



ORIGINAL ARTICLE

# Effects of suture technique on mesh shrinkage

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## KEYWORDS

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**Summary Objective:** Polypropylene meshes are one of the most frequently used patches in inguinal hernia repairs. This material was proved to be not completely inert, and may cause inflammatory responses like foreign body reactions. One of the physical results of these inflammatory reactions against the mesh is mesh shrinkage which is responsible for recurrence and pain. In this study, we aimed to investigate the effects of the suture technique on mesh shrinkage.

**Methods:** 36 animals were used for the study. Subjects were divided into 3 groups. In the first group the mesh (onlay) was not fixated by any means. In the second group, mesh was placed on the abdomen wall, after which the mesh was fixated with interrupted suturing. In the third group, continuous suturing was applied after the placement of the mesh. Mesh shrinkage was measured macroscopically, and the mesh site reaction was evaluated microscopically. At the end of the second month, 18 subjects were sacrificed again to conduct the same procedure.

**Results and Conclusion:** When meshes are used for hernia repairs, shrinkage may be observed in meshes placed on fascia. In the first group without mesh fixation, mesh shrinkage was more significant in the second month compared to the first month. The amount of shrinkage of without fixation group was found to significantly differ during the second month from interrupted and continuous suture groups. Even though statistically not significant, fixation of the mesh with interrupted sutures seems to be more advantageous compared to fixation with continuous sutures.

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## 1. Introductions

Hernia repair is one of the most frequently conducted general surgeries. After Bassini and Shouldice described repair methods using the person's own tissues, Lichtenstein popularized the "tensionless hernia repair" procedure that makes use of the graft.<sup>1,2</sup> Especially during the last 2 or 3 decades, meshes have become more prevalent in hernia repairs.<sup>3,4,5</sup> Recurrence is reported as 2–33% in patients for whom mesh was not used.<sup>3,5</sup> In a randomized prospective study conducted in Netherlands with 300 patients, 3-years recurrence rate for repairs was 1% when mesh was used and 7% when it was not.<sup>5</sup> Polypropylene meshes are one of the most frequently used patches in inguinal hernia repairs.<sup>6</sup> These meshes were introduced in 1958 by Usher and colleagues to be used in incisional hernia repairs.<sup>7</sup> This material was proved to be not completely inert. Polypropylene mesh may cause inflammatory responses like foreign body reactions, depending on the amount of the material and nature of the mesh.<sup>6,8,9</sup> One of the physical results of these inflammatory reactions against the mesh is mesh shrinkage which causes recurrence and pain.<sup>6,10,11</sup> Shrinkage of the mesh over time is held responsible for the rare but possible long-term recurrences in inguinal hernia reparations using meshes. The shrinking patch fails to cover the defect area entirely, causing recurrences. Meshes can be fixated to the tissue in various ways including interrupted and continuous sutures. We have conducted an experimental study to evaluate the effects of suture use and suture technique (interrupted vs. continuous) on mesh shrinkage.

## 2. Methods

The study was conducted with the approval of the Istanbul University Ethical Board for Animal Experiments, issue number 2014/89, in the animal laboratory of the Istanbul University experimental medicine research center. 36 Wistar Albino rats weighing 200–250 g were used. Animals were kept in individual cages after the operation. Subjects were divided into three groups. Following the ketamine anesthetization, the skin was lifted with midline incision, and a 2 × 3 cm polypropylene mesh (PROLENE®Ethicon Johnson&Johnson family companies) was placed on the abdomen wall. In the first group (12 subjects), after the 2 × 3 cm meshes were placed on the abdomen wall, they were not fixated by any means (Figure 1), and the skins were closed using 3/0 silk sutures. In the second group (12 subjects), again the 2 × 3 cm meshes were placed on the abdomen wall, after which the meshes were fixated with interrupted (3 on the 2-cm side, and 4 on the 3-cm side) suturing using 3/0 polypropylene sutures (PROLENE®Ethicon Johnson&Johnson family companies). 4 knots were used in each interrupted suture. In continuous sutures, (Figure 2) 4 knots were used at the beginning and the end. Skins were closed with 3/0 silk sutures using continuous suturing. In the third group (12 subjects), after the placement of the 2 × 3 cm meshes, continuous suturing (3 on the 2-cm side, and 4 on the 3-cm side) using 3/0 polypropylene sutures was applied, and the skins were closed with 3/0 continuous silk sutures. All subjects received 50 mg/kg single-dose cefazolin sodium IM injection. Water

and food intake (ad libitum) were allowed 6 h after the operation. From each group, 6 subjects were sacrificed at the end of the first month and the mesh was completely removed together with the abdomen wall underneath. They were measured millimetrically together with the tissue under the mesh, and were placed in formole in order to evaluate the histopathological prosthesis host reaction (Figures 3 and 4). At the end of the second month, the remaining 6 subjects from each group were sacrificed to conduct the same procedure.

### 2.1. Statistical analyses of the results

The data were provided as median, minimum and maximum. Changes between 1st and 2nd months within groups themselves were analysed with Mann Whitney U test. Values of the 3 groups based on months were compared with Kruskal Wallis one way analysis of variance. Multiple comparisons (post hoc) were done with Dunn test. Limit of significance was set as  $p < 0.05$  and two way. Analysis were made by using NCSS 10 (2015. Kaysville, Utah, USA) software.

## 3. Results

There were not any intraoperative complications. After the meshes were removed together with the abdomen wall, they were measured using a millimetrical paper. The resulting value was extracted from the originally placed mesh surface to determine the amount of shrinkage. This procedure was conducted at the end of the both first and second month. On Table 1, mesh shrinkage values for all groups are presented in  $\text{cm}^2$  see (Figs. 1–3).

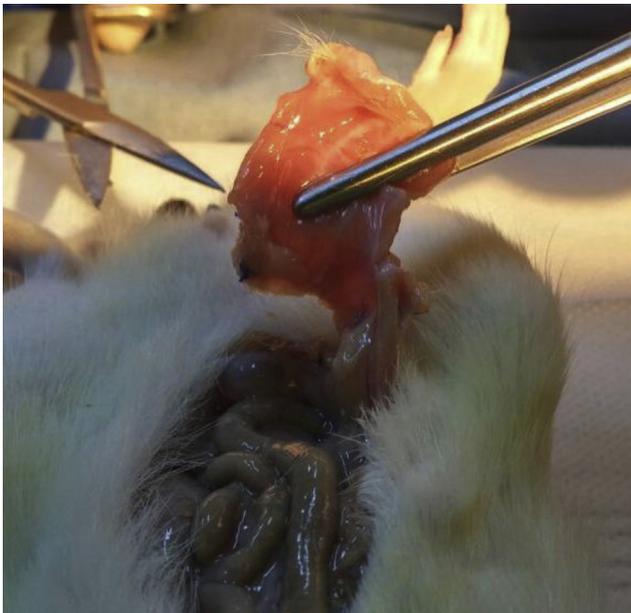
In comparison of the mesh shrinkage values on the 1st and 2nd months, only group 1 had a difference. There was no difference between the mesh shrinkage values of the groups in the 1st month. At the second month, group 1 was different from group 2 ( $Z = 2.68$ ;  $p < 0.05$ ) and group 1 was different from group 3 ( $Z = 3.0$ ;  $p < 0.05$ ). The mesh shrinkage value of group 1 was higher than both groups 2 and 3. However, the difference between group 2 and group 3 was not statistically significant ( $Z = 0.32$ ;  $p > 0.05$ ). Even though the difference was not significant, group 3 seemed to be slightly more advantageous compared to group 2 continuous suture.

**Table 1** Amount of shrinkage in all groups provided in  $\text{cm}^2$ .

	1st month	2nd month	$P^a$
Group1, median (range)	1.63 (1.29–1.83)	2.96 (2.63–3.54) <sup>#</sup>	<b>0.004</b>
Group2, median (range)	1.40 (1.12–2.90)	1.73 (1.02–2.37)	0.63
Group3, median (range)	0.78 (0.30–2.70)	1.40 (1.16–2.64)	0.34
$p^b$	0.39	<b>0.004</b>	

<sup>a</sup> Mann Whitney U.

<sup>b</sup> Kruskal Wallis one way ANOVA # $p < 0.05$  compared with group2 and group3 (Dunn test).



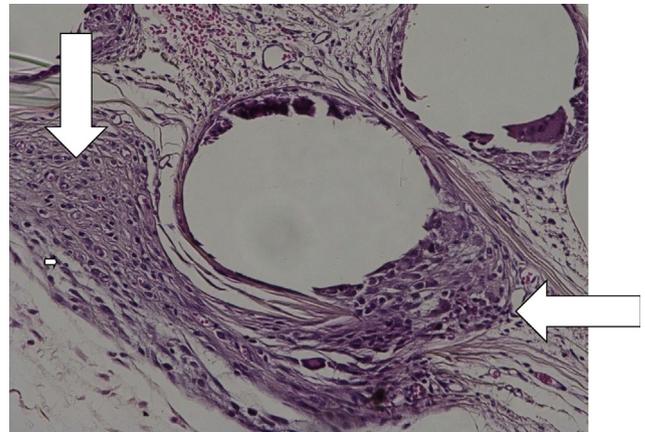
**Figure 1** Sample collection for non-suture mesh.

In the microscopic evaluation, all meshes were observed to stick to the host tissue with dense scar tissue. Compared to the 1st month group, those sacrificed at the 2nd month, and especially the non-suture group showed more inflammatory reactions and myofibroblastic activity (Figures 3 and 4).

Polymorphonuclear leucocyte infiltration and a large inflammatory reaction accompanied by foreign body reaction with giant cells were especially significant in the non-suture group.



**Figure 2** Example of a continuously sutured mesh.



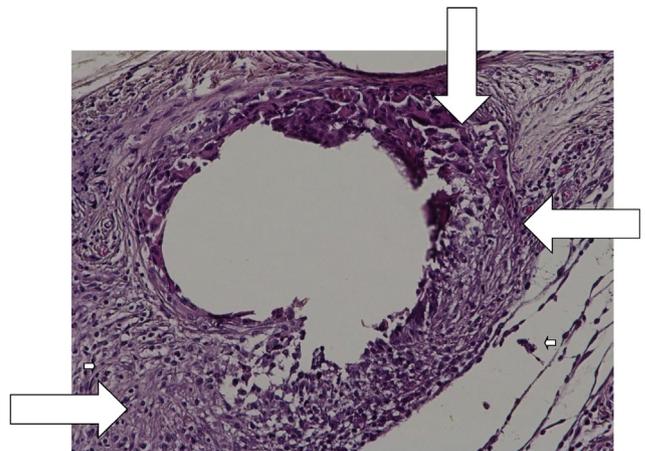
**Figure 3** Weak fibroblastic activity and inflammation (Interrupted suture group).

#### 4. Discussion

Polypropylene meshes are the most frequently used prosthetic materials for inguinal hernia repairs. Polypropylene meshes were initially used for incisional hernia repairs.<sup>6,12</sup> These meshes were first used on 1958 by Usher and colleagues, and were later popularized by Lichtenstein, becoming the standard method in inguinal hernias.<sup>2,6,7</sup> In spite of the mesh usage, some studies continue to report hernia recurrence up to 1%.<sup>5</sup> In addition to the patient-related factors (e.g. collagen synthesis defect, chronic obstructive pulmonary disease, age), shrinkage of the inserted patch is also held responsible for these recurrences.

Studies investigating effects of fixing the meshes used for hernia repairs or whether this fixation procedure is achieved through interrupted or continuous sutures on mesh shrinkage, and therefore recurrence and resulting pain, are still limited.

Recurrence and pain after hernia repairs using meshes are results of mesh shrinkage due to inflammatory responses observed as foreign body reactions.



**Figure 4** Significant fibroblastic activity in the non-suture mesh group.

It is well known that inflammatory reactions also vary between different polypropylene meshes and also between individuals.<sup>6,13,14</sup> In a study comparing shrinking of PP meshes with or without fixation after 90 days, the fixation group shrank less and retained their original shapes.<sup>15</sup> Mesh contraction also has been observed after the use of other types of materials such as expanded polytetrafluorethylene, polyester, and polyethylene terephthalate.<sup>16–18</sup>

In our study, we investigated the mesh shrinkage and tissue reactions against the mesh, both without fixing the meshes we placed on the abdominal wall, and by using continuous and interrupted sutures for fixation. Similar to the literature, we observed significantly more mesh shrinkage at the end of the 2nd month in the non-fixation group, compared to other groups. Histopathologically as well, the group with no suture fixation showed more inflammatory reactions and fibroblastic activities. In the continuous suture group, even though statistically insignificant, there were more shrinkage compared to the interrupted suture group. One possible reason for this may be the ischemia formed on the sides.

Scar healing in bowel anastomoses is a well-researched subject, and continuous sutures are known to cause more ischemia and inflammation on scar sides, as compared to interrupted sutures. Furthermore, anastomotic structure and fibrosis are observed more frequently in early phases of bowel anastomoses.<sup>19,20</sup> In a similar effect, excess of ischemia and inflammation in mesh fixations through continuous sutures may increase shrinkage.

## 5. Conclusion

Currently, meshes are prevalently used in hernia repairs. When meshes are used for hernia repairs, shrinkage may be observed in meshes placed on fascia. Since it may result in pain and recurrence, mesh fixation is required to decrease its occurrence. Although chronic pain does not occur in every mesh shrinkage, mesh shrinkage is stated as one the reasons for chronic pain in the literature. Ischemia theory was studied in intestinal anastomosis and more ischemia was observed in continuous sutures. Adjusting the tightness can reduce ischemia. At least, this should be considered when the mesh is sutured continuously. Even though statistically not significant, fixation of the mesh with interrupted sutures seems to be more advantageous compared to fixation with continuous sutures.

## Conflict of interest

None.

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