). While, in the HW group; the mean of the postoperative VAS values (65.2) was higher than the mean of the preoperative VAS values (58.3). The difference between the two groups was statistically significant ($p = 0.014$). Our results **coincided with** the results reported by Post et al. [12] in which, regardless of type of mesh implanted there was a significant improvement after surgery compared with preoperative scores in bodily pain (BP) ($p < 0.001$), role limitations due to physical problems (RP; $p < 0.001$), physical functioning (PF) (/XO-OOI) and social Functioning (SF) ($p = 0.005$). Also, **Smietanski *et al.*** [9] found that general health (GH) score (one item of SF-36 questionnaire) was significantly higher after 3 and 6 months in the LW group than at baseline. Although we did that comparison of QOL pre- and postoperative as did most of the authors in their studies, it is of no value because the cause hindering QOL preoperatively was much different from that developed postoperatively.

There was no hernia recurrence in both groups during the period of follow-up (6 months) in our patients. The two major meta-analysis Uzzaman *et al.* [10] and Zhong *et al.* [11] have shown recurrence rates for the LW and HW groups to be (2.9%) and (2.2%) respectively with no significant difference. They concluded that the use of LW mesh for ventral repair does not appear to be associated with an increased rate of hernia recurrence. Despite a reduced tensile strength, LW mesh can still withstand pressure above the maximum abdominal pressures and can provide the same safety and efficacy as HW meshes. In this way, the LW mesh is able to closely match the abdominal wall dynamics. **O'dwyer *et al.*** [14] was the only study to show a significantly increased rate of LW mesh recurrence versus HW mesh recurrence (5.6 % vs 0.7 %) respectively after 12 months. Most of the recurrences occurred in a single center that did not adjust their technique for surgical repair in the LW mesh.

Therefore, more standardized methods for reporting outcomes based on published recommendations would greatly help future meta-analysis of different studies.

CONCLUSION

- The lightweight mesh offers benefits over heavyweight mesh for ventral hernia repair by reducing the incidence of chronic pain and foreign body sensation. Although lightweight mesh is more expensive than heavyweight mesh, the increased costs may be offset by the cost of investigating and treating these sometimes debilitating symptoms.
- QOL values in the 3rd postoperative month were no statistically significant higher in the LW group than that of the LW group.
- QOL values of the both groups in the 3rd postoperative month were significantly higher when compared to the baseline (preoperative values).
- Foreign body sensation and seroma were significantly less frequent in the LW group than that of the HW group.
- There was no effect on postoperative analgesic and hospital stay used when comparing the LW group to the HW group.

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