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Original Article

Surgery Section

A Prospective Clinical Study of Mesh Size Required for Open Inguinal Hernia Repair

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ABSTRACT

Introduction: Inguinal hernia repair by open method is among the most frequently performed surgical procedures. The current standard surgical procedure employed is Lichtenstein's tension-free mesh repair which requires covering an area defined by anatomic landmarks like Anterior Superior Iliac Spine (ASIS), pubic tubercle, conjoint tendon etc. with a mesh. The distances among these landmarks vary depending upon stature, race and gender of the patients.

Aim: To study whether the commercially available mesh size can be reduced specifically for a subset of Indian population by estimating the actual sizes of mesh applied during inguinal hernia surgery.

Materials and Methods: In this prospective clinical study, 25 patients undergoing open inguinal mesh hernioplasty were studied at a tertiary care centre, Department of General Surgery, Rabindra Nath Tagore Medical College, Udaipur Rajasthan, India, over a period of one year from August 2019 to July 2020. During surgery the standard size commercially available mesh (15×7.5 cm^2) was trimmed down according to the dimensions and anatomical landmarks that were assessed during surgery in the usual manner. Since, it is difficult to measure size of applied mesh intraoperatively and because it is often irregular in shape, a novel method was adopted to estimate the mesh size applied. The trimmed out portions of the mesh were weighed using a high precision electronic weighing machine. The ratio of weight of trimmed out portion to total weight of the standard sized mesh was used to derive the area of the mesh applied. Statistical analysis and significance tests were performed using spreadsheet software and student's t-test, respectively.

Results: Areas of mesh actually applied in the study- mean (85.26±11.04 cm^2), mean+2SD (107.34 cm^2), most common (75-97.4 cm^2) and maximum (102.75 cm^2)- all were found to be less than the standard, commercially available size of mesh. No statistically significant difference was found between areas of mesh applied in patients with indirect and direct hernias using unpaired student t-test (p-value=0.1076).

Conclusion: Areas of mesh actually applied in present study were found to be less than the standard, commercially available size of mesh for inguinal hernia repair.

Keywords: Inguinal canal, Lichtenstein repair, Mesh hernioplasty, Mesh size estimation

INTRODUCTION

Inguinal hernia repair is one of the most common surgical procedures [1]. Approximately 75% of all abdominal wall hernias occur in the inguinal region. The dimensions of the inguinal canal vary according to race, stature and gender of the person [1]. Open tension-less mesh hernioplasty is the most commonly performed operative procedure for inguinal hernia patients. It is recommended that the mesh is required to cover upto or beyond 2 cm medial to pubic tubercle, 5-6 cm lateral to the Direct Inguinal Ring (DIR) and 3-4 cm above the Hesselbach triangle [2]. The size of the mesh is of paramount importance, as a smaller size mesh inadequately covers all the defects and potential hernia sites and, hence, results in recurrence. However, if larger mesh is used then it can lead to restriction of movements, abdominal wall stiffness and paresthesia [2]. Therefore, choice of correct size of mesh requires a correct estimation of inguinal canal dimensions in patients taking into consideration region, gender and race.

The two commercially available sizes of the mesh are used (TVM 151, Healthium Medtech Private Limited) for repair of inguinal hernia are 3×3 inches (7.5×7.5 cm) to 3×6 inches (7.5×15 cm). The current standard surgical procedure employed is Lichtenstein's tension-free mesh repair of the posterior wall inguinal canal, following which recurrences resulting in reoperation is only 25% that of non mesh repairs [3-4]. In this repair, the posterior wall is strengthened by the formation of a fibrous frame over and through the pores of the mesh [2]. Size of the mesh to be applied depends upon the area bounded by deep inguinal ring, pubic tubercle, inguinal ligament and lower border of the conjoint tendon in the inguinal canal region. The mesh must cover this area and also extend beyond it [5]. The distances among these points vary depending upon gender, race and stature of the patients. Only a few studies concerning the appropriate size of mesh covering adequate anatomic area for open inguinal hernia repair have been reported [6-8].

One of the factors affecting financial implications of undergoing inguinal hernia repair is the cost of the mesh which in turn depends upon its size. In a relatively poor population cost effectiveness of the material used is of even bigger concern. Almost invariably the commercially available mesh is tailored during inguinal hernia repair, obviously leading to substantial wastage of costly material. However on literature search no studies were found dealing with this specific aspect of inguinal hernia surgery. The size of commercially available mesh has hitherto largely been determined based on anthropometric measurements of western populations. Obviously, a serious effort to determine mesh size appropriate for Indian population is required. Present study made an attempt to achieve the same objective by studying whether the commercially available mesh size can be reduced specifically for a subset of Indian population by estimating the actual sizes of mesh applied during inguinal hernia surgery.

MATERIALS AND METHODS

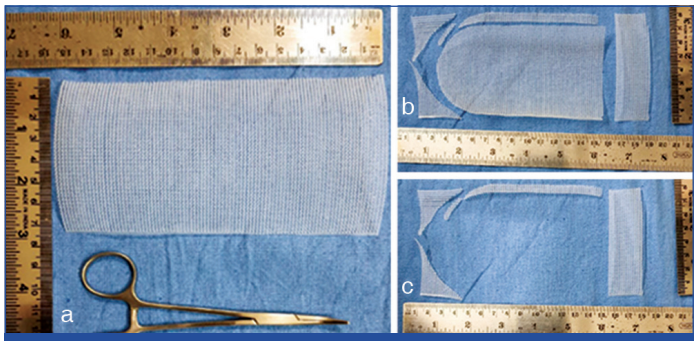
This prospective clinical study was conducted on 25 adult age group patients (15 indirect hernias, 10 direct hernias) undergoing open inguinal mesh hernioplasty in a single unit of Department of General Surgery, Rabindra Nath Tagore Medical College, Udaipur Rajasthan, India, during a one year period between August 2019 to July 2020. Appropriate Institutional Ethical Committee (IEC) approval was taken to conduct the study (IEC/2020/394). Informed consent was obtained from every patient included in the study.

All the patients undergoing open inguinal hernia repair during the study period from a single surgical unit constituted the sample population for the present study.

Inclusion criteria: Patients of either sex who were undertaken for open inguinal hernia surgery under local/regional/general anaesthesia in a single surgery unit were included in the study.

Exclusion criteria: Emergency inguinal hernia repairs e.g., obstructed or strangulated hernia, laparoscopic hernia repairs, repairs for recurrent inguinal hernia and or those following inguinal lymph node dissection were not included in the study. Patients of paediatric age group were not included in the study.

Data collection: Patients undergoing planned surgery for inguinal hernias were recruited for the study after assessing the inclusion/exclusion criteria. A detailed clinical examination was carried out for all patients and the details of the operating procedures were recorded. Standard size commercially available polypropylene mesh of the Healthium Medtech Private Limited company, TVM 151 made of 15×7.5 cm^2 size was used in all hernia repairs. Trimming and application of the mesh proceeded as usual, and all these procedures were carried out in the same surgical unit and under direct supervision of single senior surgeon. The trimmed out portions of the mesh were collected and preserved [Table/Fig-1].



[Table/Fig-1]: Standard trimming of mesh prior to fixation; a) Commercially available 15×7.5 cm^2 polypropylene mesh prior to trimming; b) Manner of trimming usually employed. It also illustrates re-trimming often required; c) Trimmed out portions of the mesh which were preserved and later weighed to derive area of the mesh applied, as described in the text.

Mesh Size

Mesh used in the study was of the same company (Healthium Medtech Private Limited), make and size. The standard size commercially available mesh (15×7.5 cm^2) was trimmed down according to the dimensions and anatomical landmarks assessed during surgery in the usual manner. The mesh is often also re-trimmed after taking a few fixation sutures. In order to account for curved, uneven and often multiple trimmings of the mesh which made a direct intraoperative measurement of mesh area impossible, the trimmed out portions of the mesh were preserved. Since, these portions were also curved, uneven and irregular, a novel method was adopted to estimate the mesh size applied. The trimmed out portions of the mesh were weighed using a high precision electronic weighing machine. This weight (w_1) was subtracted from total weight of a standard commercially available mesh (w) to arrive at the weight of mesh applied (w_2) [i.e., $w_2=w-w_1$]. Since, a uniform distribution of weight can be presumed over the whole area of the mesh, the ratio of weight of the mesh applied and weight of the whole mesh ($R=[w_2/w]$) can reasonably be expected to reflect the ratio of area of applied mesh (A_1) and its total area (A). Thus, the following equations were used-

Weight of mesh applied (w_2) [i.e., $w_2=w-w1$]

Weight of applied mesh (w_2)/Total weight of standard mesh (w)=Area of mesh applied (A_1)/Area of standard mesh (A)=R

i.e., Area of mesh applied (A_1)=Area of standard mesh (A)×R=(15×7.5)×R

The weight of the standard mesh was 1500 mg which was cross checked by weighing whole meshes at different times. After calculating mean and Standard Deviation (SD), maximum area of mesh required in the study population (mean+2SD) was determined.

STATISTICAL ANALYSIS

Standard Spreadsheet software (iOS, numbers) was used for analysis of the data. Statistical significance was evaluated using student's unpaired t-test and $p<0.05$ was considered to be significant.

RESULTS

A total of 25 patients undergoing open inguinal hernioplasty were included in the study. Mean age was 52.24±14.31 years (range-19-68 years), most of the patients 12 (48%) were from the age group of 60-69 years followed by 40-49 year and 50-59 year age groups (four patients each), 30-39 year age group (three patients), 10-19 year and 20-29 year age groups (one patient each). All the patients were male. Out of the 25 patients included in the study, 15 patients had indirect hernias while 10 patients had direct hernias. Majority 13 (52%) of patients had risk factors like chronic cough 5 (20%), prostatomegaly 5 (20%), weight lifting 4 (16%) and constipation 1 (4%). Three patients had more than one risk factors. Rest of the patients did not have any risk factors.

Mesh Size

In present study mean weight of the mesh was 1137±147 mg corresponding to an area of 85.26±11.04 cm^2. Minimum and maximum weights of mesh used were 570 mg and 1370 mg respectively which corresponded to 42.75 cm^2 and 102.75 cm^2 [Table/Fig-2]. Area of the standard commercially available mesh was 112.5 cm^2.

Patient serial no.	Weight of applied mesh (mg)	Calculated corresponding area of applied mesh (cm^2)
1	1120	84.00
2	1370	102.75
3	1230	92.25
4	1170	87.75
5	1080	81.00
6	1110	83.25
7	1250	93.75
8	1290	96.75
9	1120	84.00
10	570	42.75
11	1120	84.00
12	1260	94.50
13	1100	82.50
14	1160	87.00
15	1040	85.50
16	990	74.25
17	1170	87.75
18	1090	81.75
19	1060	79.50
20	1080	81.00
21	1090	81.75
22	1100	82.50
23	1230	92.25
24	1270	95.25
25	1250	93.75

[Table/Fig-2]: Weight and corresponding area of the mesh applied in each patient.

In an overwhelming majority of patients 22 (88%) weight of mesh applied was in the range of 1000-1299 mg which corresponded to an area range of 75-97.4 cm^2. In only one patient the weight and area of mesh (1370 mg, 102.75 cm^2) exceeded this range. Rest of the two patients had meshes applied with less weight and hence lesser areas [Table/Fig-3].

Maximum area of mesh applied were 102.75 cm^2 among patients with direct hernias while among patients with indirect hernias these statistics was 96.75 cm^2 [Table/Fig-4]. Mean+2SD weight of mesh applied among direct hernias was 1447 mg (1096+351 mg) which corresponded to 108.98 cm^2 (82.70+26.28 cm^2). These figures for indirect hernias were 1332 mg (1188+144 mg) and 99.91 cm^2

(89.10+10.81 cm^2) respectively. No statistically significant difference was found between areas of meshes applied in patients with indirect and direct hernias using unpaired student t-test (p-value=0.1076).

S. No.	Weight of mesh applied (mg)	Calculated corresponding area of mesh applied (cm^2)	Total no. (n=25)
1	400-699	30.0-52.4	1 (4%)
2	700-999	52.5-74.9	1 (4%)
3	1000-1299	75.0-97.4	22 (88%)
4	1300-1599	97.5-119.9	1 (4%)

[Table/Fig-3]: Categorised weights and corresponding areas of mesh applied.

Patient serial no.	Area of mesh in direct hernia (cm^2)	Patient serial no.	Area of mesh in indirect hernia (cm^2)
1	84.00	3	92.25
2	102.75	5	81.00
4	87.75	7	93.75
6	83.25	8	96.75
10	42.75	9	84.00
11	84.00	14	87.00
12	94.50	17	87.75
13	82.50	22	82.50
15	85.50	23	92.25
16	74.25	25	93.75
18	81.75		
19	79.50		
20	81.00		
21	81.75		
24	95.25		

[Table/Fig-4]: Comparison of mesh areas applied in patients with direct and indirect hernias.

DISCUSSION

Inguinal hernioplasty is one of the most commonly performed elective surgery in the general surgery operating room. Since, most of morphometric studies are essentially cadaveric studies, only a few studies assessing the inguinal hernia patients to determine the mesh size are available in the literature [7-9].

In a study conducted by Rabe R et al., after considering the morphometric assessment of the inguinal canal anatomy, the ideal mesh size for the population was 9×15 cm^2 (135 cm^2) to cover all the potential sites of recurrence using European Hernia Society guidelines [8]. In another study conducted by Fitzgibbons RJ Jr et al., the optimal mesh size for the majority of patients was determined to be 8.5×14.0 cm^2 (119 cm^2) measuring dimensions of inguinal floor undergoing herniorrhaphy. These areas were larger than area of commercially available mesh for inguinal hernia repair (112.5 cm^2) [9]. However, in present study, maximum expected area of mesh applied was 107.34 cm^2 (mean+2SD) during open inguinal hernia surgery, regardless of whether the hernia was indirect or direct. It is therefore reasonable to accept that mesh area required for Lichtenstein repair in some populations may be different from mesh area deemed to be required based on other population data.

Thus, areas of mesh actually applied in present study- mean (85.26±11.04 cm^2), mean+2SD (107.34 cm^2), most common (75-97.4 cm^2) and maximum (102.75 cm^2) all were found to be less than the standard, commercially available size of mesh. Hence, a serious effort must be made to reduce the commercial mesh size for Indian population which will naturally translate into better utilisation of resources and increase affordability. Another suggestion to emerge from this study is that since medial side of the mesh is invariably trimmed in a curved manner, the mesh could be designed in that shape, so that this this wastage is also minimised. On a practical note, it can be recommended that commercially available mesh sizes for inguinal hernia repair should be available in more than two (15×15 cm and 15×7.5 cm) sizes currently available.

Limitation(s)

Present study has addressed the size of the mesh only and authors have not studied its exact financial impact. However, it is intuitive that reduction of mesh size would have financial benefits too.

CONCLUSION(S)

Areas of mesh actually applied in present study were found to be less than the standard, commercially available size of mesh for inguinal hernia repair. Hence, a serious effort must be made to reduce their size or make available more than just two standard sizes and also possibly to redesign them in order to ensure better utilisation of resources.

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