



Effect of Incisional Hernia Repair Technique on Subsequent Recurrent Herniation: A Retrospective Study

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Abstract

Purpose: This study aimed to evaluate the association between the method employed for Incisional Hernia (IH) repair and subsequent recurrence.

Methods: The study cohort consisted of 324 consecutive patients who underwent IH repair from January 2004 to December 2014 at a single institution. We retrospectively analyzed pre- and perioperative data collated from all patients' medical records. Totally, 44 (13.6%), 57 (17.6%), and 223 (68.8%) patients were classified into the simple suturing, partial mesh, and full mesh groups, respectively. The mean follow-up period was 39.4 (range, 0 to 259) months.

Results: The overall incidence of recurrent incisional hernia was 9.9% (32/324). The two-year cumulative recurrent rates for simple suturing, partial mesh, and full mesh groups were 23%, 14%, and 6%, respectively. This study revealed that mesh application in incisional hernia repair surgery resulted in significantly lower cumulative recurrence rates than that observed with simple suturing. Mesh was applied either only on the hernial site (partial coverage) or overall the previously incised fascia (complete coverage). However, the recurrence rate did not differ significantly between patients who had received partial and total mesh coverage (log rank $p=0.096$). Factors such as age, sex, obesity, and number of previous abdominal surgeries did not influence incisional hernia recurrence. Adjusted analysis showed that mesh application was the only significant factor associated with IH recurrence. (Mesh, $p<0.0001$, full mesh group vs. simple suturing group, Exp(B) 2.418, 95% CI 1.397 to 4.182, $p=0.002$; full mesh group vs. partial mesh group, Exp(B) 0.970, 95% CI 0.529 to 1.776, $p=0.921$).

Conclusion: This study demonstrates that mesh reinforcement during IH repair is an important technique for preventing recurrence. Future studies are indicated to determine the exact extent of mesh application in individual patients to prevent further complications.

Keywords: Incisional hernia; Recurrence; Mesh

Introduction

Incisional Hernia (IH) is known to occur after abdominal surgery in 2% to 20% of patients and commonly requires surgical repair [1-3]. Standard techniques for IH repair include primary suturing and mesh reinforcement [4]. While mesh repair lowers the chances of IH recurrence, it is associated with postoperative complications. There is a risk of mesh infections, which exposes affected patients to a greater risk of developing overlying skin infection and associated serious complications, such as non-healing wounds and chronic pain [5].

The size of the mesh used for hernia repair may be associated with the occurrence of mesh-related adverse effects. Thus, using an appropriately sized mesh may prevent postoperative complications [6]. Since inappropriate mesh application is a risk factor for IH recurrence, the general recommendation is to overlap minimum 4 cm to 5 cm of the hernia site with the mesh. However, since most recurrent hernias occur through healed fascia, *via* the initial surgical incision, a clear consensus on the extent of mesh application over previously incised fascia during IH repair remains to be established.

Therefore, in this study, we primarily aimed to reinvestigate the recurrence rates of IH in patients who underwent repair procedures either with, or without mesh application. We further aimed to analyze the IH recurrence rate in relation to the extent of mesh-application (partial/complete), to

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determine a suitable area of coverage during hernioplasty.

Methods

Study design

In this retrospective study, data of patients who underwent incisional hernia repair at Seoul National University Hospital from January 2004 to December 2014 were prospectively collected for analysis. Patients with a surgical history of IH were excluded from the study. We also gathered follow-up data of patients who experienced recurrent symptoms of herniation after the IH-repair procedure, of those who had been found to have IH on abdominal imaging, and of those who had undergone re-operation for IH. The latest follow-up was performed until December 2016. This study was approved by Institutional review board of Seoul National University Hospital (number 1701-056-822).

Incisional hernia repair technique

The same IH-repair procedure was performed for all study patients, as described. After reduction of the herniated tissue, the overlying fascia was continuously sutured with 1-0 PDS (polydioxanone) sutures and was reinforced using simple, 1-0 Vicryl (polyglycolic acid) sutures. We applied 3 cm to 5 cm of standard polypropylene mesh using an on lay, overlapping method, to further reinforce the hernial repair. A surgical drain (Hemovac) was placed, and the overlying skin incision was closed using simple, 2-0 nylon sutures.

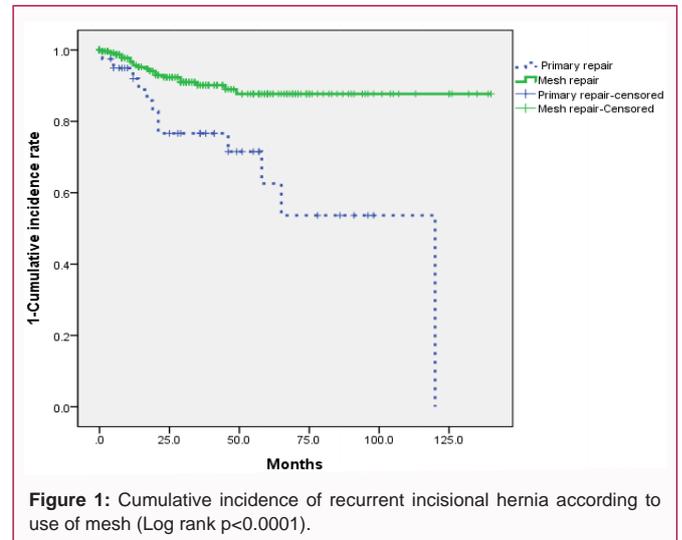
Study groups

In this study, the simple suturing and partial mesh groups refer to those patients who underwent hernial repair with primary suturing of fascia without mesh placement, and primary suturing of the site of incisional herniation with overlapping partial mesh reinforcement limited to hernia site, respectively. The patients who underwent mesh-repair with primary suturing of the IH along with exposure of the whole previous incised fascia followed by overlapping mesh implantation over the exposed fascia were sorted into the full mesh group.

Outcome measures

The primary outcome measure of this study was the recurrence rate of IH in relation to both the presence and extent (partial/complete) of mesh application. Baseline clinical data along with perioperative and postoperative characteristics of patients from the pre-defined groups were compared and analyzed based on the type of hernia repair technique employed. We analyzed baseline clinical data including age, sex, BMI (Body Mass Index), history of smoking, medical history (of diabetes and hypertension), concomitant chemotherapy details, detail of primary surgery, number of previous abdominal operations, and location of the incision. Further, we evaluated perioperative data including levels of preoperative blood Hemoglobin (Hb), albumin, Creatinine (Cr), Prothrombin Time, and International Normalized Ratio (PT/INR) as well as the surgical method, and the absence, and extent of mesh usage (if applied). Postoperative side effects included data of complications occurring until 30 days after the IH-repair operation and included cases with recurrence.

IH was considered to have recurred if i) Fascia defect was identified on physical examination, ii) recurrence was identified on postoperative abdominal Computed Tomography (CT), or iii) the study patients' medical records included history of reoperation for IH repair. Each case of recurrence with the date closest to the IH repair



operation was identified. The recurrence classified after 30 days from IH repair operation.

Statistical analysis

An independent sample t-test was used for the analysis of continuous variables, and Chi-square test was applied for all categorical variables. A life table and Kaplan-Meier analysis were used to estimate the cumulative survival rate. A Cox-regression model (reference: $p \leq 0.250$) was used to perform adjusted multivariate analysis. All analyses were carried out using the SPSS software version 21.0 (SPSS Inc., Chicago, IL).

Results

Totally, 324 patients, including 105 men and 219 women, underwent incisional hernia repair at the study center from January 2004 to December 2014. The total average duration of follow-up was 39.4 (range: 0 to 259) months. Of all study patients, 205 (63.3%) and 119 (36.7%) had undergone 1 and ≥ 2 abdominal operations, respectively, in the past. Totally, 44 (13.6%) and 57 (17.6%) patients were classified into the simple suturing repair and the partial mesh repair groups, respectively. The remaining 223 (68.8%) patients constituted the full mesh repair group. The IH recurred in 32 (9.9%) of the 324 operated patients (Table 1).

With the exception of blood Hb levels (simple suturing vs. partial mesh vs. full mesh group; 11.5 ± 3.7 vs. 12.7 ± 2.6 vs. 12.7 ± 2.1 g/dl, $p=0.015$) nutritional and functional laboratory test parameters including albumin, Cr, and liver function test results did not differ between the three groups, i.e. based on the surgical method employed for IH repair (Table 2).

Death after IH repair was observed only in one patient (2.3%) from the simple suturing group, due to postoperative pneumonia. There were no significant differences in overall morbidity between the three groups ($p=0.65$) (Table 3).

Two-year cumulative recurrent incisional hernia rates in the simple suturing, partial mesh, and full mesh repair groups were 23%, 14%, and 6%, respectively (Table 4). A comparative analysis revealed that the recurrence rate of IH was lower in the mesh-repair group as compared to those who underwent the simple suture repair procedure (Figure 1, log $p < 0.0001$), though this difference was not statistically significant. The partial-mesh and the full-mesh groups were also not

Table 1: Baseline characteristics of entire patients.

Factors	Total number: 324 patients (percent)
Male	105 (32.4)
Age ≥ 65	177 (54.6)
BMI ≥ 25	159 (49.2)
Smoking	20 (6.2)
Diabetes mellitus	64 (19.8)
Hypertension	155 (47.8)
Chemotherapy	64 (19.8)
Previous type of operation	
Small bowel and colon	140 (43.2)
Hepatobiliary and stomach	31(9.6)
Gynecology	50(15.4)
Urology	25 (7.7)
Aortic aneurysm	26 (8.0)
Heart surgery	33 (10.2)
Rectus abdominis flap	10 (3.1)
Others*	9 (2.8)
Previous type of operation	
Midline	168 (51.9)
Paramedian	55 (17.0)
Laparoscopy	23 (7.1)
Fannenstiel	57 (17.6)
Others	21 (6.5)
Number of operation	
Single	205 (63.3)
Multiple	119 (36.7)
Type of incisional hernia repair	
Simple suturing	44 (13.6)
Partial mesh	57 (17.6)
Full mesh	223 (68.8)
Recurrence	32 (9.9)

Others*: Spine surgery, Chondrosarcoma surgery

found to significantly differ in this regard (Figure 2).

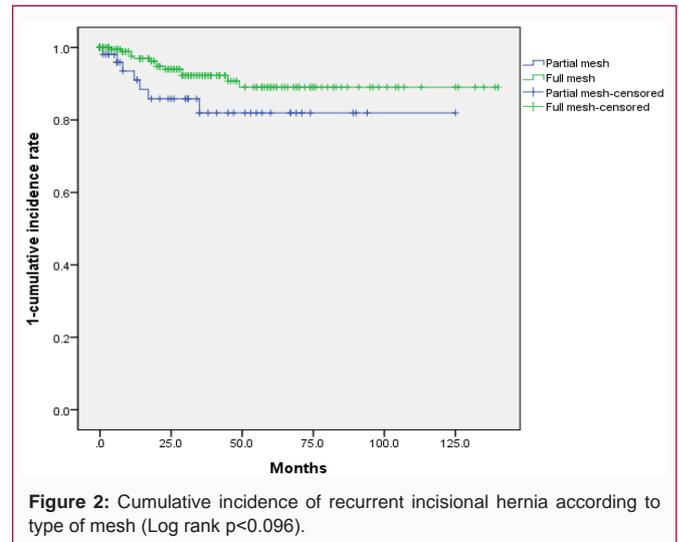
After controlling for risk factors (sex, smoking, SSI), mesh application was still found to affect IH recurrence. However, the extent of mesh application (partial/complete coverage) was not found to be significantly related to IH recurrence (Table 4 and 5).

Discussion

Abdominal herniation is one of the serious adverse effects of

Table 2: Nutritional status according to type of incisional hernia repair.

Factors	Simple suturing	Partial mesh group	Full mesh group	p-value
Hemoglobin (g/dl)	11.5 ± 3.7	12.7 ± 2.6	12.7 ± 2.1	0.015
Albumin (g/dl)	3.8 ± 0.6	4.1 ± 0.4	3.9 ± 0.5	0.271
Creatinine (mg/dl)	1.0 ± 0.6	1.0 ± 1.0	1.0 ± 0.5	0.404
Total bilirubin (g/dl)	0.8 ± 0.4	0.9 ± 0.4	0.8 ± 0.5	0.838
AST (IU/L)	22.9 ± 9.4	27.1 ± 20.4	26.3 ± 16.3	0.352
ALT (IU/L)	20.3 ± 12.9	29.7 ± 29.4	24.1 ± 19.2	0.804
PT (INR)	1.1 ± 0.2	1.1 ± 0.3	1.1 ± 0.2	0.176



abdominal surgical procedures, and may lead to life-threatening complications. It therefore requires immediate surgical management. While a repair procedure involving mesh-application is known to decrease the recurrence rate, the standard area of coverage of the hernia site, is not properly defined. Therefore, we aimed to determine an appropriate area of mesh-coverage during hernioplasty for IH, by investigating the association between mesh-application techniques used for hernia repair and recurrent herniation.

Data analysis showed that the recurrence rate of IH was 9.9%, with the 2-year cumulative incidence rate for all patients being 10%. All IH repair operations analyzed in the current study utilized either the simple suturing or the on lay open mesh repair technique. Recent reports show IH-recurrence rate of 9.9% after application of the mesh repair procedure, while a 12.7% recurrence rate was reported in large scale cohort studies [7,8]. The recurrence rates in the current study matched the reported rates, thus confirming that appropriate surgical technique had been employed for IH repair in the study patients.

Two-year cumulative incidence rates of recurrent IH were 23%, 14%, and 6% for the simple suturing, partial mesh, and full mesh groups, respectively. The difference in cumulative recurrence rates between the simple suturing and the mesh repair groups was statistically significant (log rank p<0.001). Mesh reinforcement technique is the standard surgical method for IH repair, as per different guidelines recommended worldwide [9,10]. The findings of the current study also illustrated that mesh application was associated with a lower rate of recurrence, indicating that mesh repair should be standardized for IH repair procedures, except in special situations wherein hernia repair with simple sutures are considered mandatory (surgical site infection, entero-cutaneous fistula, bowel contents

Table 3: Morbidity after surgery for incisional hernia according to type of incisional hernia repair.

Factors	Simple suturing	Partial mesh group	Full mesh group	p-value
Morbidity	3 (7.0)	5 (8.8)	25 (11.2)	0.65
Ileus	2 (4.7)	0	5 (2.2)	
Medical problem	1 (2.3)	2 (3.5)	2 (0.9)	
Surgical site infection	0	4 (7.0)	21 (9.4)	
Intestinal perforation	0	0	2 (0.9)	
Entero-cutaneous fistula	0	0	1 (0.4)	
Flap infection	0	1 (1.8)	10 (4.5)	
Hematoma	0	2 (3.5)	3 (1.3)	
Others*	0	1 (1.8)	5 (2.2)	

*Wound seroma, intra-abdominal fluid collection

Table 4: Cumulative incidence of recurrent incisional hernia after incisional hernia repair.

Factors	Recurrent incisional hernia incidence rate (% (s.e))							
	Recur	6 mo.	12 mo.	18 mo.	24 mo.	36 mo.	48 mo.	60 mo.
Simple suturing	12 (27.3)	5%	8%	14%	23%	23%	28%	37%
Partial mesh	7 (12.3)	4%	9%	14%	14%	18%	18%	18%
Full mesh	13 (5.8)	1%	3%	4%	6%	8%	9%	11%

Table 5: Uni-variable analysis for type of incisional hernia repair.

Factors	Multivariate		
	Exp(B)	95% CI	P-value
Mesh			0.001
Partial mesh	1.02	0.285-1.784	0.944
Simple suturing	2.077	1.278-3.378	0.003
Age ≥ 65	0.809	0.404-1.620	0.549
Sex	0.616	0.276-1.375	0.237
BMI ≥ 25	1.029	0.514-2.061	0.936
Smoking	2.097	0.731-6.015	0.168
Diabetes mellitus	0.552	0.193-1.578	0.267
Chemotherapy	0.623	0.239-1.622	0.332
Previous type of operation	1.033	0.898-1.189	0.645
Previous incision at abdomen	1.076	0.837-1.383	0.568
Number of operation	1.292	0.642-2.599	0.472
Surgical site infection	2.044	0.715-5.845	0.182

Table 6: Adjusted multi-variable analysis for type of incisional hernia repair.

Factors	Multivariate		
	Exp(B)	95% CI	P-value
Mesh			0.001
Partial mesh	0.976	0.539-1.768	0.936
Simple suturing	2.229	1.328-3.742	0.002
Sex	0.467	0.185-1.175	0.106
Smoking	3.223	0.968-10.730	0.057
Surgical site infection	2.391	0.782-7.311	0.123

leakage during operation and etc).

There are no clear guidelines defining the extent of mesh coverage for IH repair. Our findings showed that the recurrence rate did not differ significantly between patients who had been offered partial and total mesh coverage during IH repair (log rank p=0.096). This showed

a lack of association between hernia recurrence and mesh coverage area. The results remained the same after controlling for known factors. However, the cumulative incidence rates of the partial and total mesh application groups were 6% and 14%, respectively. This difference could be attributed to application of a complete mesh in patients presenting with larger IHs, a factor that may be responsible for the higher recurrence rate. Furthermore, the smaller sample size of the partial mesh repair group may have lowered the statistical power of the comparative analysis, which is another flaw in the current study. Therefore, larger scale studies are indicated in the future to confirm these findings.

The size of the mesh applied during IH repair, is known to have a positive association with the occurrence of postoperative complications [8]. Application of a portion of mesh that sufficiently overlaps 4 cm to 5 cm of a normal sized hernia is generally recommended [11]. Thus, a bigger mesh size is used to provide coverage for larger IHs, leading to higher risk of adverse postoperative sequelae [5,12]. In this study, the occurrence of side effects did not differ significantly between the three treatment groups. However, surgical wound infection, an important mesh-related postoperative complication, occurred in 10 patients from the full mesh group. This finding indicates that due caution must be exercised during mesh application, especially during that of a large-sized mesh for coverage of larger IHs.

This study has certain limitations. Firstly, the retrospective study design did not allow us to identify the natural course of IHs in affected patients. We were only able to review medical records and include patients diagnosed with IH recurrence (on imaging or follow-up clinical examinations) and those who had undergone reoperation. However, the most important aspect of this study was finding cases of reoperation due to IH recurrence, with which we were able to calculate the cumulative incidence rate, through application of data analysis and statistical techniques. Lack of information in patients' medical records regarding an important risk factor, i.e., the size of the mesh applied during IH repair, limited our ability to fully understand the relationship between mesh size and hernia recurrence. Moreover, patients with relatively larger IH could have been categorized into the

full mesh group, thus reducing the difference in group sizes. Lastly, while a standard operative technique was used for IH repair, most procedures were performed by a single surgeon and therefore, the data does not reflect outcomes that may have been achieved with participation of different surgeons across various centers.

In conclusion, we suggest that mesh should be applied during IH repair to lower the risk of recurrence. Currently, it is unclear whether reinforcing the complete incision of the previous operation with mesh during the IH repair surgery, will help prevent recurrence. Full mesh coverage may also increase the risk of wound infections and other postoperative complications. Therefore, there is a need to exercise caution regarding the size of mesh applied during IH repair.

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